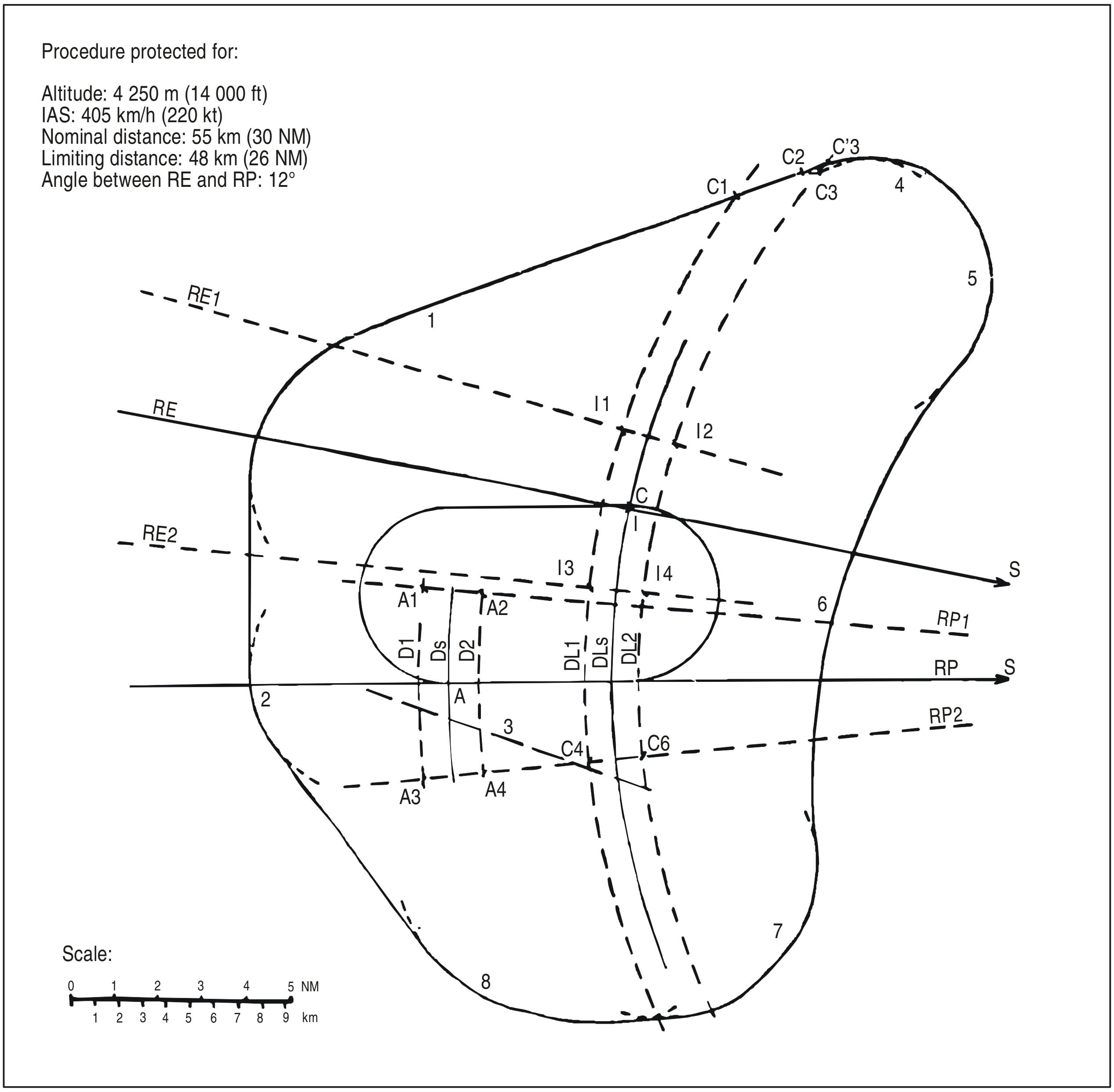


Diagram I-4-3-App C-18. VOR/DME procedure from the facility — basic area and the associated area for reciprocal direct entry to the secondary point

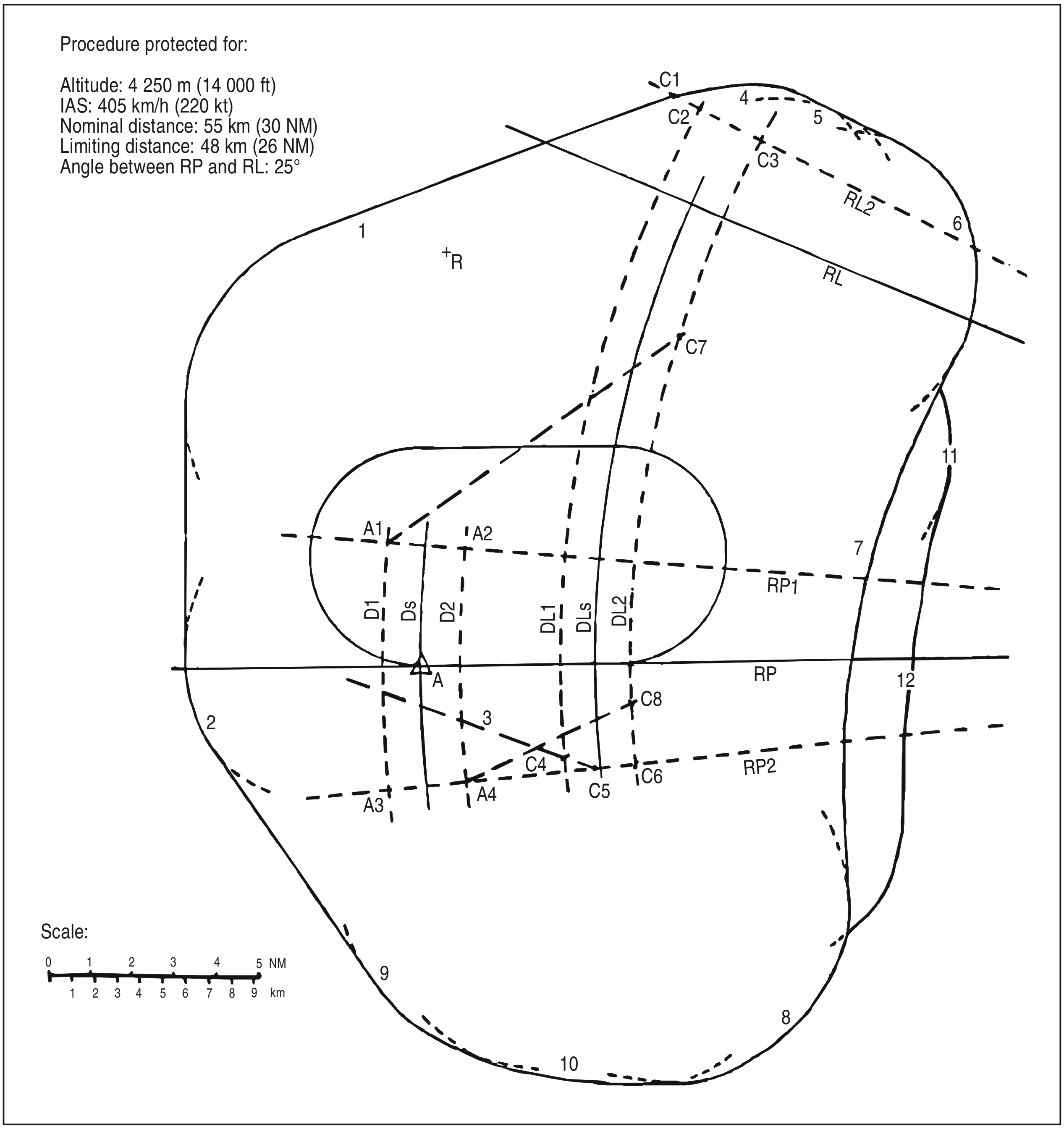


Diagram I-4-3-App C-19. VOR/DME procedure away from the facility with a limiting radial — basic area and associated area for entries

Chapter 4

INTERMEDIATE APPROACH SEGMENT

4.1 GENERAL

4.1.1 The intermediate approach segment blends the initial approach segment into the final approach segment. It is the segment in which aircraft configuration, speed, and positioning adjustments are made for entry into the final approach segment.

4.1.2 There are two types of intermediate approach segments:

a) one which begins at a designated intermediate approach fix (IF); and

b) one which begins upon completion of a dead reckoning (DR) track, a reversal or a racetrack procedure.

4.1.3 In both cases, track guidance shall be provided inbound to the final approach fix (FAF) where the intermediate approach segment ends. See Figure I-4-3-2 of Chapter 3 for typical intermediate approach segments.

4.2 ALTITUDE/HEIGHT SELECTION

The minimum altitude/height in the intermediate approach segment shall be established in 100-ft increments or 50-m increments as appropriate.

4.3 INTERMEDIATE APPROACH SEGMENT BASED ON A STRAIGHT TRACK ALIGNMENT

The track to be flown in the intermediate approach segment should normally be the same as the final approach track. Where this is not practicable and the final approach fix in a non-precision procedure is a navigation facility, the intermediate track shall not differ from the final approach track by more than 30° (Cat H, 60°). Where the turn at the FAF is greater than 10° the final approach area should be widened on the outer side of the turn as described in Chapter 6, 6.4.6.3.3, “TP marked by a facility (NDB or VOR)”.

4.3.1 Area

This section deals with the construction of the area of an intermediate approach segment based on a straight track alignment.

4.3.1.1 *Length*

4.3.1.1.1 The length of the intermediate approach segment shall not be more than 28 km (15 NM) (Cat H, 9.3 km (5.0 NM)), or less than 9.3 km (5.0 NM) (Cat H, 3.7 km (2 NM)), (except as provided for in ILS, MLS, RNAV [DME/DME, VOR/DME, GNSS] and radar sections), measured along the track to be flown.

4.3.1.1.2 The optimum length is 19 km (10 NM) (Cat H, 9.3 km (5.0 NM)). A distance greater than 19 km (10 NM) should not be used unless an operational requirement justifies a greater distance. When the angle at which the initial approach track joins the intermediate approach track exceeds 90° (Cat H, 60°), the minimum length of the intermediate approach track is as shown in Table I-4-4-1.

4.3.1.2 *Width*

In a straight-in approach, the width of the intermediate approach segment tapers from a maximum width of 19 km (5 NM) at the IF to its minimum width at the FAF (or FAP). The segment is divided longitudinally as follows:

a) a primary area which extends laterally on each side of the track; and

b) a secondary area on each side of the primary area. (See Figure I-4-3-2 of Chapter 3.)

For calculating secondary area width at a given point, see Section 2, Chapter 1, 1.2.2, "Calculating secondary area width at a given point".

Note.— See also Appendix B to Chapter 3, "Reduction of the width of a straight initial approach area after the IAF and interface between straight initial approach area and reversal procedure areas" *for possible reduction of the width of the initial approach area.*

4.3.2 Obstacle clearance

4.3.2.1 A minimum of 150 m (492 ft) of obstacle clearance shall be provided in the primary area of the intermediate approach segment. In the secondary area, 150 m (492 ft) of obstacle clearance shall be provided at the inner edge, reducing to zero at the outer edge. See Figure I-4-1-2 of Chapter 1. For calculating obstacle clearance at a given point, see Section 2, Chapter 1, 1.3, "Obstacle clearance".

4.3.2.2 The altitudes/heights selected by application of the obstacle clearance specified shall be rounded upwards to the next 50 m or 100 ft as appropriate.

4.3.3 Procedure altitude/height and descent gradient

4.3.3.1 Because the intermediate approach segment is used to prepare the aircraft speed and configuration for entry into the final approach segment, this segment should be flat or at least have a flat section contained within the segment.

4.3.3.2 If a descent is necessary the maximum permissible gradient will be 5.2 per cent (Cat H, 10 per cent). In this case, a horizontal segment with a minimum length of 2.8 km (1.5 NM) should be provided prior to the final approach for Cat C and D aircraft. For procedures specific to Cat A and B aircraft, this minimum length may be reduced to 1.9 km (1.0 NM). This should allow sufficient distance for aircraft to decelerate and carry out any configuration changes necessary before final approach segment.

4.3.3.3 Procedure altitudes/heights in the intermediate segment shall be established to allow the aircraft to intercept a prescribed final approach descent.

4.4 INTERMEDIATE SEGMENT WITHIN A REVERSAL OR RACETRACK PROCEDURE

4.4.1 General

The intermediate approach segment begins upon interception of the intermediate approach track. Criteria are the same as those shown in 4.3, "Intermediate approach segment based on a straight track alignment", except as specified in the paragraphs below.

4.4.2 Area width

When used with the reversal or racetrack procedure, the intermediate segment width expands uniformly from the width of the final approach segment at the navigation facility to 9.3 km (5.0 NM) on each side of the track at 28 km (15 NM) from the facility, for a total width of 18.6 km (10 NM). Beyond 28 km (15 NM) the area remains 19 km (10 NM) wide. See Figure I-4-4-2.

The intermediate approach area is divided into primary and secondary areas as specified in Section 2, Chapter 1, 1.2, "Areas".

4.4.3 Area length

When an IF is available the intermediate approach segment is normally 19 km (10 NM) long (Cat H, maximum length of 9.3 km (5 NM)). See Figure I-4-4-1.When no IF is available, the intermediate approach area shall extend to the far boundary of the reversal procedure primary area. See Figures I-4-4-2 and I-4-4-3.

4.4.4 Turn not at the facility

If the reversal or racetrack procedure is predicated on a FAF which is not located at the facility, the intermediate approach area extends 9.3 km (5.0 NM) on each side of the intermediate track at 28 km (15 NM) from the facility, and tapers uniformly to the width of the final approach area at the FAF. See Figure I-4-4-3.

4.4.5 Descent gradient

The constraints specified for the inbound track in Table I-4-3-1 apply.

Table I-4-4-1. Minimum intermediate track length

Interception angle (degrees)	*Minimum track length*
91 — 96	11 km (6 NM)
97 — 102	13 km (7 NM)
103 — 108	15 km (8 NM)
109 — 114	17 km (9 NM)
115 — 120	19 km (10 NM)
Cat H	
61 — 90	5.6 km (3 NM)
91 — 120	7.4 km (4 NM)

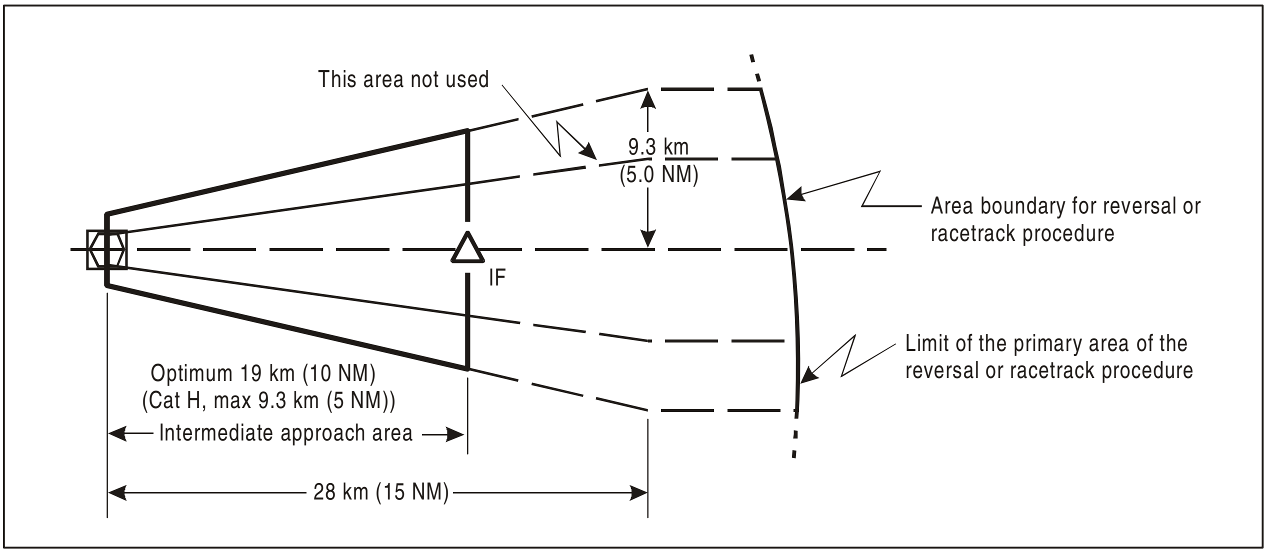


Figure I-4-4-1. Intermediate approach area within reversal or racetrack procedure with a fix

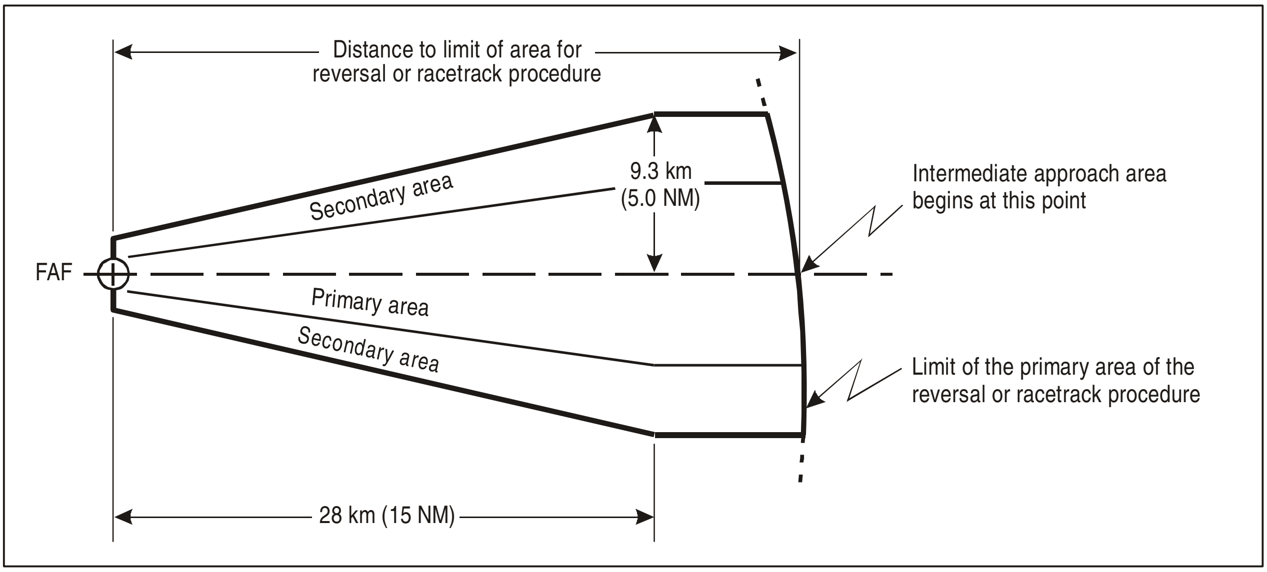


Figure I-4-4-2. Intermediate approach area within reversal or racetrack procedure with no IF

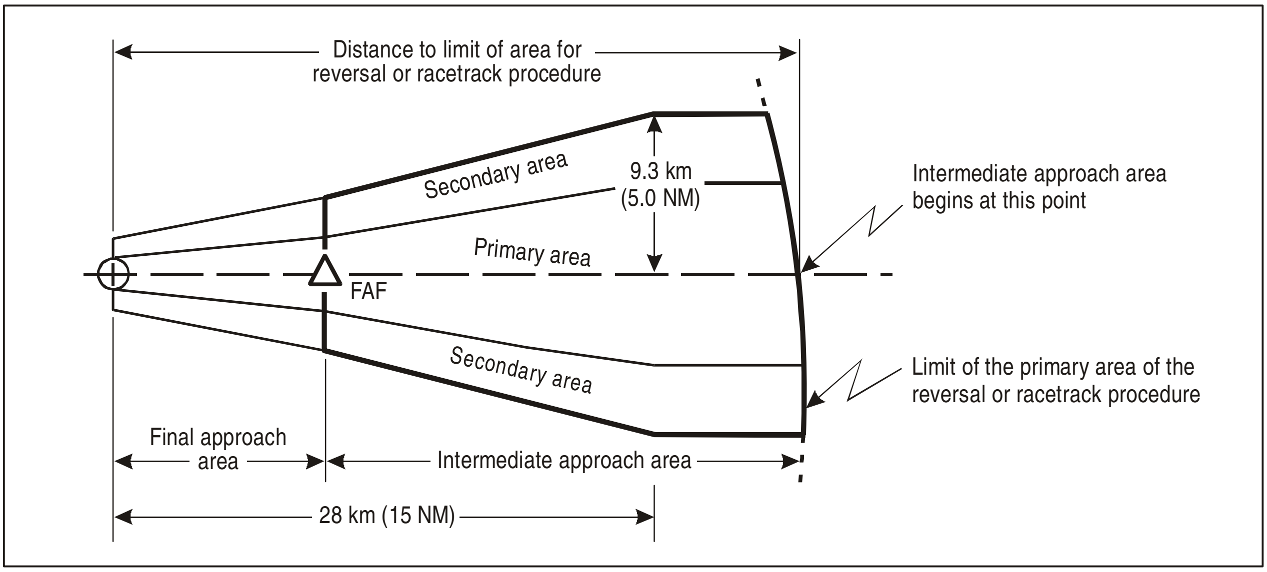


Figure I-4-4-3. Intermediate approach area within reversal or racetrack procedure based on FAF (not the facility)

Chapter 5

FINAL APPROACH SEGMENT

5.1 GENERAL

5.1.1 In the final approach segment, alignment and descent for landing are carried out. The instrument part of the final approach segment begins at the final approach fix, and ends at the missed approach point (MAPt). Track guidance shall be provided for the instrument phase of the final approach segment. Final approach may be made:

a) to a runway for a straight-in landing; or

b) to an aerodrome for a circling approach.

5.1.2 The final approach segment should be aligned with a runway whenever possible. All final approaches with a FAF have an optimum length of 9.3 km (5 NM). Other than this, however, the alignment and dimensions of the final approach segment, as well as minimum obstacle clearance (MOC) vary with the location and type of navigation aid. For this reason, criteria specific to each type are contained in the applicable sections.

5.2 ALIGNMENT

5.2.1 The final approach and its track guidance should be aligned with a runway whenever possible. When this is not possible it may be offset up to 5 degrees without OCA/H penalty (see 5.4.3.1, "Aligned straight-in approach"). Above that value, a category-dependent penalty is applied (see 5.4.3.2, "Non-aligned straight-in approach"). Beyond these limits (or where other requirements cannot be met) a circling approach shall be used.

5.2.2 Straight-in approach

5.2.2.1 This paragraph contains the alignment criteria for non-precision approaches. The alignment criteria for approaches other than non-precision are found in the applicable sections.

5.2.2.2 *Final approach with track not intersecting the extended runway centre line.* A final approach which does not intersect the extended centre line of the runway (θ equal to or less than 5°) may also be established, provided such track lies within 150 m laterally of the extended runway centre line at a distance of 1 400 m outward from the runway threshold (see Figure I-4-5-1).

5.2.2.3 *Final approach with track intersecting the extended runway centre line.*

5.2.2.3.1 *Maximum angle.* For a straight-in approach, the angle formed by the final approach track and the runway centre line shall not exceed:

a) 30° for procedures restricted to Cat A and B aircraft ; and

b) 15° for other aircraft categories.

5.2.2.3.2 *Minimum distance.* The distance between the runway threshold and the point at which the final approach track intersects the runway centre line shall not be less than 1 400 m (see Figure I-4-5-1).

5.2.2.4 *Final approach track angle for helicopters.* For helicopters, the final approach track shall intersect the final approach and take-off area (FATO) axis at an angle not exceeding 30° and at a distance not less than 400 m from the FATO. When the final approach track does not intersect the extended axis of the FATO, the track shall lie within 75 m of it laterally at a point 400 m from the FATO.

5.2.3 Circling approach

The circling approach contains the visual phase of flight after completing an instrument approach, to bring an aircraft into position for landing on a runway that for operational reasons is not suitably located for straight-in approach. In addition, when the final approach track alignment or the descent gradient does not meet the criteria for a straight-in landing, only a circling approach shall be authorized and the track alignment should ideally be made to the centre of the landing area. When necessary, the final approach track may be aligned to pass over some portion of the usable landing surface. In exceptional cases, it may be aligned beyond the aerodrome boundary, but in no case beyond 1.9 km (1.0 NM) from the usable landing surface (see Figure I-4-5-2).

5.3 DESCENT GRADIENT

5.3.1 Gradient/angle limits

5.3.1.1 *Minimum/optimum descent gradient/angle.* The minimum/optimum descent gradient is 5.2 per cent for the final approach segment of a non-precision approach with FAF (3° for a precision approach or approach with vertical guidance). Descent gradients steeper than the optimum should not be used unless all other means to avoid obstacles have been attempted since these steeper descent gradients may result in rates of descent which exceed the recommended limits for some aircraft on final approach.

5.3.1.2 *Maximum descent gradient/angle.* The maximum descent gradient is:

a) for non-precision procedures with FAF:

   6.5 per cent for a non-precision approach for Cat A and B aircraft (Cat H: 10 per cent); and

   6.1 per cent for Cat C, D and E aircraft;

b) for a non-precision approach with no FAF, see Table I-4-5-1;

c) 3.5° for an approach with vertical guidance; and

d) for precision approaches:

   3.5° for a Cat I precision approach; and

   3° for Cat II and III precision approaches.

5.3.2 Determination of the descent gradient for a non-precision approach with FAF

The descent gradient (g) for a non-precision approach with FAF is computed using the equation: g = h/d. The values for h and d are defined as follows:

a) For a straight-in approach use:

   d = the horizontal distance from the FAF to the threshold (Cat H, LDAH); and

   h = the vertical distance between the altitude/height over the FAF and the elevation 15 m (50 ft) (Cat H, 10.7 m (35 ft) over the threshold).

b) For a circling approach use:

   d = the distance from the FAF to the first usable portion of the landing surface; and

   h = the vertical distance between the altitude/height over the FAF and the circling OCA/H.

c) For an approach where a stepdown fix (SDF) is used in the final segment, two descent gradients are calculated (g_1 and g_2).

   1) In calculating the gradient (g_1) between the FAF and the stepdown fix:

      d_1 = the horizontal distance from the FAF to the SDF; and

      h_1 = vertical distance between the height of the FAF and the height of the SDF.

   2) In calculating the gradient (g_2) between the stepdown fix and the approach runway threshold:

      d_2 = the horizontal distance from the SDF to the threshold; and

      h_2 = the vertical distance between the altitude/height at the SDF and the elevation 15 m (50 ft) (Cat H, 10.7 m (35 ft) over the threshold).

5.4 OBSTACLE CLEARANCE ALTITUDE/HEIGHT (OCA/H)

5.4.1 General

5.4.1.1 This paragraph describes the application of OCA/H for the different types of approach and its relationship to the aerodrome operating minima. The OCA/H is based on clearing obstacles by a specified minimum obstacle clearance (MOC). In some situations, an additional margin is added to the MOC, or an absolute lower limit should be applied, which will override the OCA/H. See 5.4.5, “MOC and OCA/H adjustments”, and Figure I-4-5-3 a) to c). Table I-4-5-2 does not apply to helicopter procedures.

5.4.1.2 *Precision approach procedures/approach procedures with vertical guidance (APV)*

a) *OCA/H.* In a precision approach procedure (or APV), the OCA/H is defined as the lowest altitude/height at which a missed approach must be initiated to ensure compliance with the appropriate obstacle clearance design criteria.

b) *Reference datum.* The OCA is referenced to mean sea level (MSL). The OCH is referenced to the elevation of the relevant runway threshold.

5.4.1.3 *Non-precision approach procedure (straight-in)*

a) *OCA/H.* In a non-precision approach procedure, the OCA/H is defined as the lowest altitude or alternatively the lowest height below which the aircraft cannot descend without infringing the appropriate obstacle clearance criteria.

b) *Reference datum.* The OCA is referenced to mean sea level (MSL). The OCH is referenced to

   1) aerodrome elevation; or

   2) runway threshold elevation when the threshold elevation is more than 2 m (7 ft) below the aerodrome elevation.

5.4.1.4 *Visual manouevring (circling) procedure*

a) *OCA/H.* Same as in the non-precision approach procedure.

b) *Reference datum.* The OCA is referenced to mean sea level (MSL). The OCH is referenced to the aerodrome elevation.

5.4.1.5 *Aerodrome operating minima*

OCA/H is one of the factors taken into account in establishing operating minima for an aerodrome in accordance with Annex 6. See Figure I-4-5-3 a) to c).

5.4.2 OCA/H for precision approaches and approach procedures with vertical guidance

The determination of OCA/H in precision approaches and approach procedures with vertical guidance is described in Part II, Section 1 and Part III, Section 3, Chapters 4 to 6.

5.4.3 OCA/H for non-precision approach (straight-in)

5.4.3.1 *Aligned straight-in approach*

The OCA/H for a straight-in, non-precision approach where the angle between the track and the extended runway centre line does not exceed 5 degrees shall provide the following minimum obstacle clearance (MOC) over the obstacles in the final approach area:

a) 75 m (246 ft) with FAF; and

b) 90 m (295 ft) without FAF.

The OCA/H shall also ensure that missed approach obstacle clearance is provided. See Chapter 6, "Obstacle clearance". A straight-in OCA/H shall not be published where final approach alignment or descent gradient criteria are not met. In this case, only circling OCA/H shall be published.

5.4.3.2 *Non-aligned straight-in approach*

For a final approach where the track intersects the extended runway centre line, OCA/H varies according to the interception angle. The OCH of the procedure shall be equal to or greater than the lower limits shown in Table I-4-5-2. The calculations used to arrive at these values appear in the Appendix to this chapter. For nominal descent gradients above 5.2 per cent, increase by 18 per cent the lower limits shown in the table for each per cent of gradient above 5.2 per cent.

5.4.4 OCA/H for visual manoeuvring (circling)

The OCA/H for visual manoeuvring (circling) shall provide the minimum obstacle clearance (MOC) over the highest obstacle in the visual manoeuvring (circling) area as specified in Table I-4-7-3 of Chapter 7. It shall also be:

a) above the lower limits (also specified in Table I-4-7-3); and

b) not less than the OCA/H calculated for the instrument approach procedure which leads to the circling manoeuvre. See Chapter 7, " Visual manouevring (circling) area".

Circling procedures are not provided for helicopters. When a helicopter instrument approach is followed by visual manoeuvring, the OCH shall not be less than 75 m (246 ft). See Chapter 7.

5.4.5 MOC and OCA/H adjustments

5.4.5.1 In certain cases the MOC and/or the OCA/H must be increased. This may involve:

a) an additional margin that is added to MOC;

b) a percentage increase in OCA/H; and

c) applying a lower limit (a minimum value) to OCA/H; as described below.

5.4.5.2 *Additional margin applied to MOC*

a) *Mountainous areas.* See 1.7, "Increased altitudes/heights for mountainous areas" in Section 2, Chapter 1 for guidance on increased MOC in mountainous areas.

b) *Excessive length of final approach.* When a FAF is incorporated in a non-precision approach procedure, and the distance from the fix to the runway threshold for which the procedure is designed exceeds 11 km (6 NM), the obstacle clearance shall be increased at the rate of 1.5 m (5 ft) for each 0.2 km in excess of 11 km (0.1 NM in excess of 6 NM).

5.4.5.2.1 Where a stepdown fix is incorporated in the final approach segment, the basic obstacle clearance may be applied between the stepdown fix and the MAPt, provided the fix is within 11 km (6 NM) of the runway threshold.

5.4.5.2.2 These criteria are applicable to non-precision approach procedures only.

5.4.5.3 *Percentage increase in OCA/H*

5.4.5.3.1 *Remote altimeter setting.* When the altimeter setting is derived from a source other than the aerodrome, and more than 9 km (5 NM) remote from the threshold, the OCA/H shall be increased at a rate of 0.8 m for each kilometre in excess of 9 km (5 ft for each nautical mile in excess of 5 NM) or a higher value if determined by local authority. In mountainous areas or other areas where reasonably homogenous weather cannot always be expected, a procedure based on a remote altimeter setting source should *not* be provided. In all cases where the source of the altimeter setting is more than 9 km (5 NM) from the threshold, a cautionary note should be inserted on the instrument approach chart identifying the altimeter setting source.

5.4.5.3.2 *Remote altimeter setting source (RASS) in mountainous areas*

a) The use of RASS in mountainous areas requires additional calculations to determine the correct OCA/H. The calculation uses the formula

$$OCA/H = 2.3x + 0.14z \text{ (non SI)}$$

$$OCA/H = 0.4x + 0.14z \text{ (SI)}$$

where: OCA/H is the RASS increased altitude/height value (m/ft);

x is the distance from the RASS to the landing area (km/NM); and

z is the difference in elevation between the RASS and the landing area (m/ft).

These formulas are used where no intervening terrain adversely influences atmospheric pressure patterns. The use of this criteria is limited to a maximum distance of 138 km (75 NM) laterally or an elevation differential of 1 770 m (6 000 ft) between the RASS and the landing area. An example calculation in nautical miles and feet is illustrated in Figure I-4-5-4.

b) Where intervening terrain adversely influences atmospheric pressure patterns, the OCA/H shall be evaluated in an Elevation Differential Area (EDA). The EDA is defined as the area within 9 km (5 NM) each side of a line connecting the RASS and the landing area, including a circular area enclosed by a 9 km (5 NM) radius at each end of the line. In this case, z becomes the terrain elevation difference (m/ft) between the highest and lowest terrain elevation points contained in the EDA. An example of a calculation in nautical miles and feet is illustrated in Figure I-4-5-5.

5.4.5.4 *Lower limit (a minimum value) applied to OCA/H*

a) *Forecast altimeter setting.* When the altimeter setting to be used with procedures is a forecast value obtained from the appropriate meteorological office, the OCA/H shall be increased by a value corresponding to the forecasting tolerance for the location as agreed by the meteorological office for the time periods involved. Procedures which require the use of forecast altimeter setting shall be suitably annotated on the approach charts.

b) *Final approach track intersecting the extended runway centre line between 5º and 30º.* When the final approach track intersects the extended runway centre line between 5º and 30º a lower limit is applied to OCA/H (5.4.3.2, "Non-aligned straight-in approach").

c) *Final approach track intersecting the extended runway centre line at more than 30º or descent gradient exceeding 6.5 per cent.* When the final approach track intersects the extended runway centre line at more than 30º, or the descent gradient exceeds 6.5 per cent, the OCA/H for visual manoeuvring (circling) becomes the lower limit and is applied to the approach procedure.

d) *Visual manoeuvring (circling).* For visual manoeuvring (circling) a lower limit consisting of the OCA/H for the associated instrument approach procedure is applied (see 5.4.4, “OCA/H for visual manoeuvring (circling)”).

5.5 PROMULGATION

5.5.1 *Descent gradients/angles for charting*. Descent gradients/angles for charting shall be promulgated to the nearest one-tenth of a percent/degree. Descent gradients/angles shall originate at a point 15 m (50 ft) above the landing runway threshold. For precision approaches different origination points may apply (see RDH in specific chapters). Earth curvature is not considered in determining the descent gradient/angle.

5.5.2 *Descent angles for database coding*. Paragraph 5.5.1 applies with the exception that descent angles shall be published to the nearest one-hundredth of a degree.

5.5.3 *FAF altitude-procedure altitude/height*. The descent path reaches a certain altitude at the FAF. In order to avoid overshooting the descent path, the FAF published procedure altitude/height should be 15 m (50 ft) below this altitude. The procedure altitude/height shall not be less than the OCA/H of the segment preceding the final approach segment. See Figure I-4-5-6.

5.5.4 Both the procedure altitude/height and the minimum altitude for obstacle clearance shall be published. In no case shall the procedure altitude/height be lower than the minimum altitude for obstacle clearance.

5.5.5 The designed stabilized descent path shall clear the step-down fix minimum obstacle clearance altitude. This can be achieved by increasing the descent gradient by:

a) increasing the procedure altitude/height at the FAF; or (if a) is not possible)

b) moving the FAF toward the landing threshold.

5.5.6 *Publication of OCA/H.* An OCA and/or an OCH shall be published for each instrument approach and circling procedure. For non-precision approach procedures, either value shall be expressed in 5-m or 10-ft increments by rounding up as appropriate.

Table I-4-5-1. Rate of descent in the final approach segment of a non-precision procedure with no FAF

Aircraft categories	*Rate of descent*	
	Minimum	*Maximum*
Cat A/B	200 m/min (655 ft/min)	120 m/min (394 ft/min)
Cat H	230 m/min (755 ft/min)	N/A
Cat C/D/E	305 m/min (1 000 ft/min)	180 m/min (590 ft/min)

Table I-4-5-2. Lower limit on OCH

Aircraft category	*Lower limit on OCH (m (ft))*	
	5° < θ ≤ 15°	15° < θ ≤ 30°
A	105 (340)	115 (380)
B	115 (380)	125 (410)
C	125 (410)	
D	130 (430)	
E	145 (480)	

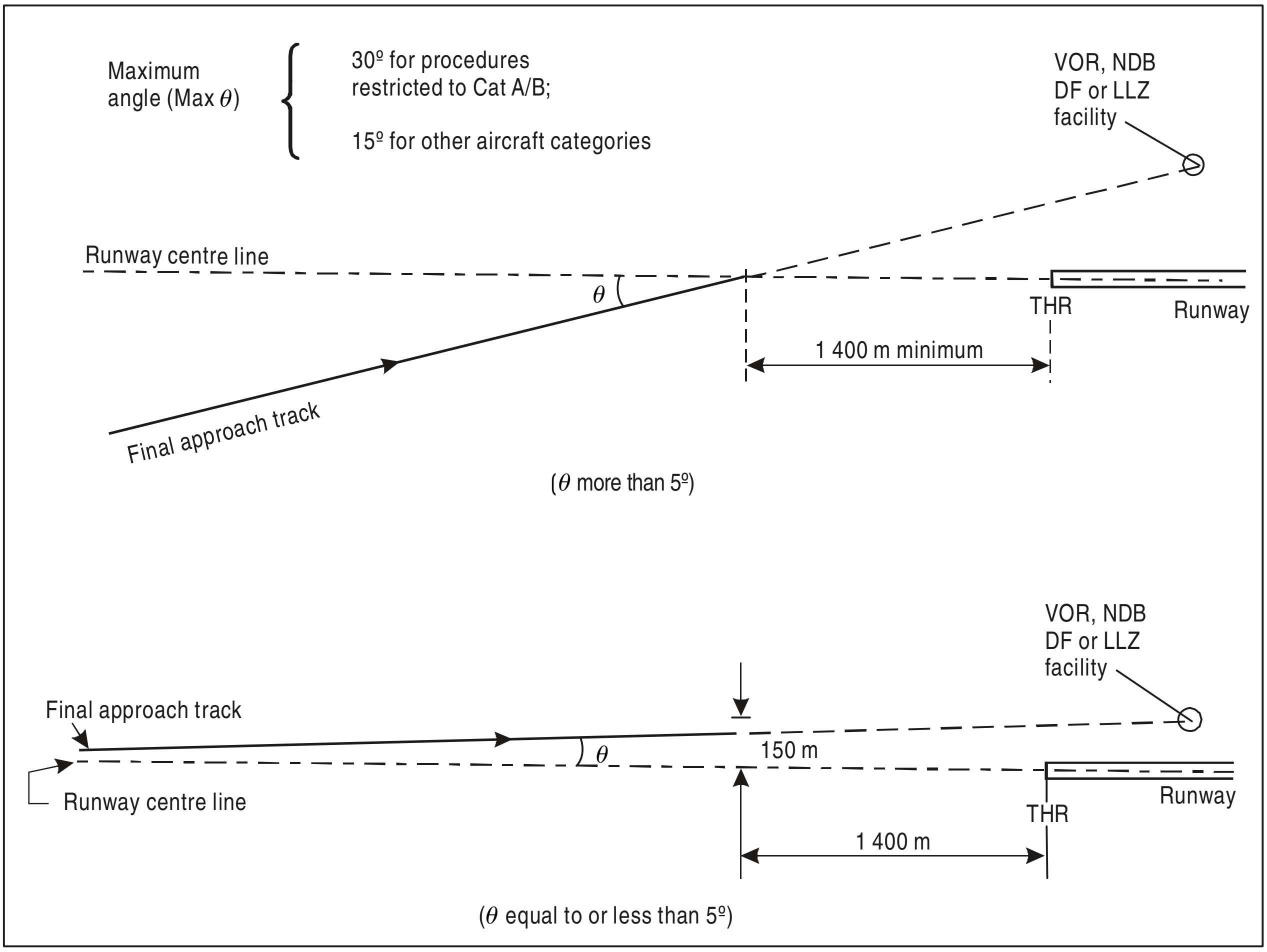


Figure I-4-5-1. Final straight-in approach alignment

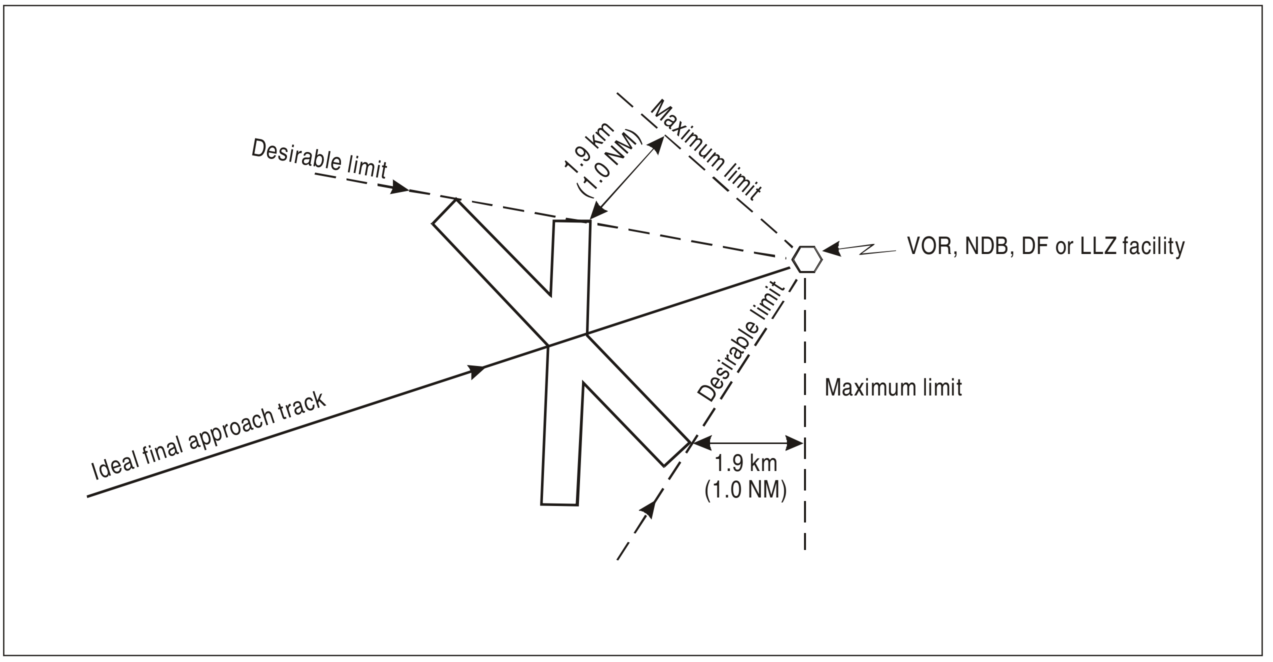


Figure I-4-5-2. Final circling approach alignment

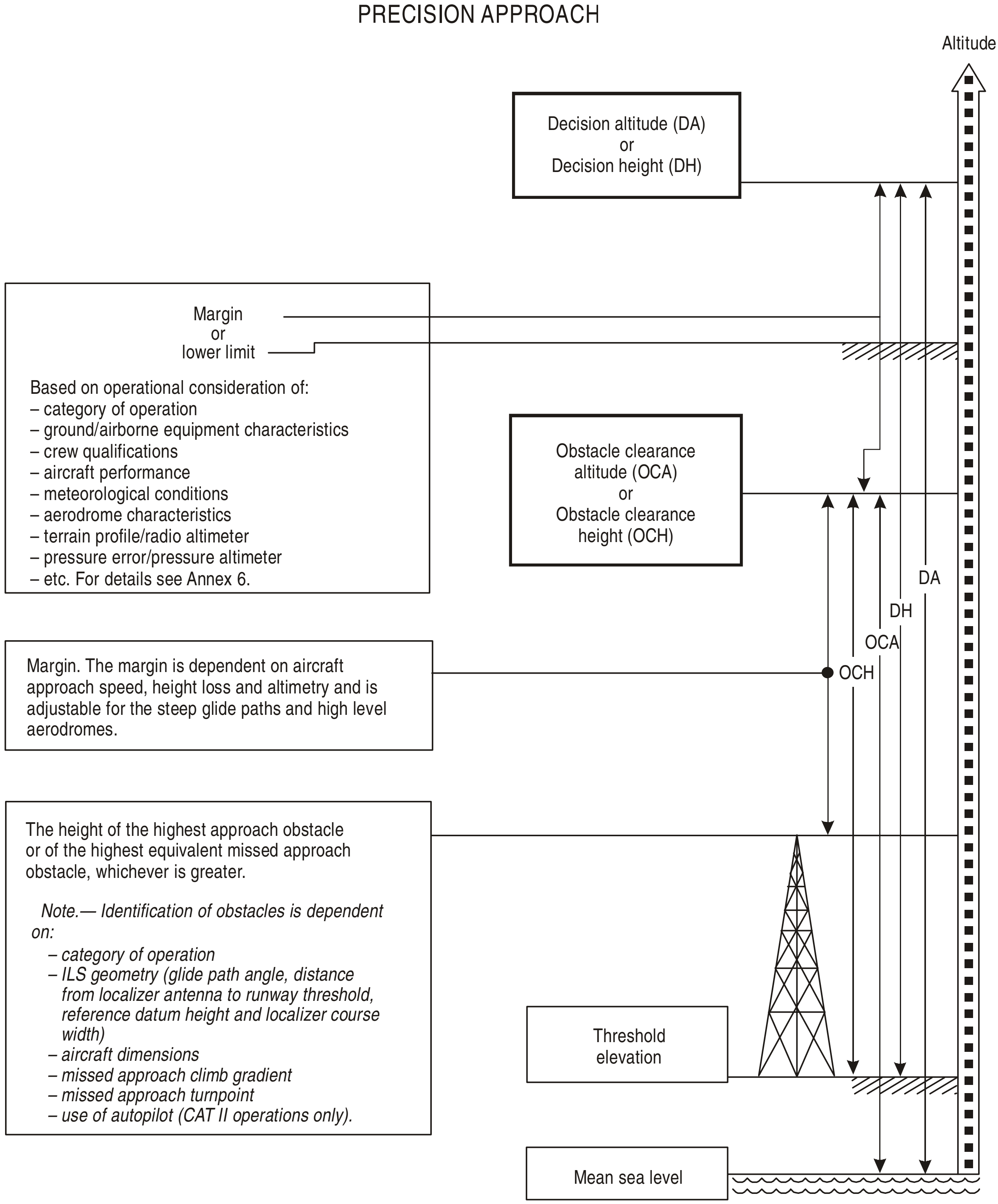


Figure I-4-5-3 a). Relationship of obstacle clearance altitude/height (OCA/H) to decision altitude/height (DA/H) for precision approaches

This figure does not apply to Category H. See Section 4, Chapter 7.

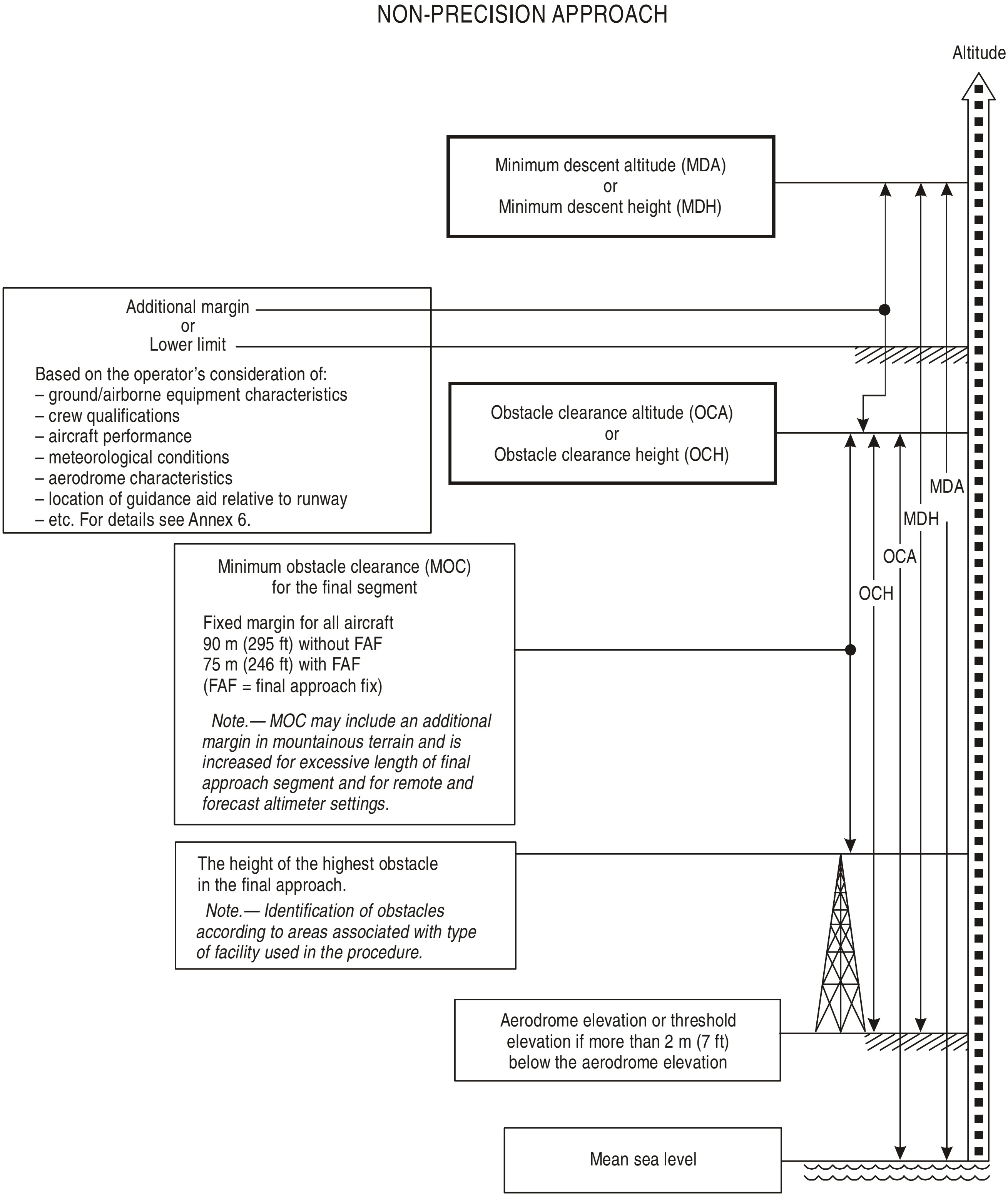


Figure I-4-5-3 b). Relationship of obstacle clearance altitude/height (OCA/H) to minimum descent altitude/height (MDA/H) for non-precision approaches (example with a controlling obstacle in the final approach)

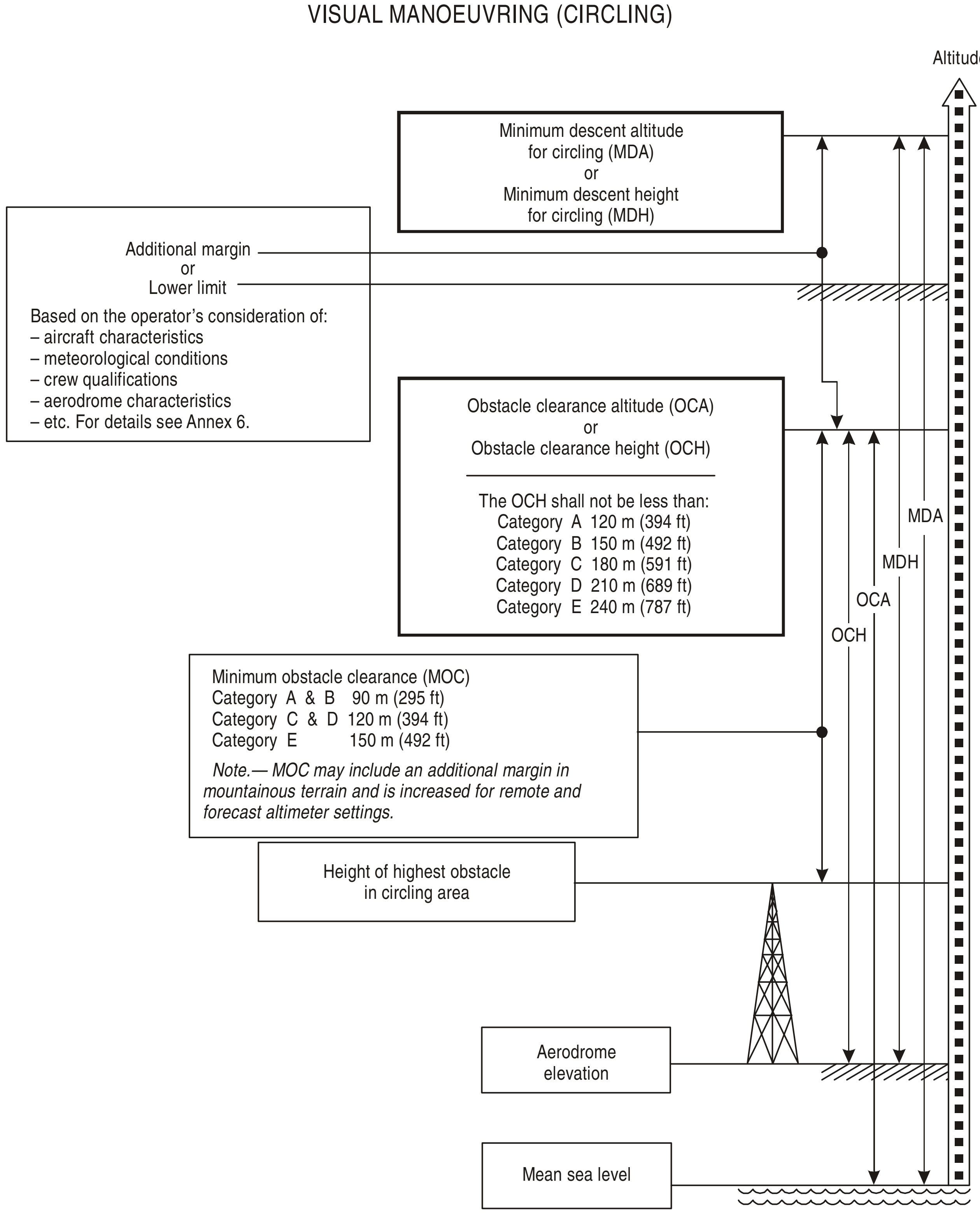


Figure I-4-5-3 c). Relationship of obstacle clearance altitude/height (OCA/H) to minimum descent altitude/height (MDA/H) for visual manoeuvres (circling)

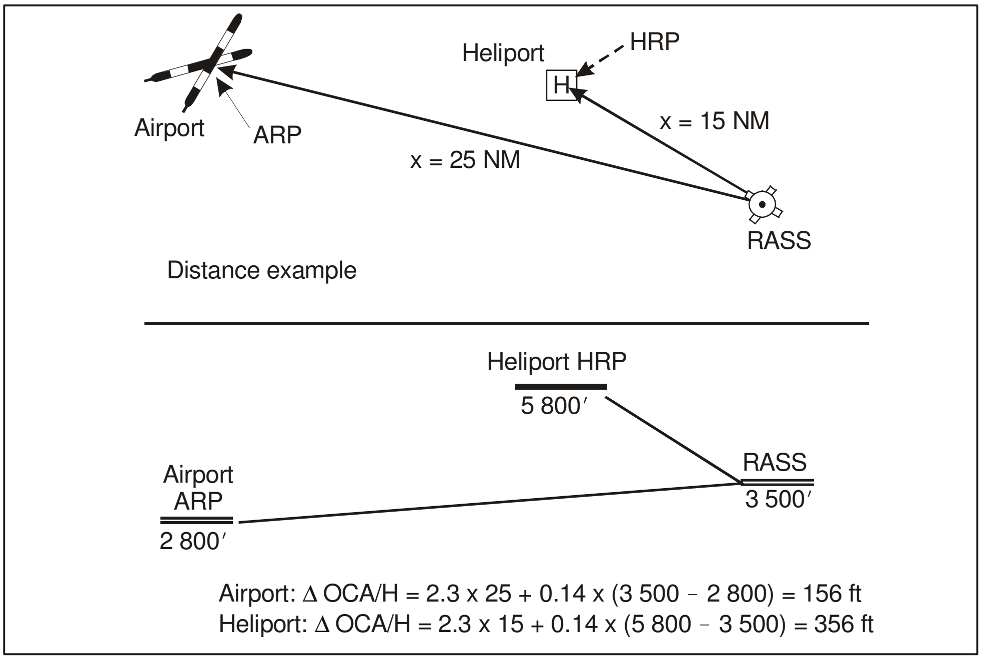


Figure I-4-5-4. Remote altimeter setting source (RASS) in mountainous areas

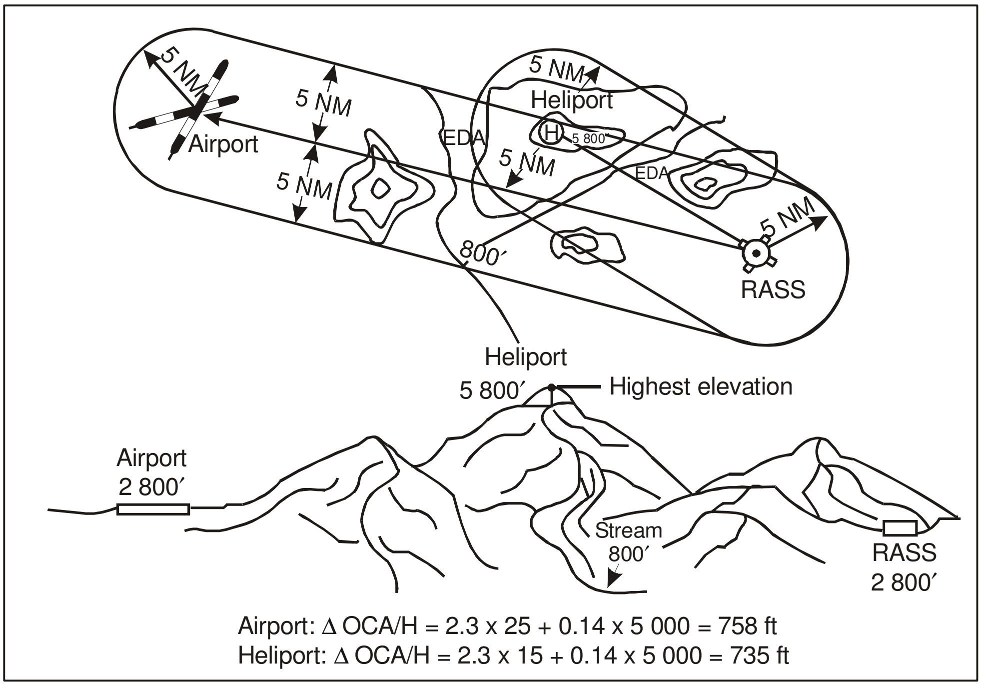


Figure I-4-5-5. Elevation differential area (EDA)

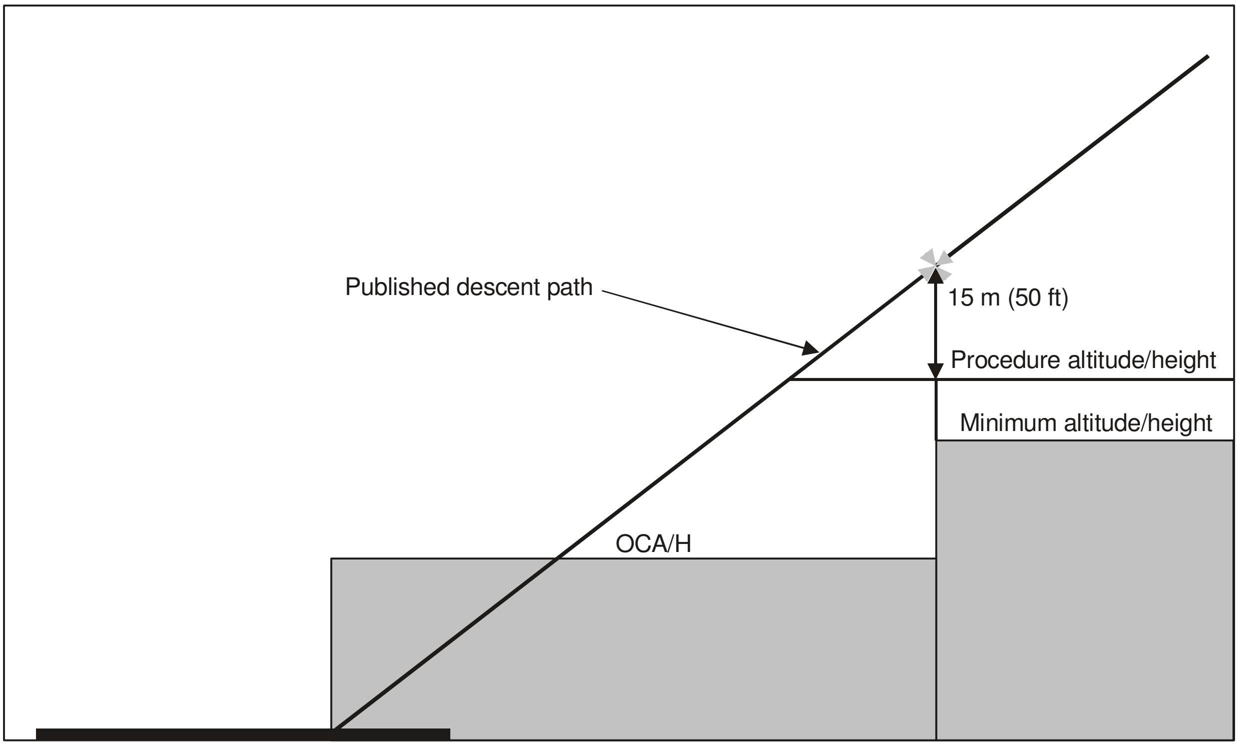


Figure I-4-5-6. Procedure altitude descent path

Appendix to Chapter 5

CALCULATIONS FOR OCA/H IN NON-ALIGNED STRAIGHT-IN APPROACHES

The values shown in Table I-4-5-2 in Chapter 5 are based on the following calculations:

Minimum OCH = 15 m + Total distance × descent gradient

Total distance = $d_{intercept} + d_{Add} + d_{Turn}$

where:

Minimum intercept distance ($d_{intercept}$) = 1 400 m

Additional flight time distance (d_{Add}) = TAS_{Cat} * 5/3 600

TAS_{Cat} = TAS corresponding to the maximum final approach IAS for each aircraft category + 19 km/h (10 kt) tailwind, based on a 600 m (2 000 ft) aerodrome elevation.

Additional flight time before crossing centreline = 5 seconds

Turn distance (d_{Turn}) = r_{Cat}* $\tan(\theta_{max}/2)$

r_{Cat} = Radius of turn calculated for TAS_{Cat}

Maximum turn angle (θ_{max}) = 15 degrees (for $5 < \theta \leq 15$) or 30 degrees (for $15 < \theta \leq 30$)

Chapter 6

MISSED APPROACH SEGMENT

6.1 GENERAL

6.1.1 Requirements

6.1.1.1 A missed approach procedure shall be established for each instrument approach and shall specify a point where the procedure begins and a point where it ends. The missed approach procedure is initiated:

a) at the decision altitude height (DA/H) in precision approach procedures or approach with vertical guidance (APV); or

b) at the missed approach point (MAPt) in non-precision approach procedures.

6.1.1.2 The missed approach procedure shall terminate at an altitude/height sufficient to permit:

a) initiation of another approach; or

b) return to a designated holding pattern; or

c) resumption of en-route flight.

Only one missed approach procedure shall be established for each approach procedure.

Note.— This chapter contains general criteria which apply to all types of instrument landing procedures, as well as criteria specific to non-precision procedures. For the details regarding precision approaches and approaches with vertical guidance, see the applicable chapters.

6.1.2 Phases of missed approach segment

In principle the missed approach segment starts at the MAPt and includes the following three phases (see Figure I-4-6-4):

a) initial phase — begins at the earliest MAPt, and extends until the Start of Climb (SOC);

b) intermediate phase — extends from the SOC to the point where 50 m (164 ft) (Cat H, 40 m (132 ft)) obstacle clearance is first obtained and can be maintained; and

c) final phase — extends to the point at which a new approach, holding or return to en-route flight is initiated. Turns may be carried out during this phase.

6.1.3 Types of missed approach

There are two types of missed approach:

a) straight missed approach (includes turns less than or equal to 15 degrees); and

b) turning missed approach.

6.1.4 Missed approach area

The area considered for the missed approach shall start at the earliest MAPt tolerance, with a width equal to that of the final approach segment at that point. The subsequent size and shape of the area depends on the missed approach procedure, including the point at which a turn is initiated, if applicable, and the extent of the turn.

6.1.5 Missed approach point (MAPt)

6.1.5.1 *General.* A missed approach begins at the missed approach point (MAPt) and only applies to non-precision approaches. For non-precision approaches, the MAPt shall be defined as follows:

a) *procedures without a FAF* — by a navigation facility or fix; and

b) *procedures with a FAF* — the MAPt shall be defined by one of the following three cases:

  1) by timing over the distance from the nominal FAF to the nominal MAPt, where the MAPt is not defined by a facility or fix; or

  2) by a navigation facility or fix at the MAPt, in which case the procedure must be annotated "timing not authorized for defining the MAPt"; or

  3) by both timing over the distance from the nominal FAF to the nominal MAPt, as well as a facility or fix at the missed approach point. In this case a single OCA/H, which shall be the higher of the OCA/H for the specified distance and the OCA/H for the facility or fix, shall be published. However, when an operational advantage can be achieved, both may be published.

Note.— The optimum location of the MAPt is the runway threshold. However, where obstacles in the missed approach require an MAPt before the threshold, the MAPt may be located closer to the FAF. It should be moved no farther than necessary and normally should not be located before the point where the OCH intersects the path of a nominal 5.2 per cent descent gradient to the runway.

6.1.5.2 *Determining earliest and latest MAPt for an MAPt determined by distance.* When the MAPt is determined by timing over the distance from the FAF, the total MAPt tolerance (Y) may be determined by taking the values from Table I-4-6-1 and applying them as shown in Figure I-4-6-3. For the refined calculations see the appendix to this chapter.

6.1.6 Calculating start of climb (SOC)

6.1.6.1 There are two methods for calculating SOC. The method used depends on whether:

a) the MAPt is defined by a navigation facility or fix; or

b) the MAPt is defined by a specified distance from the FAF.

6.1.6.2 *Determining SOC with an MAPt defined by a navigation facility or fix.* When the MAPt is defined by a navigation facility or fix (see Figure I-4-6-1), SOC is determined by the sum of :

a) the MAPt tolerance; and

b) the transitional distance (X).

6.1.6.2.1 *MAPt tolerance when MAPt is defined by a navigation facility or fix.* When the MAPt is defined by a navigation facility or fix (see Figure I-4-6-1), the MAPt longitudinal tolerance is defined by the sum of :

a) the full tolerance of the facility/fix; plus

b) a distance (d), allowing for pilot reaction time. This value corresponds to 3 seconds of flight at the maximum final approach speed for the specific aircraft category, plus a tail wind factor of 19 km/h (10 kt). Example values of d for each aircraft category (calculated for a 600 m (2 000 ft) aerodrome elevation) appear in Table I-4-6-3.

If the MAPt is defined by overheading a navigation facility (VOR, NDB or 75 MHz marker beacon) the fix tolerance is 0 km (NM).

6.1.6.2.2 *Transitional distance with an MAPt defined by a navigation facility or fix.* Transitional distance (X) with an MAPt defined by a navigation facility or fix is based on 15 seconds (Cat H, 5 seconds) of flight at a TAS based on the highest final approach speed for each aircraft category (see Tables I-4-1-1 and I-4-1-2 of Chapter 1), at the aerodrome elevation with a temperature of ISA + 15°C and a tailwind of 19 km/h (10 kt). These values are applied as shown in Figure I-4-6-1.

6.1.6.3 *Determining SOC with an MAPt defined by a distance from the FAF (simplified method).* For determining SOC with an MAPt defined by a distance from the FAF, a simplified method can be used as an estimate for altitudes up to 4 000 m (13 000 ft), see Figure I-4-6-2. In this case SOC is determined by the sum of:

a) the distance from the nominal FAF to the nominal MAPt; and

b) transitional distance (X).

6.1.6.3.1 *Transitional distance with an MAPt defined by distance.* Transitional distance with an MAPt defined by distance is based on 15 seconds (Cat H, 5 seconds) of flight at the appropriate TAS, at the aerodrome elevation with a temperature of ISA + 15°C and a tailwind of 19 km/h (10 kt). See Table I-4-6-2 for computation of transitional distance (X).

6.1.6.4 *Determining SOC with an MAPt defined by a distance from the FAF (refined method).* The refined method shall be used for altitudes over 4 000 m (13 000 ft), and may give an operational advantage in some conditions under 4 000 m (13 000 ft). This method is shown in the appendix.

6.2 CLIMB GRADIENT AND MOC

6.2.1 Initial phase

6.2.1.1 The initial phase begins at the earliest missed approach point (MAPt) and ends at the start of climb point (SOC). The manoeuvre during this phase requires the concentrated attention of the pilot, especially when establishing the climb and the changes in configuration, and it is assumed that guidance equipment is not utilized during these manoeuvres. No turns may be specified during this phase.

6.2.1.2 *Climb gradient in the initial phase.* In the initial phase the flight track is horizontal.

6.2.1.3 *Obstacle clearance in the initial phase.* In the initial missed approach area, the minimum obstacle clearance shall be the same as for the last part of the final approach area except where the extension of the intermediate missed approach surface backwards towards the missed approach point requires less clearance. (See Figures I-4-6-4 and I-4-6-5.)

6.2.2 Intermediate phase

6.2.2.1 The intermediate phase begins at the SOC. The climb is continued at stabilized speeds up to the first point where 50 m (164 ft) (Cat H, 40 m (132 ft)) obstacle clearance is obtained and can be maintained. In the construction of this phase it is assumed that advantage may be taken of available navigation guidance. During the intermediate phase, the missed approach track may be changed from that of the initial phase by a maximum of 15°.

6.2.2.2 *Climb gradient in the intermediate phase.* The nominal climb gradient (tan Z) of the missed approach surface is 2.5 per cent. A gradient of 2 per cent may be used if the necessary survey and safeguarding can be provided. Additional climb gradients of 3, 4 or 5 per cent may also be specified. These may be used by aircraft whose climb performance permits the operational advantage of the lower OCA/H associated with these gradients, with the approval of the competent authority.

Note.— In case of non-precision approach, any intermediate values (e.g. 3.4 per cent) between 2 and 5 per cent may be considered.

6.2.2.3 *Obstacle clearance in the intermediate phase*

6.2.2.3.1 In the intermediate missed approach phase, the minimum obstacle clearance shall be 30 m (98 ft) in the primary area, and in the secondary area the minimum obstacle clearance shall be 30 m (98 ft) at the inner edge, reducing linearly to zero at the outer edge. See Section 2, Chapter 1, 1.3, "Obstacle clearance".

6.2.2.3.2 The OCA/H for the nominal 2.5 per cent must always be published on the instrument approach chart. If additional gradients are specified in the construction of the missed approach procedure, they and their associated OCA/H values must be published as alternative options.

Note.— MOC may be obtained by increasing the OCA/H or by a longitudinal adjustment of the MAPt or both.

6.2.3 Final phase

The final phase begins at the point where 50 m (164 ft) (Cat H, 40 m (132 ft)) obstacle clearance is first obtained and can be maintained. It ends at the point at which a new approach, holding or return to en-route flight is initiated. Turns may be carried out during this phase.

6.2.3.1 *Climb gradient in the final phase.* The criteria of the intermediate phase apply.

6.2.3.2 *Obstacle clearance in the final phase*

6.2.3.2.1 In the final missed approach phase of a straight missed approach the minimum obstacle clearance shall be 50 m (164 ft) (Cat H, 40 m (132 ft)) in the primary area, reducing linearly to zero at the outer edge of the secondary area. See Figure I-4-6-4.

6.2.3.2.2 Turning missed approaches have specific criteria for MOC and for the arrangement and extent of secondary areas (see 6.4, "Turning missed approach").

Note.— MOC may be obtained by increasing the OCA/H or by a longitudinal adjustment of the MAPt or both. In addition, obstacles may be excluded from consideration by defining a turn.

6.3 STRAIGHT MISSED APPROACH

6.3.1 This section contains the criteria for a straight missed approach. It includes turns less than or equal to 15 degrees.

6.3.2 Area for straight missed approach

6.3.2.1 The straight missed approach area has a width at its origin equal to that of the final approach area at that point. Thereafter it splays at an angle:

a) determined by the accuracy of the tracking navigation aid used (10.3° for NDB, 7.8° for VOR) (see Figure I-4-6-6); or

b) with a divergence of 15° where no reference to a navigation aid is available.

6.3.2.2 The area extends a sufficient distance to ensure that an aircraft executing a missed approach has reached an altitude at which obstacle clearances for subsequent procedures (such as for en-route or holding) can be observed. The initial phase of the missed approach surface is horizontal, and is based on the lowest assumed flight path at the OCA/H. The start of climb (SOC) for the intermediate and final phases originates immediately beyond the transitional distance (see 6.1.6.2.2, "Transitional distance with an MAPt defined by a navigation facility or fix" and 6.1.6.3.1, "Transitional distance with an MAPt defined by distance"). The intermediate and final phases ascend uniformly with the gradient of the missed approach surface, as specified in 6.2, "Climb gradient and MOC".

6.3.2.3 *Additional track guidance.* An operational advantage may be obtained during the development of the missed approach procedure by using suitably located facilities to reduce the dimensions of the final phase. In this case the boundaries of the final phase are continued until they intersect the appropriate boundaries for the facility provided:

a) for a VOR ± 1.9 km (± 1.0 NM) with a splay (towards the MAPt) of 7.8°; and

b) for an NDB ± 2.3 km (± 1.25 NM) with a splay of 10.3°.

Figures I-4-6-7 and I-4-6-8 show missed approach areas both with and without additional track guidance.

6.3.2.4 *Continuous track guidance.* When the track guidance for missed approach is a continuation of guidance from the facility used on the final approach, the missed approach area is a continuation of the area(s) defined for that facility. See Figure I-4-6-9.

6.3.3 Primary and secondary area

The general criteria apply.

6.3.4 Alignment

Wherever practical the missed approach track should be a continuation of the final approach track. Missed approaches involving turns are permitted (see 6.4, "Turning missed approach"), but should only be employed when an operational advantage may be obtained.

6.3.5 Obstacle clearance for the straight missed approach

The general criteria apply as stated in 6.2, "Climb gradient and MOC".

6.4 TURNING MISSED APPROACH

6.4.1 This section contains the criteria for a turning missed approach for turns of more than 15 degrees. For turns less than or equal to 15 degrees, the criteria for a straight missed approach apply. See 6.3, "Straight missed approach", above. Turns may be defined as occurring at:

a) an altitude/height;

b) a fix or facility; or

c) the MAPt.

6.4.2 General

If a turn from the final approach track is specified, turning missed approach areas must be constructed. The criteria in 6.3, "Straight missed approach" above remain in effect until the following:

a) the turning point (TP) for turns specified by altitude/height (see 6.4.5, "Turn initiated at a designated altitude/height"); and

b) the earliest TP for turns at a designated TP (see 6.4.6, "Turn initiated at a designated turning point"). To obtain the minimum OCA/H it may be necessary to adjust the designated turn altitude or turning point (TP). The number of variables is such that this may involve a trial and error process.

Note.— All calculations in this chapter are made for the 2.5 per cent nominal gradient. See 6.2.2 for use of gradients other than 2.5 per cent.

6.4.3 Turn parameters

This section shows the parameters on which the turn areas are based, together with the variables which represent them in the drawings.

a) *Altitude:* Aerodrome altitude plus 300 m (1 000 ft) or the defined turn altitude.

b) *Temperature:* ISA + 15°C corresponding to a) above.

c) *Indicated airspeed (IAS):* The speed for final missed approach is shown in Tables I-4-1-1 and I-4-1-2 of Chapter 1. However, where operationally required to avoid obstacles, reduced speeds as slow as the IAS for intermediate missed approach may be used, provided the procedure is annotated "Missed approach turn limited to _______ km/h (kt) IAS maximum."

d) *True airspeed:* The IAS in c) above adjusted for altitude a) and temperature b).

e) *Wind:* Maximum 95 per cent probability wind on an omnidirectional basis, where statistical wind data is available. Where no wind data is available, an omnidirectional 56 km/h (30 kt) wind should be used.

f) *Average achieved bank angle:* 15°.

g) *Fix tolerance:* As appropriate for the type of fix. See Section 1, Chapter 2, "Terminal area fixes".

h) *Flight technical tolerances:*

   1) c = a distance equivalent to 6 seconds of flight (3-second pilot reaction and 3-second bank establishing time) at the final missed approach speed (for maximum published missed approach speed) plus 56 km/h (30 kt) tailwind; and

   2) see also the turning parameters shown as examples in Tables I-4-6-5 and I-4-6-6.

i) d_o = Distance to an obstacle.

j) d_z = Shortest distance to an obstacle or datum measured from SOC parallel to the straight missed approach track.

k) O_i = Obstacle (subscript indicates the specific obstacle).

l) tan Z = Tangent of the angle of the missed approach surface with the horizontal plane.

m) R = Rate of turn.

n) r = Turn radius.

o) E = Wind effect.

6.4.4 Secondary areas

6.4.4.1 In the turn area, the secondary area always applies on the outer side of the turn, as a continuation of the straight missed approach secondary area (see Figures I-4-6-13 to I-4-6-19 for a turn designated at a turn point). The secondary areas resume as soon as the aircraft has track guidance.

6.4.4.2 *Additional track guidance.* After the turn an operational advantage may be obtained during the development of the missed approach procedure, by using suitably located facilities to reduce the dimensions of the final missed approach area. Examples of typical turning missed approach areas with additional track guidance are shown in Figures I-4-6-15 and I-4-6-19.

6.4.5 Turn initiated at a designated altitude/height

6.4.5.1 *General*

A turn is prescribed upon reaching a specified altitude to cope with two kinds of penalizing obstacles:

a) an obstacle located in the direction of the straight missed approach and which must be avoided; and

b) an obstacle located abeam the straight missed approach track and which must be overflown after the turn with the appropriate margin.

A turning missed approach at a designated altitude requires a climb to a specified altitude/height before initiating a turn to a specified heading or towards a fix/facility.

6.4.5.2 *Areas*

6.4.5.2.1 *Turn initiation area*

6.4.5.2.1.1 The point where the designated altitude/height is reached is not fixed. It depends on the climb performance of the aircraft and the point from which the missed approach is initiated. The aircraft may reach the designated turn altitude/height:

a) as early as the earliest MAPt when the procedure prohibits turning before the MAPt or as early as the earliest FAF when no restrictions are provided; and

b) after a climb using the minimum required gradient from the SOC to the point where it reaches the specified altitude height. This point is called the Turn Point (TP).

6.4.5.2.1.2 Procedure design should take both extremes into account. Therefore the area where the aircraft can initiate its turn is bounded by:

a) the distance from the earliest MAPt or earliest FAF to the TP; and

b) the edges of the secondary areas of the initial and intermediate phases.

This area is called the turn initiation area. The line which marks the end of the turn initiation area is defined by KK (see Figures I-4-6-11 and I-4-6-12).

6.4.5.2.2 *Turn area*

The turn area's boundaries are constructed to protect aircraft in the two extreme cases described above:

a) *inner boundary construction:*

   1) for turns less than 75 degrees, the inner boundary originates at the inner edge of the earliest MAPt (Figure I-4-6-11) and splays at an angle of 15 degrees relative to the nominal track after the turn; and

   2) for turns more than 75 degrees, the inner boundary originates at the outer edge of the earliest MAPt (Figure I-4-6-12) and splays at an angle of 15 degrees relative to the nominal track after the turn; and

b) *outer boundary construction:*

1) on the outer edge of the turn initiation area, add a tolerance to account for pilot reaction time (c: a distance equivalent to 6 seconds of flight (See 6.4.3, "Turn parameters")). This establishes point A; and

2) from point A, construct the outer boundary as described in Section 2, Chapter 3, "Turn area construction".

6.4.5.3 *Obstacle clearance for turns at a designated altitude*

a) *Obstacle clearance in the turn initiation area*. The straight missed approach obstacle clearance criteria apply up to the TP. This allows the calculation of OCA/H for final approach and straight missed approach segments (OCA/H_{fm}) (see 6.3.5, "Obstacle clearance for the straight missed approach"). An additional obstacle assessment must be made to assure that the obstacle elevation/height in the turn initiation area shall be less than

TNA/H – 50 m (164 ft)

(Cat H, TNA/H – 40 m (132 ft))

b) *Obstacle clearance in the turn area.* Obstacle elevation/height in the turn area shall be less than:

$$TNA/H + d_o \tan Z - MOC$$

where: d_o is measured from the obstacle to the nearest point on the turn initiation area boundary; and

MOC is 50 m (164 ft) (Cat H, 40 m (132 ft)) reducing linearly to zero at the outer edge of the secondary areas, if any.

6.4.5.4 *Establishment of turn altitude/height*

The choice of the turn altitude/height (TNA/H) and associated turn point (TP) is an iterative process. The TP must be located so that the obstacle clearance criteria in both the turn initiation area and turn area are satisfied. Once SOC and OCA/H_{fm} are determined, turn altitude/height (TNA/H) may be computed from the following relationship:

$$TNA/H = OCA/H_{fm} + d_z \tan Z$$

where d_z is the horizontal distance from SOC to the TP.

If the latest TP has to be located at or before the SOC calculated for the final and straight missed approach, then the MAPt shall be moved back and, if necessary, the OCA/H increased. (See 6.1.5.1.)

6.4.5.5 *Turn altitude/height adjustments*

If the criteria specified in 6.4.5.3, "Obstacle clearance for turns at a designated altitude" cannot be met, the turn altitude/height shall be adjusted. This can be done in three ways:

a) adjust TNA/H without changing OCA/H. This means that the latest TP will be moved and the areas redrawn accordingly;

b) move SOC back to increase d_z. This means that the MAPt and consequently earliest TP will be moved and the turn areas extended accordingly; and

c) increase OCA/H.

6.4.5.6 *Safeguarding of early turns*

If the procedure does not prohibit turns before the MAPt, then an additional area outside the final approach area must be considered (see Figure I-4-6-14). In this area obstacle elevation shall be less than:

$$TNA/H + d_o \tan Z - 50 \text{ m } (164 \text{ ft})$$

$$(\text{Cat H}, TNA/H + d_o \tan Z - 40 \text{ m } (132 \text{ ft}))$$

where d_o is measured from the obstacle to the nearest point on the edge of the final approach area. If this criterion cannot be met, then the procedure must prohibit turns before the MAPt and a note must be added on the profile view of the approach chart.

6.4.6 Turn initiated at a designated turning point

6.4.6.1 *General.* A designated TP shall be defined by a fix (see Section 2, Chapter 2, 2.3 and 2.4), or by a limiting radial, bearing or DME distance (see Section 2, Chapter 2, 2.6.5). It is chosen to allow the aircraft to avoid an obstacle straight ahead. The straight missed approach criteria apply up to the earliest TP. This allows the calculation of OCA/H for final and straight missed approach (OCA/H_{fm}) (see 6.2 "Climb gradient and MOC"). SOC is then determined.

6.4.6.2 *Turning point tolerance area.* The length of the TP tolerance area is determined by:

a) the limits of the fix tolerance area, plus;

b) an additional distance c (pilot reaction and bank establishing time) equivalent to 6 seconds of flight at final missed approach (or maximum published missed approach) speed plus 56 km/h (30 kt) tailwind (see Figure I-4-6-15). Some example values of c are shown in Tables I-4-6-5 and I-4-6-6.

   If the TP is defined by overheading a facility (e.g. VOR, NDB) the TP fix tolerance can be taken as ± 0.9 km (± 0.5 NM) up to a height above the facility of:

   i) 750 m (2 500 ft) for a VOR (with a cone angle of 50°); and

   ii) 1 100 m (3 600 ft) for an NDB.

6.4.6.3 *Construction of the turn area*

6.4.6.3.1 Turns are executed in the final missed approach area. This area begins at point A, which is located at the latest limit of the TP tolerance area (defined above). Its sides begin at the edges of the straight missed approach area.

6.4.6.3.2 TP defined by a fix or by a limiting radial, bearing or DME distance.

a) *Outer boundary:*

   1) On the outside edge of the missed approach area, determine point A (see Figure I-4-6-15).

2) From point A, construct the outer boundary as described in Section 2, Chapter 3, "Turn area construction".

b) *Inner boundary:*

1) On the inner edge of the missed approach area, at the earliest TP tolerance, determine point K.

2) From point K, draw a line splayed outward at an angle of 15° from the nominal track after the turn.

c) *Particular cases*: for particular cases (turns more than 90°, return to the FAF), draw the area after that turn as shown on Figures I-4-6-16, I-4-6-17 and I-4-6-18.

6.4.6.3.3 *TP marked by a facility (NDB or VOR).* When the turning point is marked by a facility (NDB or VOR) the area is constructed as follows.

a) *Inner boundary:* the boundary which is associated with tracking outbound from this facility after the turn.

b) *Outer boundary:* in order to accommodate the overshoot when turning over a navaid, the boundary on the outer side of the turn must be widened as follows:

1) determine the latest TP tolerance (point A);

2) from point A, construct the outer boundary (see Section 2, Chapter 3, "Turn area construction") up to the point where its tangent becomes parallel to the nominal track after the turn; and

3) from this point the area boundary remains parallel to the nominal track until it intersects the area associated with the navaid (see Figure I-4-6-19).

6.4.6.4 *Obstacle clearance in the turn area*

Obstacle elevation in the turn area shall be less than:

$$OCA/H_{fm} + d_o \tan z - MOC$$

where: $d_o = d_z$ + shortest distance from obstacle to line K-K,

d_z = horizontal distance from SOC to earliest TP (line K-K)

and MOC is 50 m (164 ft) (Cat H, 40 m (132 ft)) for turns more than 15° reducing linearly to zero at the outer edge of the secondary areas, if any.

6.4.7 Turn specified at the MAPt

Where the turn is specified at the MAPt which means that the pilot is supposed to establish the aeroplane on a climbing path and then to turn, the OCA/H will be taken as the turn altitude/height and the turn initiation area will extend from the earliest MAPt to the SOC (see Figure I-4-6-20).

6.5 PROMULGATION

6.5.1 If safeguarding of early turns is not provided a note must be added on the profile view of the approach chart: "No turn before MAPt".

6.5.2 The OCA/H for the nominal 2.5 per cent must always be published on the instrument approach chart. If additional gradients are specified in the construction of the missed approach procedure, they and their associated OCA/H values must be published as alternative options.

Table I-4-6-1. Values for Z (Earliest and latest MAPt for MAPt determined by distance from the FAF)

Aircraft category	*Distance from nominal MAPt to earliest and latest MAPt*
Category A	max {2463; 0.3897D + 1086}
Category B	max {2463; 0.2984D + 1408}
Category C	max {2463; 0.1907D + 1787}
Category D	max {2463; 0.1562D + 1908}

Where D = distance from nominal FAF to nominal MAPt (km). The values in the table are SI units (meters).

Table I-4-6-2. Computation of transitional distance

Aircraft category	*Transitional distance (X)*
Category A	max {0.0875D + 2591; 0.3954D + 1604}
Category B	max {0.0681D + 3352; 0.3246D +1653}
Category C	max {0.0567D + 3794; 0.2328D + 1945}
Category D	max {0.0495D + 4153; 0.2055D + 2073}

Where D = distance from nominal FAF to nominal MAPt (km). The values in the table are in SI units (meters).

Table I-4-6-3. Example: Distance d corresponding to 600 m (2 000 ft) above MSL

Aircraft category	*A*	*B*	*C*	*D*	*E*	*H*
d	0.18 km (0.10 NM)	0.23 km (0.12 NM)	0.28 km (0.15 NM)	0.32 km (0.17 NM)	0.39 km (0.21 NM)	0.16 km (0.09 NM)

Table I-4-6-4. Example: Distance of transitional tolerance

Aircraft category	*A*	*B*	*C*	*D*	*E*	*H*
X (computed at 600 m (2 000 ft) above MSL)	0.89 km (0.48 NM)	1.14 km (0.61 NM)	1.38 km (0.75 NM)	1.60 km (0.86 NM)	1.95 km (1.05 NM)	0.27 km (0.15 NM)

Table I-4-6-5. Examples of the values of the parameters used in the turning missed approach area construction (calculated for 600 m MSL) (for abbreviations, see 6.4.3)

IAS *(km/h)*	*TAS* *(600 m, ISA + 15)* *IAS × conversion factor** *(km/h)*	*c* *6 seconds* $(TAS + 56) \times \frac{6}{3\,600}$ *(km)*	*R* $\frac{542}{TAS}$ *(deg/s)*	*r* $\frac{TAS}{62.8R}$ *(km)*	*E* $\frac{1.4}{R}$ *(km)*
205	217	0.46	2.50	1.38	0.56
280	296	0.59	1.83	2.57	0.76
345	364	0.70	1.49	3.89	0.94
400	422	0.80	1.28	5.23	1.09
445	470	0.88	1.15	6.49	1.21
490	518	0.96	1.05	7.85	1.34
510	539	0.99	1.01	8.54	1.39

* For conversion from IAS to TAS, see Part I, Section 2, Chapter 1, Appendix.

Table I-4-6-6 Examples of the values of the parameters used in the turning missed approach area construction (calculated for 2 000 ft MSL) (for abbreviations, see 6.4.3)

IAS (kt)	*TAS* (2 000 ft, ISA + 15) IAS conversion factor* (kt)	*c* 6 seconds $(TAS + 30) \times \frac{6}{3600}$ (NM)	*R* $\frac{293}{TAS}$ (deg/s)	*r* $\frac{TAS}{62.8R}$ (NM)	*E* $\frac{0.75}{R}$ (NM)
110	116	0.24	2.53	0.73	0.30
150	159	0.32	1.84	1.37	0.41
185	195	0.38	1.50	2.07	0.50
200	211	0.40	1.39	2.42	0.54
240	254	0.47	1.15	3.51	0.65
265	280	0.52	1.05	4.25	0.72
275	291	0.54	1.01	4.60	0.74

* For conversion from IAS to TAS, see Part I, Section 2, Chapter 1, Appendix.

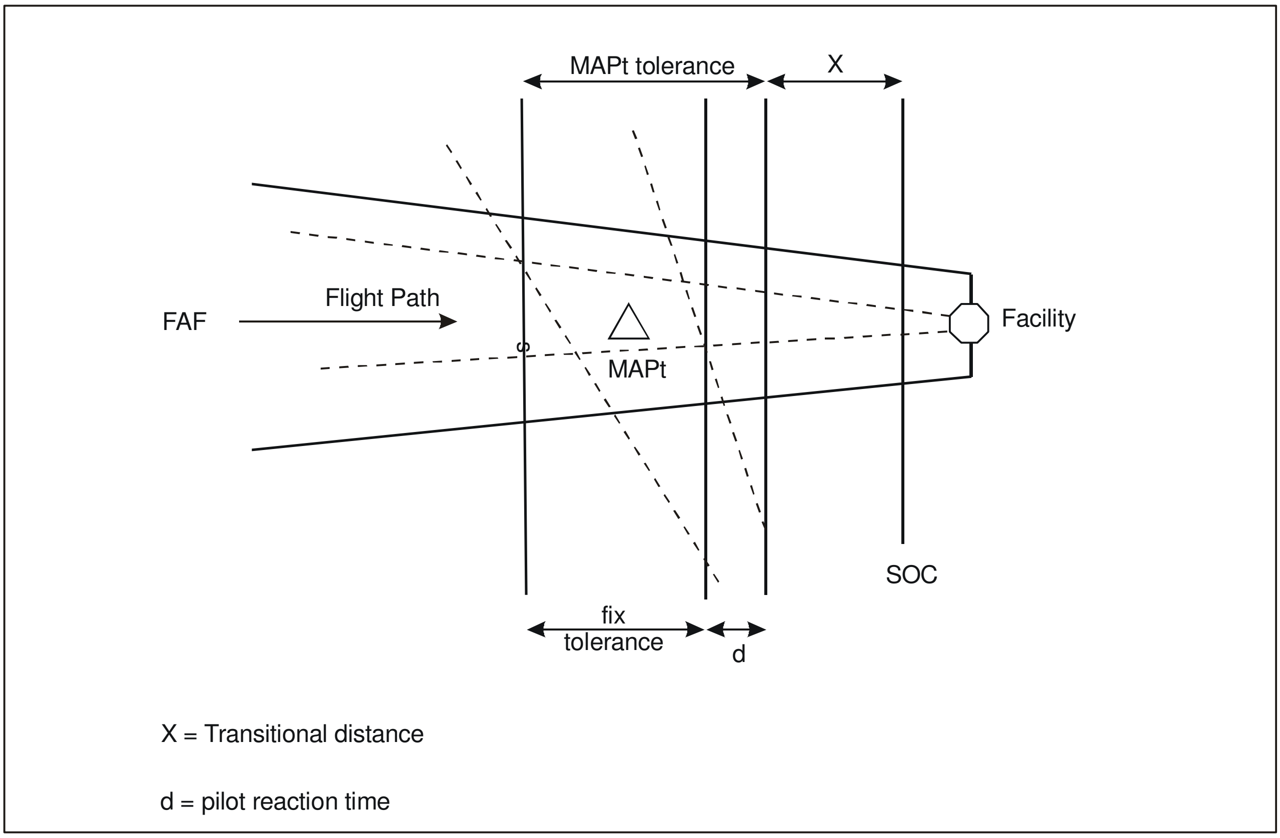


Figure I-4-6-1. Determining SOC with an MAPt defined by a navigation facility or fix

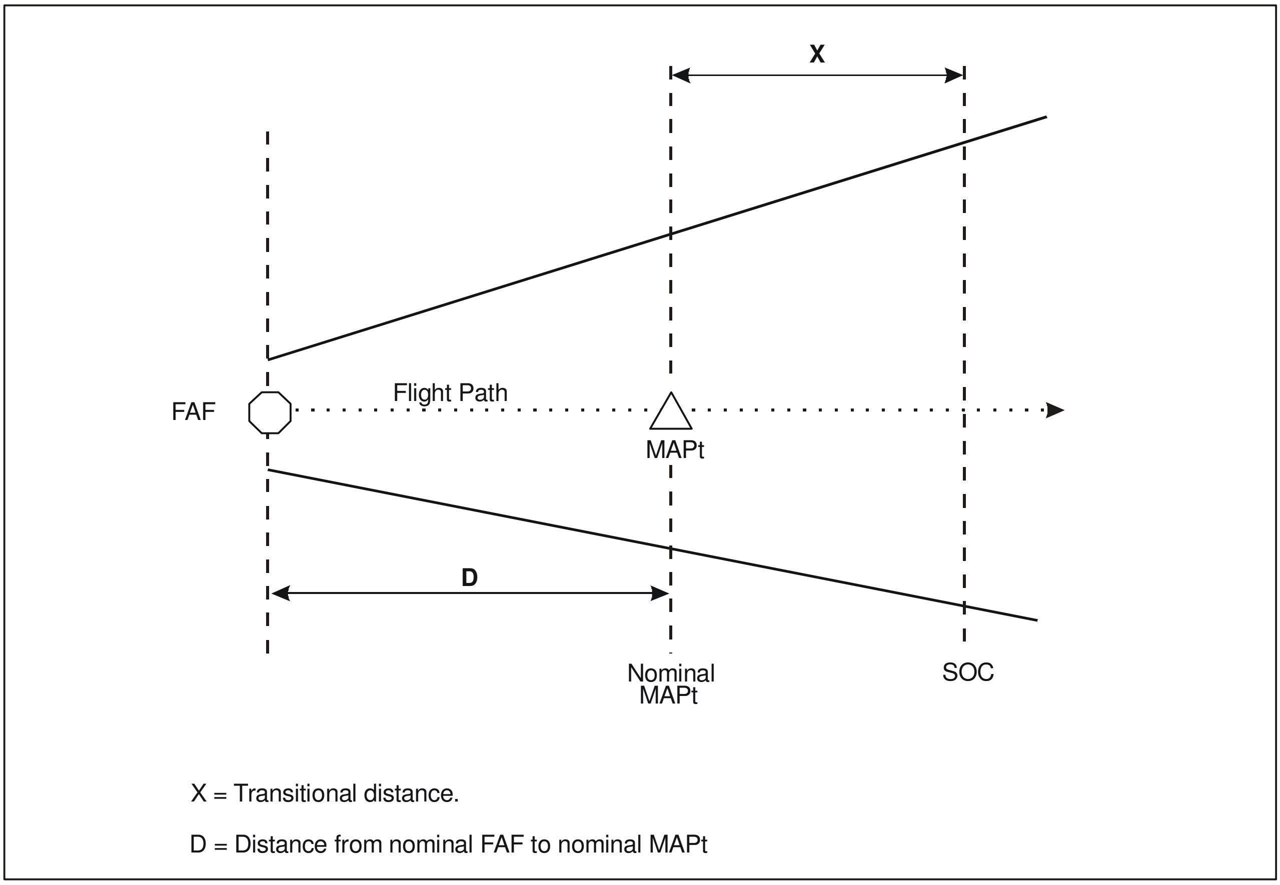
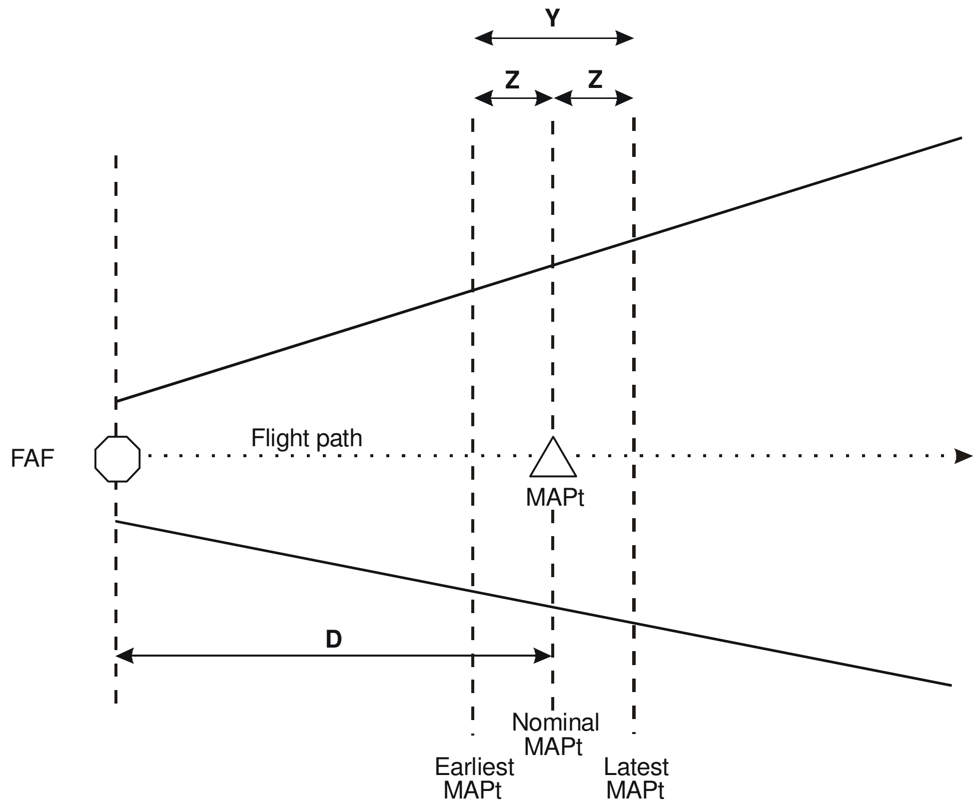


Figure I-4-6-2. Determining SOC with an MAPt defined by a distance from the FAF



D = Distance from FAF to Nominal MAPt
Z = Earliest MAPt to Nominal MAPt
or
Nominal MAPt to Latest MAPt

Y = total MAPt tolerance

Figure I-4-6-3. Distance from nominal MAPt to earliest and latest MAPt

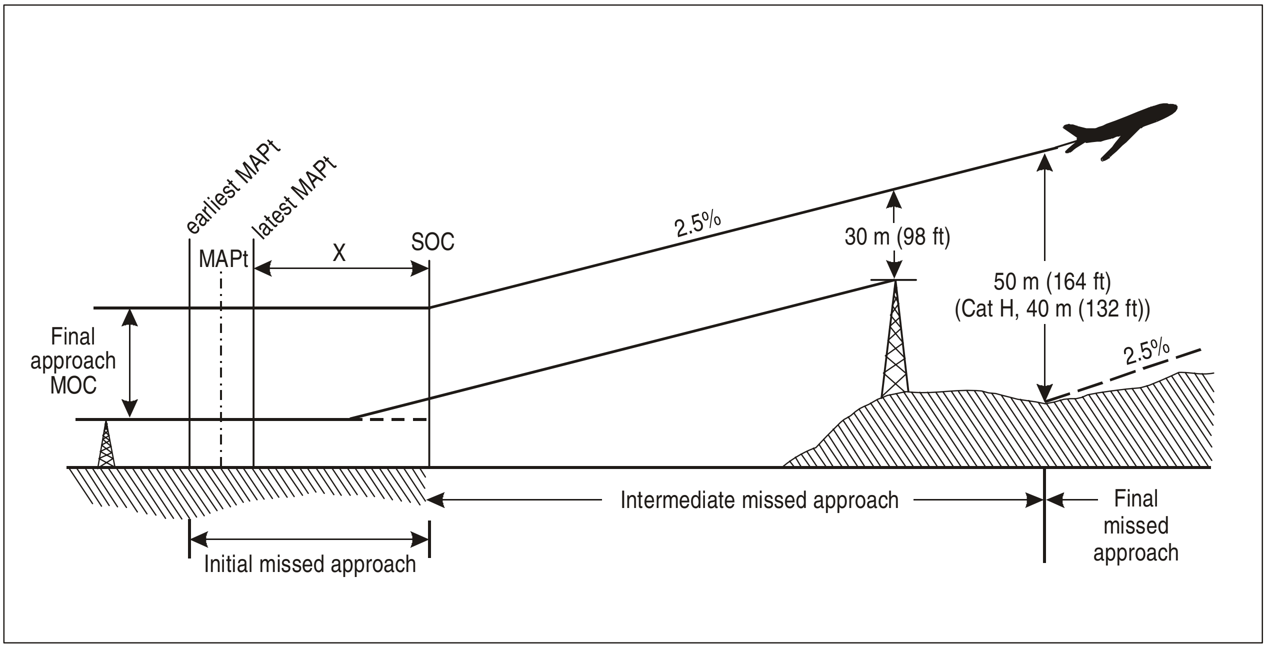


Figure I-4-6-4. Obstacle clearance for final missed approach phase

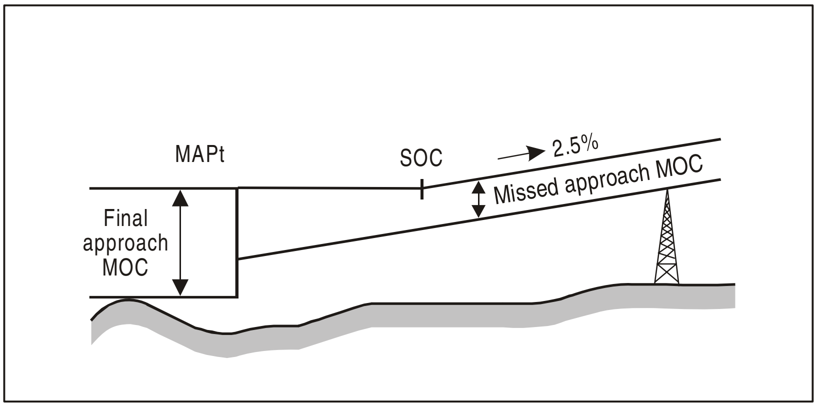


Figure I-4-6-5. Case where the extension of the missed approach surface covers the initial missed approach phase entirely

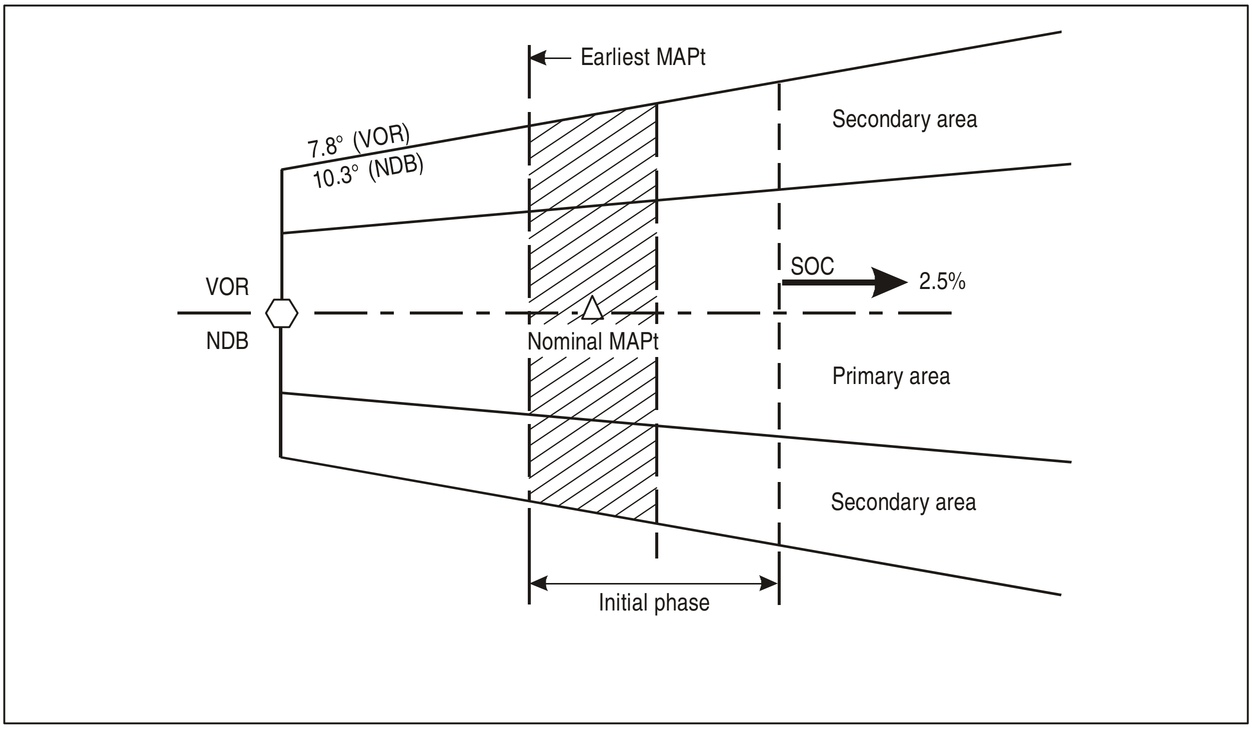


Figure I-4-6-6. Area for straight missed approach

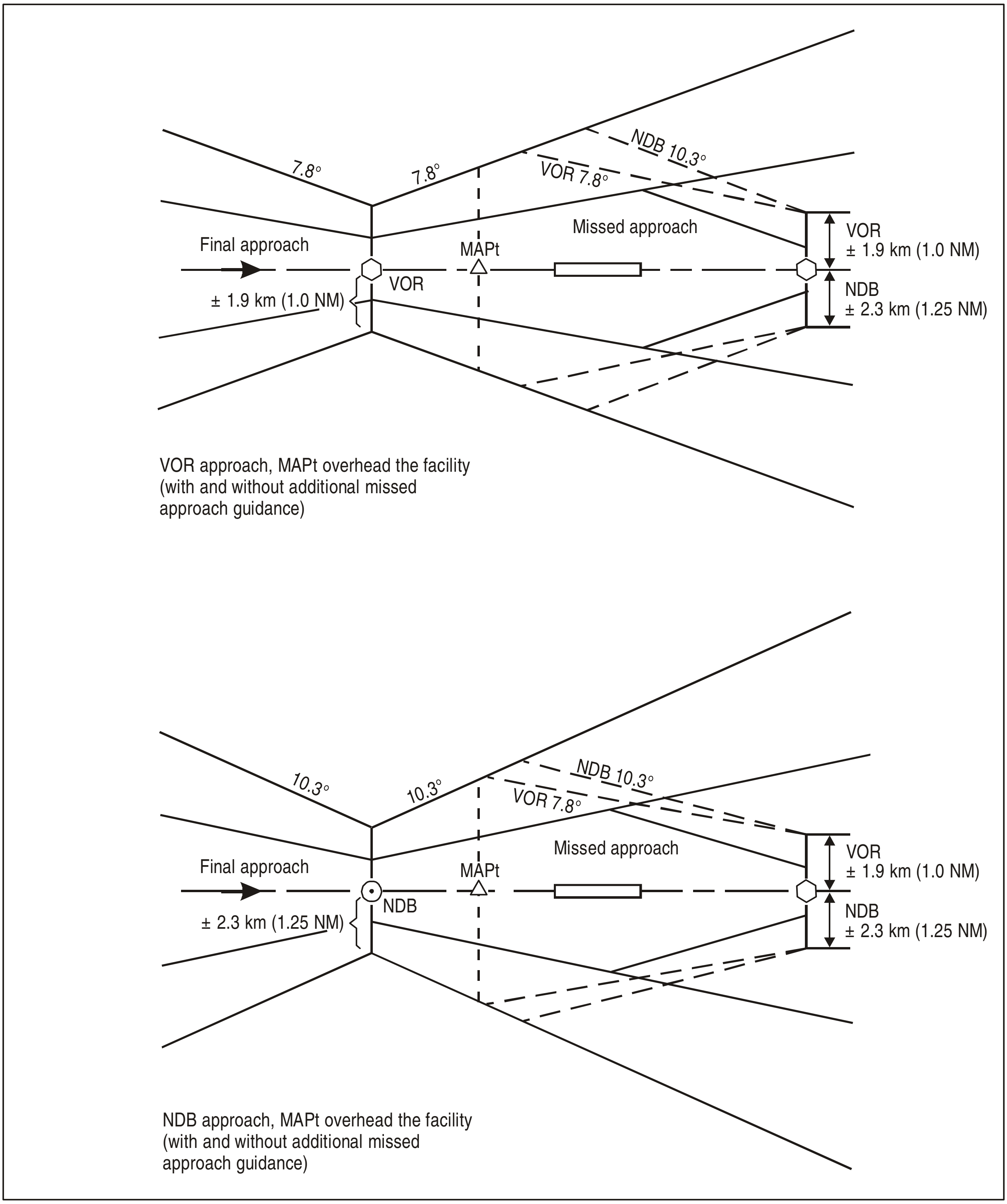


Figure I-4-6-7. Area associated with additional track guidance for MAPt defined by a navigation facility

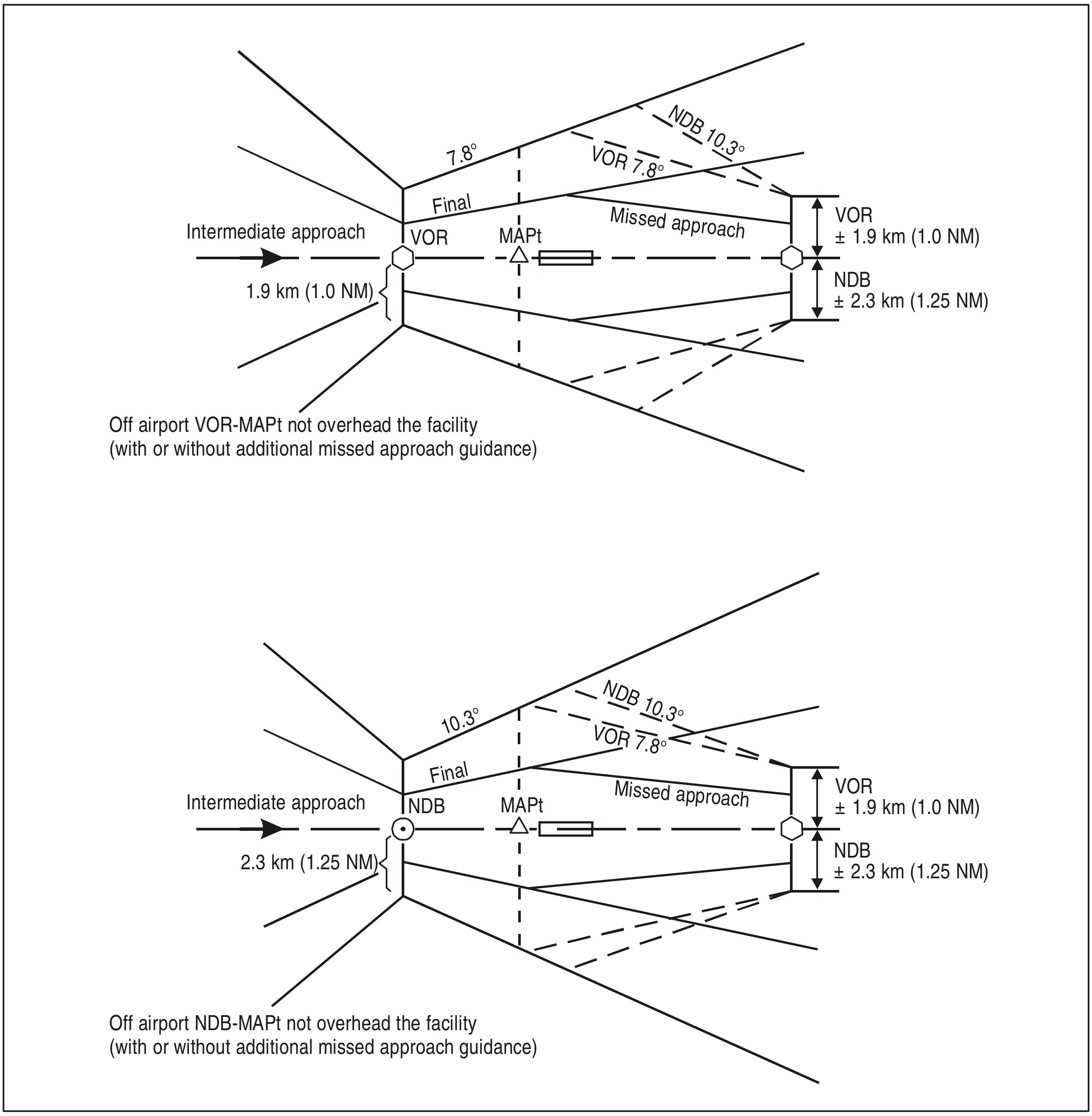


Figure I-4-6-8. Areas associated with additional track guidance for MAPt not at a facility

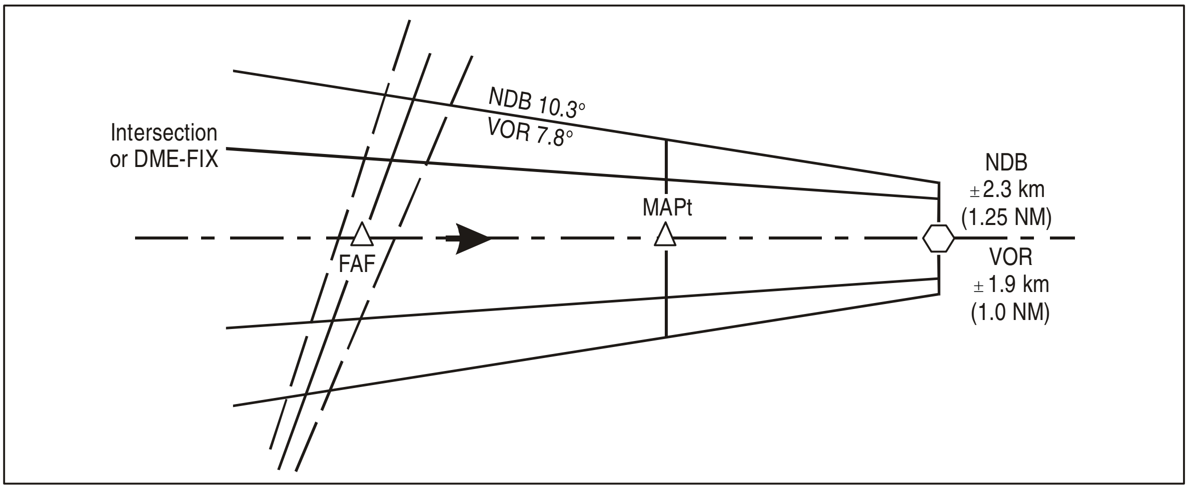


Figure I-4-6-9. Example of area where the track guidance for missed approach is a continuation of guidance from the facility used on the final approach

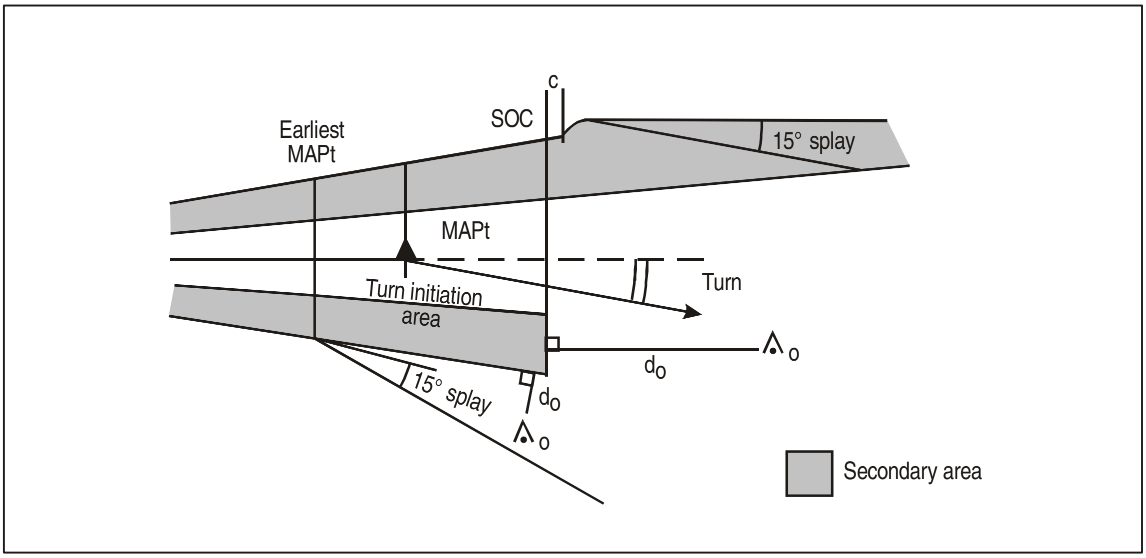


Figure I-4-6-10. Missed approach turn 15° or less at the MAPt

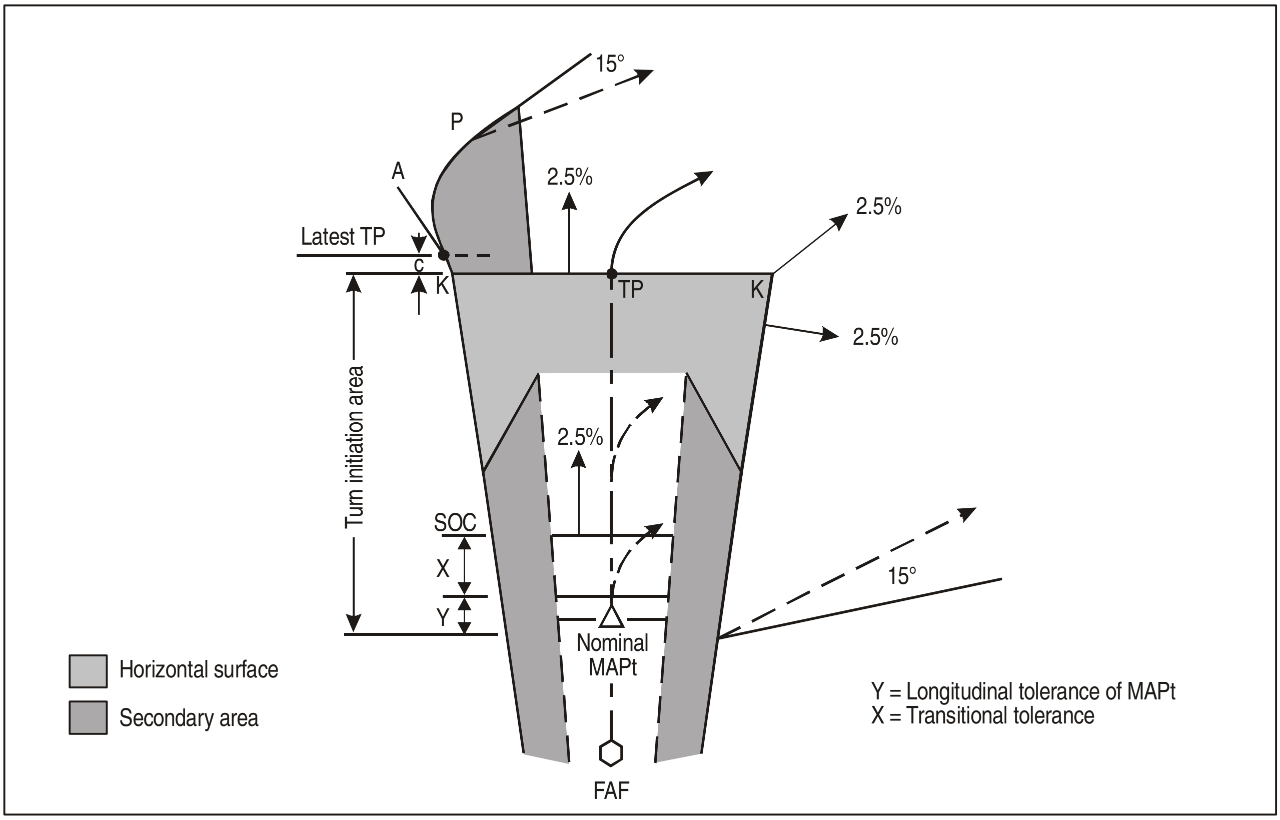


Figure I-4-6-11. Turn less than 75° at an altitude

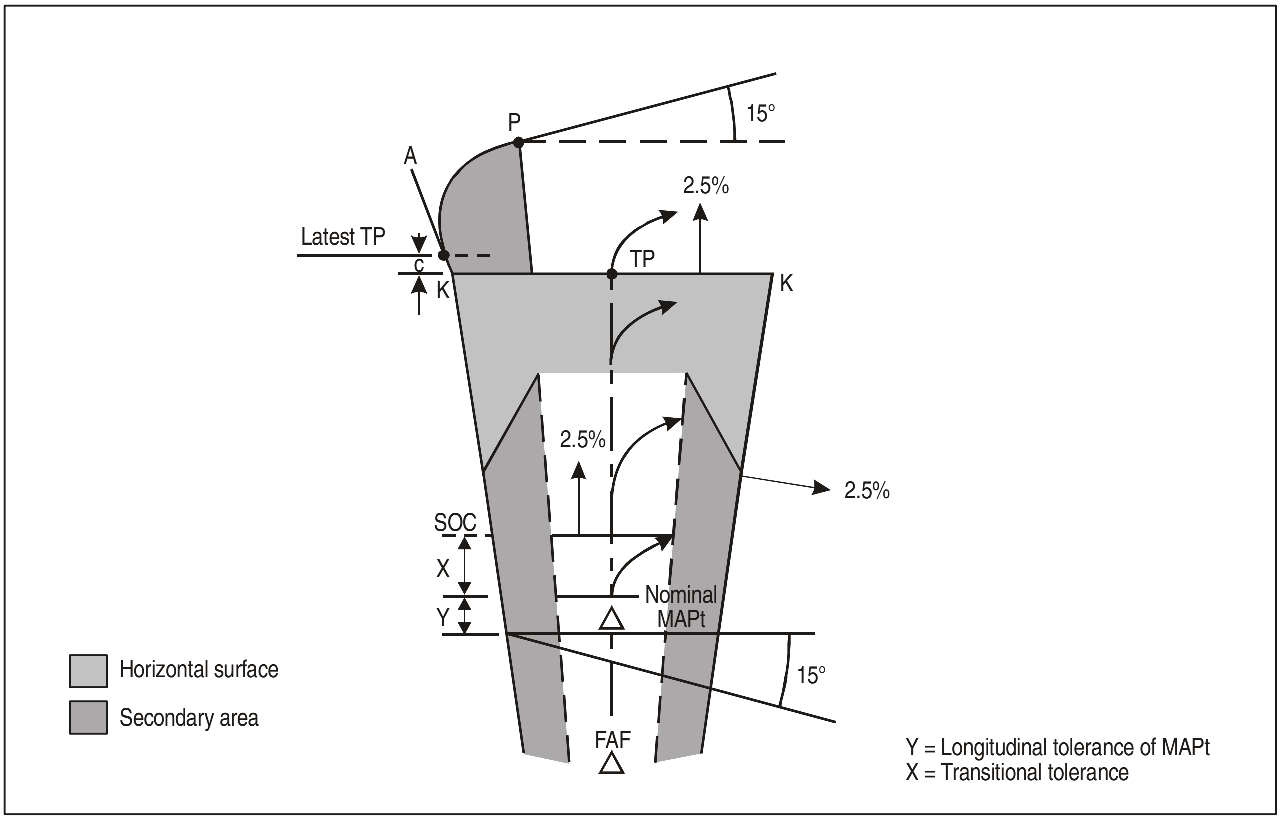


Figure I-4-6-12. Turn more than 75° at an altitude

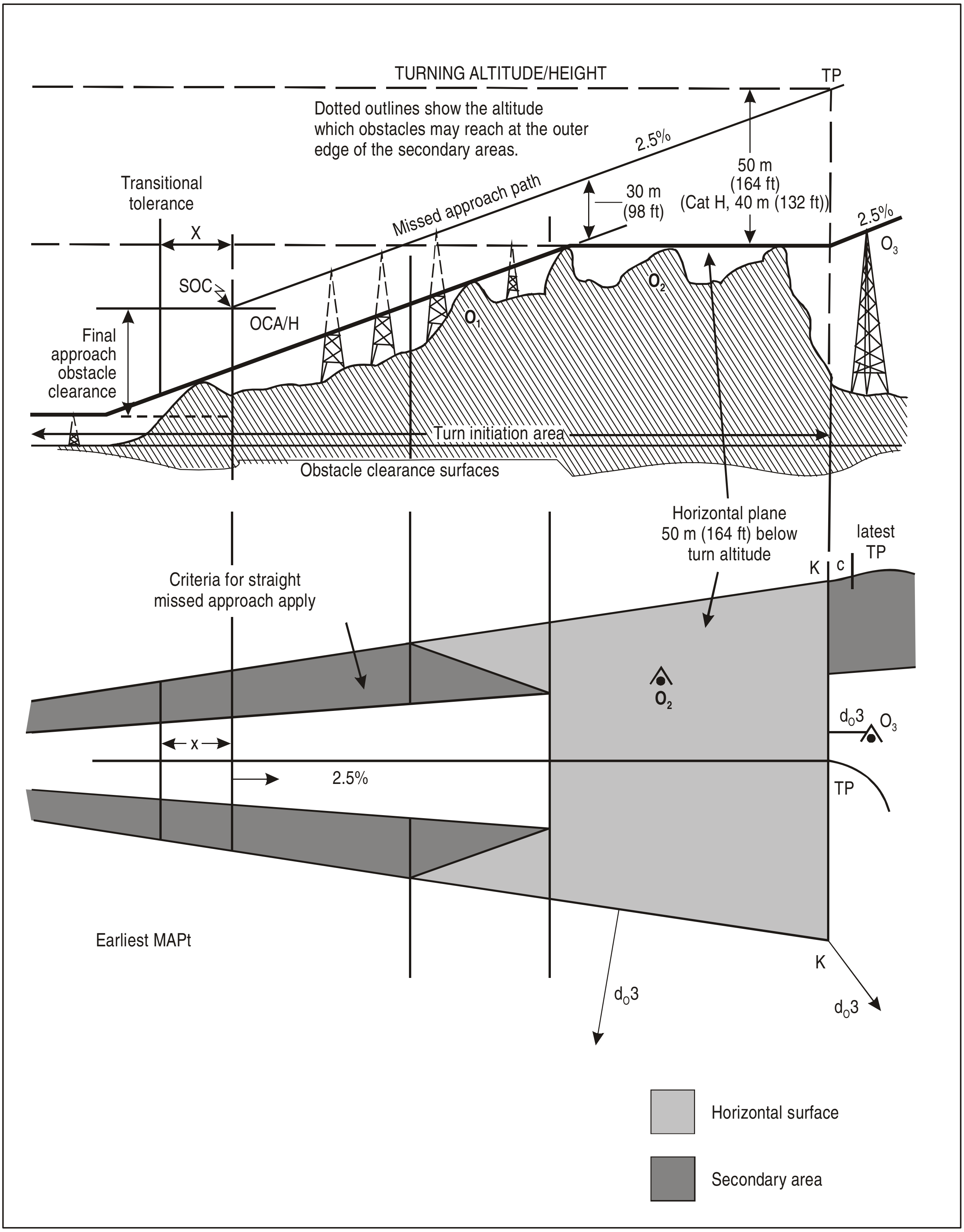


Figure I-4-6-13. Obstacle clearance within turn initiation

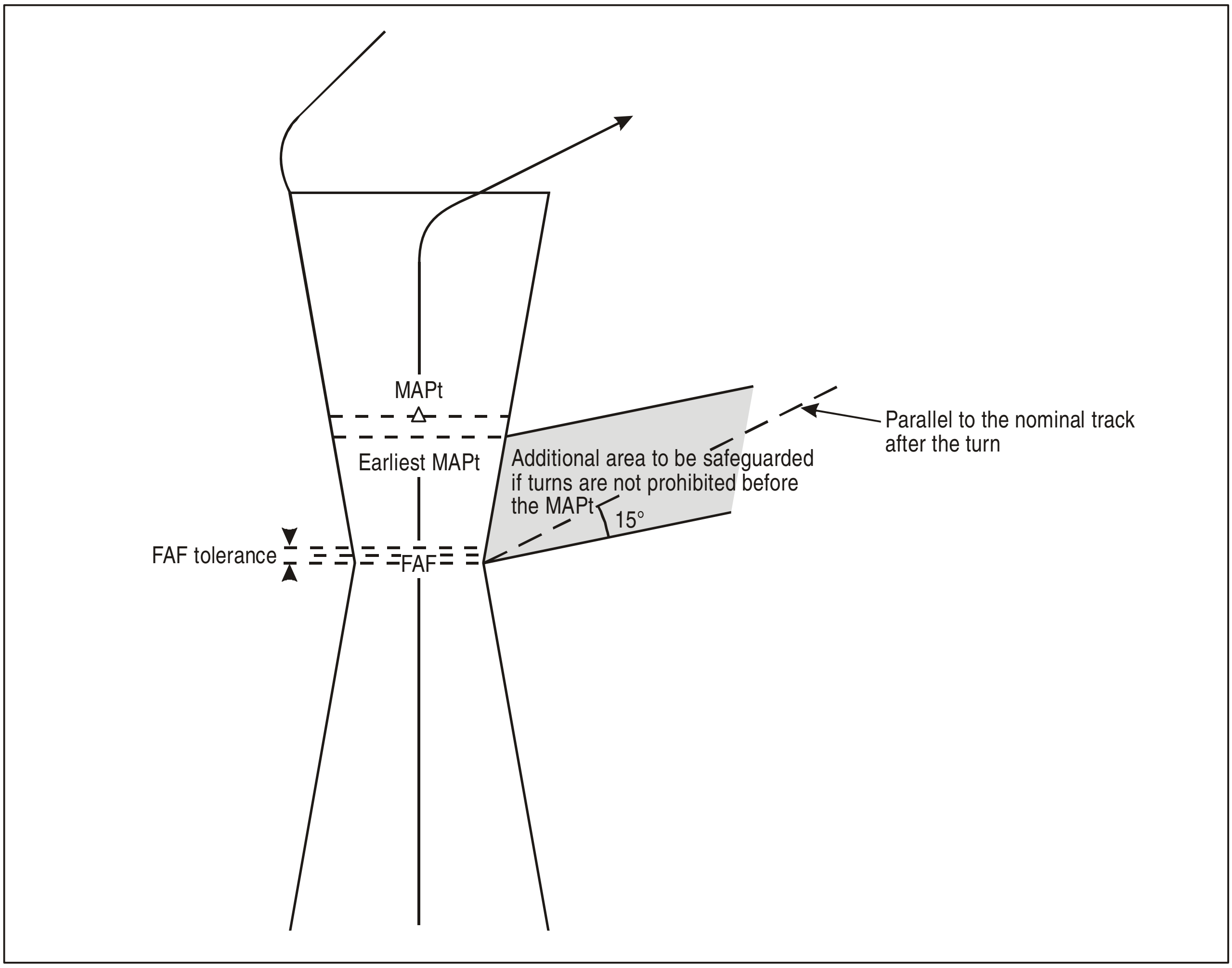


Figure I-4-6-14. Limitation of early turns — additional safeguarding requirement

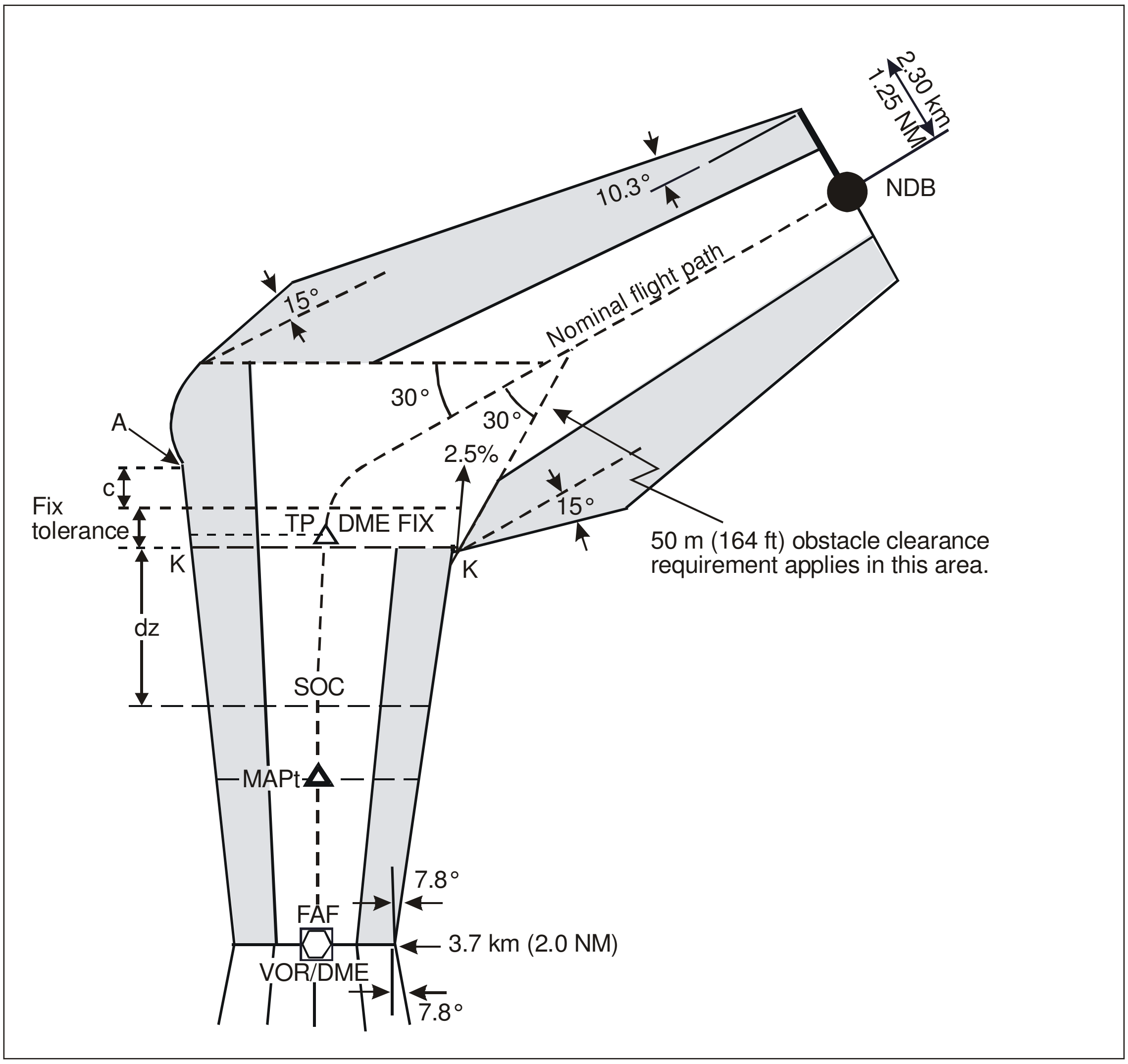


Figure I-4-6-15. Turning missed approach with DME as TP fix

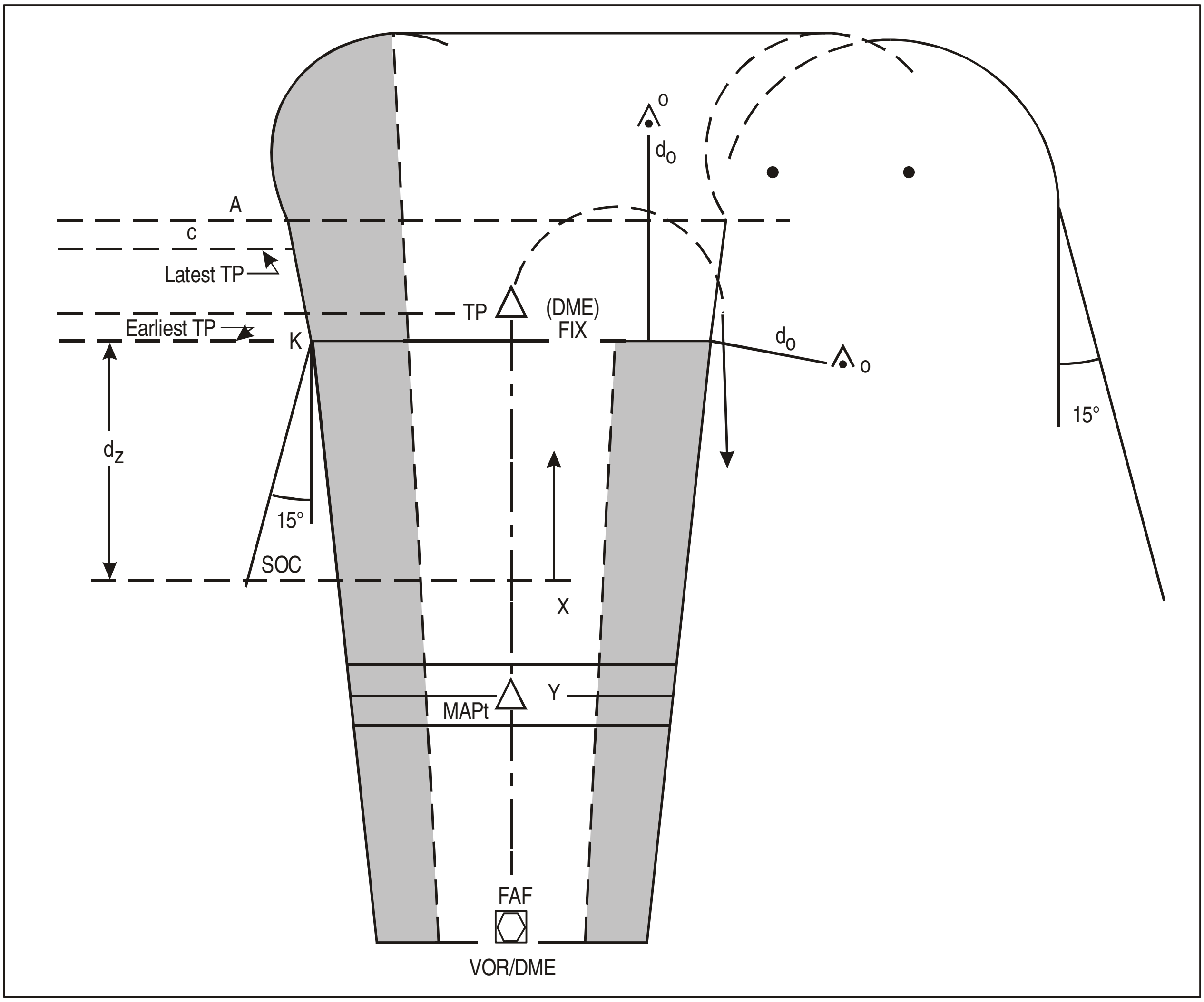
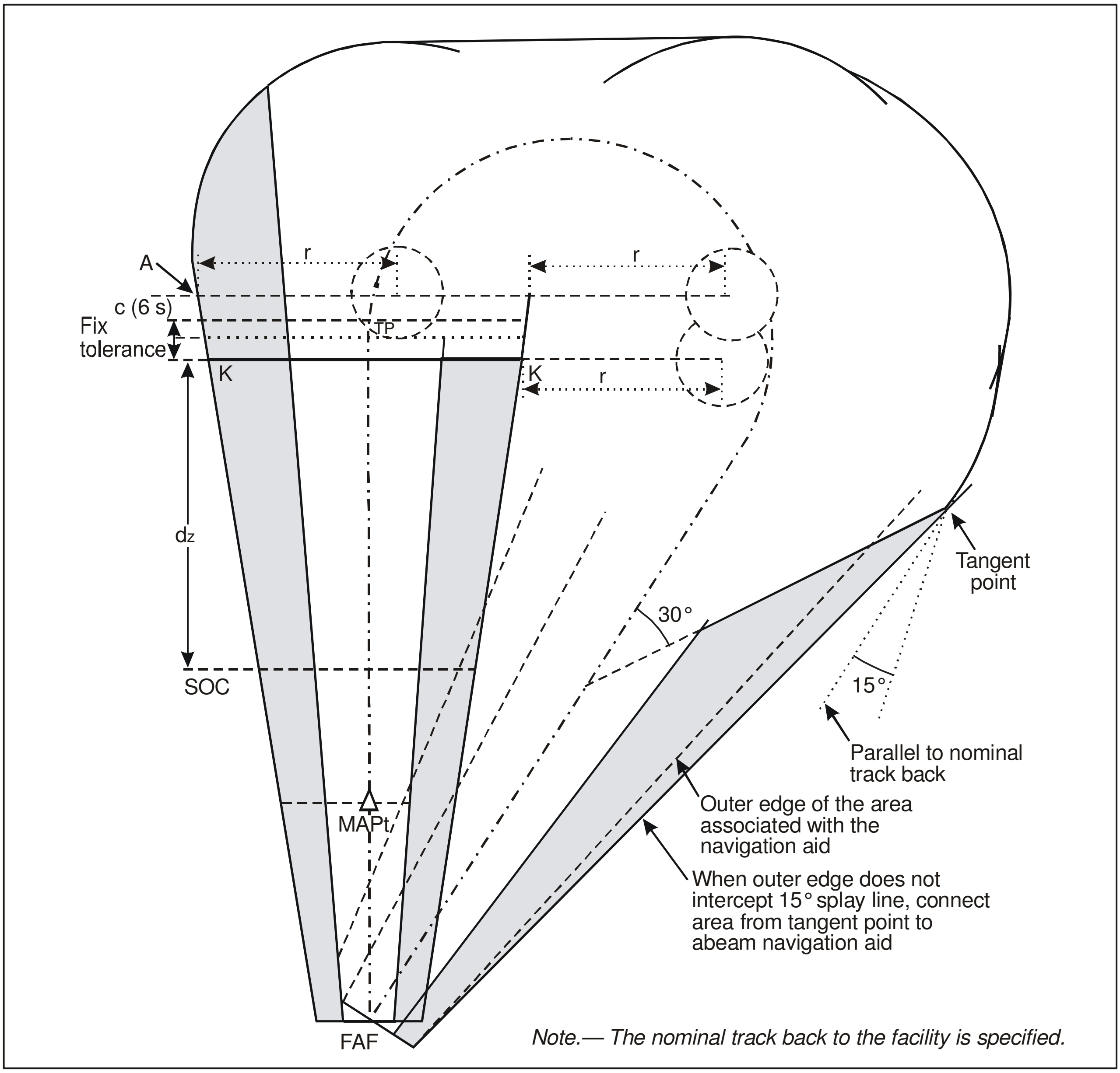


Figure I-4-6-16. 180° turning missed approach with DME as TP fix



Note.— The nominal track back to the facility is specified.

Figure I-4-6-17. Turning missed approach with TP fix and return to the facility with track back

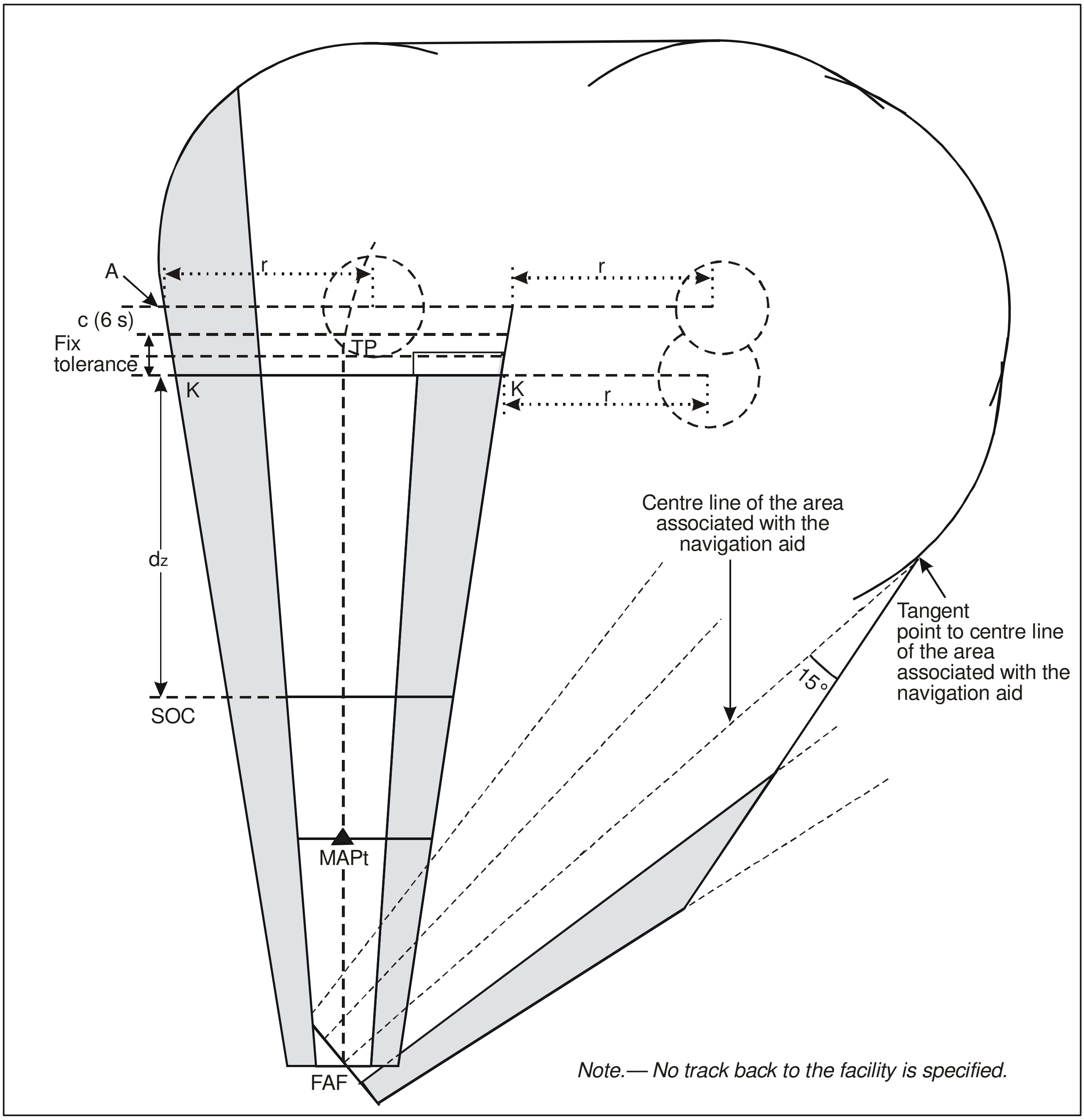


Figure I-4-6-18. Turning missed approach with TP fix and return to the facility without track back

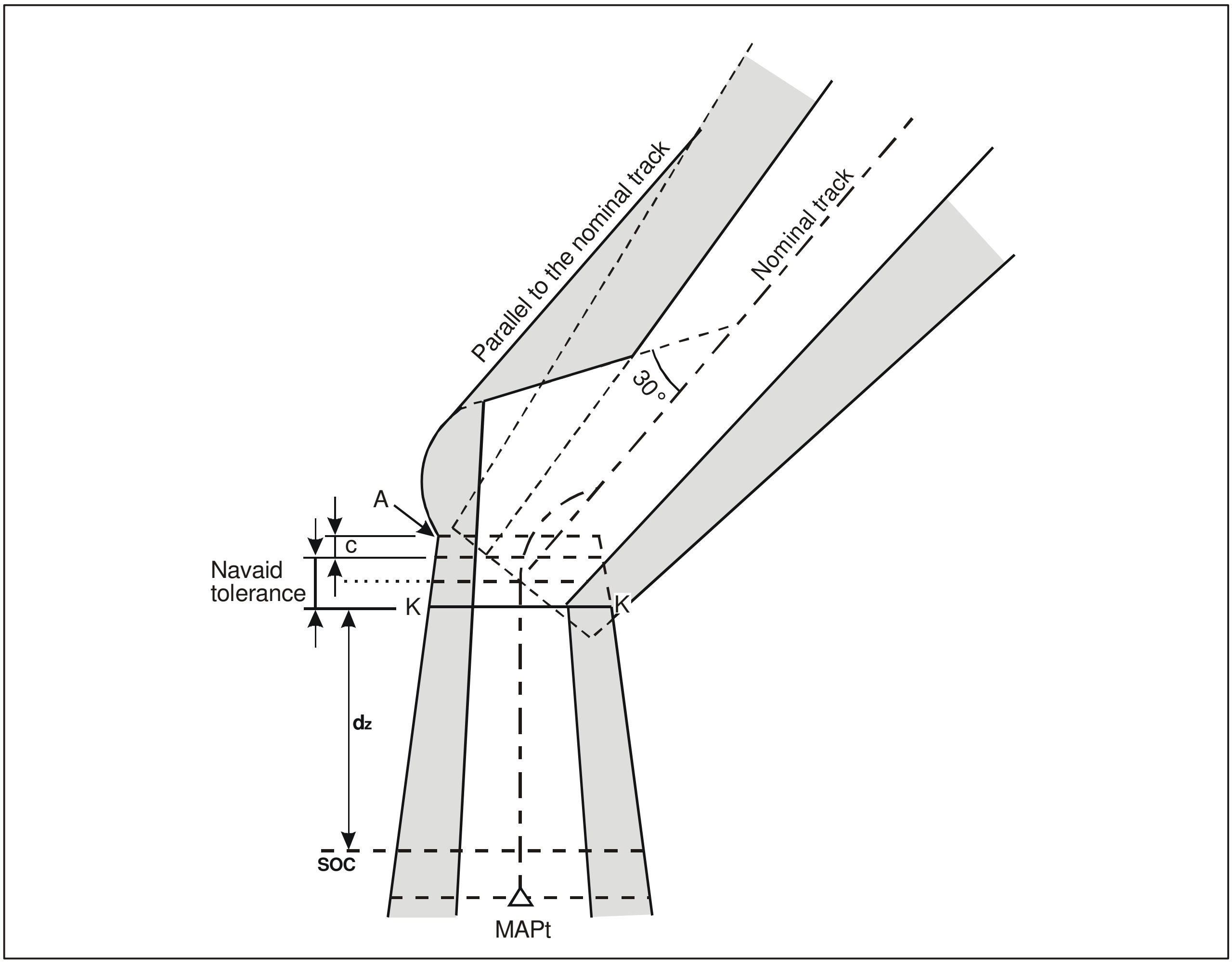


Figure I-4-6-19. Turning missed approach involving turns over a facility

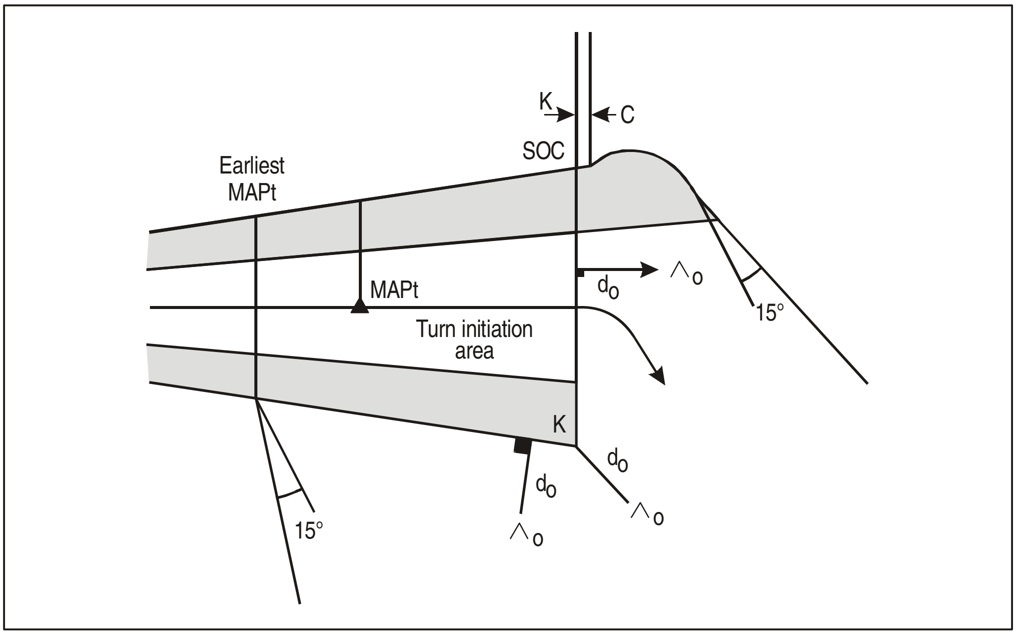


Figure I-4-6-20. Missed approach turn more than 15° at the MAPt

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Appendix to Chapter 6

REFINED METHOD FOR CALCULATING MAPt AND TRANSITIONAL TOLERANCES FOR A MISSED APPROACH POINT DEFINED BY A DISTANCE FROM THE FAF

1. INTRODUCTION

1.1 This appendix shows the full Root Sum Square (RSS) method for calculating:

a) distance from earliest MAPt to nominal MAPt;

b) distance from nominal MAPt to latest MAPt; and

c) distance from nominal MAPt to SOC,

when the MAPt is defined by a distance from the FAF.

1.2 The criteria contained in Part I, Section 4, Chapter 6, 6.1.6.3, "Determining SOC with an MAPt defined by a distance from the FAF (simplified method)" are conservative in certain cases. To overcome this conservatism, distances may be calculated precisely using the formulas in this appendix.

1.3 The equations shown in Chapter 6, Table I-4-6-1, "Values for Z (Earliest and latest MAPt for MAPt determined by distance from the FAF)" and Chapter 6, Table I-4-6-2, "Computation of transitional distance" were derived by linear interpolation from the accurate RSS calculations at the extreme values quoted (i.e. aircraft Categories A to D and for all aerodrome elevations up to 4 000 m (13 000 ft)).

2. CALCULATION

2.1 General

The calculation of each of the relevant distances is done in two steps, using the maximum and minimum final approach speeds for the category of aircraft. The considered distance is the higher of the two found.

2.2 Factors

The empirical RSS method takes into account the following factors:

a) the fix tolerance at the FAF (assumed as 1.9 km (1.0 NM) to develop the simplified equations in the body of this chapter);

b) the minimum permissible speed at ISA – 10°C or the maximum permissible speed at ISA + 15°C, whichever is the more critical for each category of aircraft considered;

c) the effect of a wind of ± 56 km/h (± 30 kt); and

d) a timing tolerance of – 10 to + 13 seconds which includes a pilot timing tolerance of ± 10 seconds and a pilot reaction time of 0 to +3 seconds.

Note.— The value in c) corresponds to the effect of a ± 56 km/h (± 30 kt) unaccounted for wind throughout the final approach segment. This is different from the 19 km/h (10 kt) wind effect considered in the calculation of d and X tolerances. In the latter case the aeroplane path is very close to the ground and the actual wind cannot be much different from the wind reported for the aerodrome.

2.3 Parameters

2.3.1

a = distance from the earliest point of the FAF tolerance to the FAF;

b = distance from the FAF to the latest point of the FAF tolerance;

D = distance from FAF to nominal MAPt;

TASMIN = slowest final approach IAS for the relevant aircraft category (Tables I-4-1-1 and I-4-1-2 in Chapter 1) converted to TAS, allowing for aerodrome elevation and temperature ISA – 10;

TASMAX = fastest final approach IAS for the relevant aircraft category (Tables I-4-1-1 and I-4-1-2 in Chapter 1) converted to TAS, allowing for aerodrome elevation and temperature ISA + 15.

2.3.2 *Distance from earliest MAPt to nominal MAPt*

SI units

$$X1 = (a^2 + (TASMIN \times 10/3600)^2 + (56 \times D/TASMIN)^2)^{0.5}$$
$$X2 = (a^2 + (TASMAX \times 10/3600)^2 + (56 \times D/TASMAX)^2)^{0.5}$$

Non-SI units

$$X1 = (a^2 + (TASMIN \times 10/3600)^2 + (30 \times D/TASMIN)^2)^{0.5}$$
$$X2 = (a^2 + (TASMAX \times 10/3600)^2 + (30 \times D/TASMAX)^2)^{0.5}$$

Distance from earliest MAPt to nominal MAPt = max {X1; X2}

2.3.3 *Distance from nominal MAPt to latest MAPt*

SI units

$$X3 = (b^2 + (TASMIN \times 13/3600)^2 + (56 \times D/TASMIN)^2)^{0.5}$$
$$X4 = (b^2 + (TASMAX \times 13/3600)^2 + (56 \times D/TASMAX)^2)^{0.5}$$

Non-SI units

$X3 = (b^2 + (TASMIN \times 13/3600)^2 + (30 \times D/TASMIN)^2)^{0.5}$
$X4 = (b^2 + (TASMAX \times 13/3600)^2 + (30 \times D/TASMAX)^2)^{0.5}$

Distance from nominal MAPt to latest MAPt = max {X3; X4}

2.3.4 *Distance from nominal MAPt to SOC*

SI units

$X5 = (b^2 + (TASMIN \times 13/3600)^2 + (56 \times D/TASMIN)^2)^{0.5} + 15 \times (TASMIN + 19)/3600$
$X6 = (b^2 + (TASMAX \times 13/3\,600)^2 + (56 \times D/TASMAX)^2)^{0.5} + 15 \times (TASMAX + 19)/3600$

Non-SI units

$X5 = (b^2 + (TASMIN \times 13/3600)^2 + (30 \times D/TASMIN)^2)^{0.5} + 15 \times (TASMIN + 10)/3600$
$X6 = (b^2 + (TASMAX \times 13/3600)^2 + (30 \times D/TASMAX)^2)^{0.5} + 15 \times (TASMAX + 10)/3600$

Distance from nominal MAPt to SOC = max {X5; X6}.

Chapter 7

VISUAL MANOEUVRING (CIRCLING) AREA

7.1 GENERAL

7.1.1 Definition of terms

Visual manoeuvring (circling) is the term used to describe the visual phase of flight after completing an instrument approach, which brings an aircraft into position for landing on a runway which is not suitably located for straight-in approach, i.e. one where the criteria for alignment or descent gradient cannot be met.

7.1.2 Area to be considered for obstacle clearance

The visual manoeuvring (circling) area is the area in which obstacle clearance shall be considered for aircraft manoeuvring visually (circling).

7.1.3 Visual manoeuvring for helicopters

This chapter does not apply to Category H. In an instrument approach where the landing axis does not permit a straight-in approach, helicopters must conduct a visual manoeuvre under meteorological conditions adequate for seeing and avoiding obstacles in the vicinity of the FATO. The OCA/H for helicopter visual manoeuvring shall not be less than 75 m (246 ft).

7.1.4 Prescribed track for visual manoeuvring

In those locations where clearly defined visual features permit, and if it is operationally desirable, a specific track for visual manoeuvring may be prescribed (in addition to the circling area). See the Appendix to this chapter.

7.2 ALIGNMENT AND AREA

7.2.1 Method for defining the area

7.2.1.1 The size of the visual manoeuvring (circling) area varies with the category of the aircraft. To define the limits of the area:

a) draw an arc from the centre of the threshold of each usable runway with a radius appropriate to the aircraft category. Example values appear in Tables I-4-7-1 and I-4-7-2;

b) from the extremities of the adjacent arcs draw lines tangent to the arcs; and

c) connect the tangent lines.

The area thus enclosed is the visual manoeuvring (circling) area. See Figures I-4-7-1 and I-4-7-2.

7.2.1.2 Note that in Figure I-4-7-1, as an example, the radius for Category E aircraft is used. An operational advantage is gained by casting arcs only from those runways usable by Category E aircraft.

7.2.1.3 In Figure I-4-7-2 all runways are used because they are available to Category A aircraft. However, since the radius for Category A is less than that for Category E the total area for all aircraft is slightly smaller than it would be if Category E criteria were applied completely.

7.2.2 Parameters

The parameters on which visual manoeuvring (circling) radii are based are as follows:

a) *speed:* speed for each category as shown in Tables I-4-1-1 and I-4-1-2 in Chapter 1;

b) *wind*: ± 46 km/h (25 kt) throughout the turn; and

c) *bank*: 20° average achieved or the bank angle producing a turn rate of 3° per second, whichever is the lesser bank. (See Figures II-4-1-App A-2 and II-4-1-App A-3 in Part II, Section 4, Appendix A to Chapter 1, “Parameters for holding area construction”).

7.2.3 Determination method

The radius is determined using the formulas in Section 2, Chapter 3, “Turn area construction”, by applying a 46 km/h (25 kt) wind to the true airspeed (TAS) for each category of aircraft using the visual manoeuvring IAS from Tables I-4-1-1 and I-4-1-2 in Chapter 1. The TAS is based on:

a) *altitude:* aerodrome elevation + 300 m (1 000 ft); and

b) *temperature:* ISA + 15°.

7.2.4 Visibility and lowest OCA/H

It is assumed that the minimum visibility available to the pilot at the lowest OCA/H will be as shown in Table I-4-7-3. This information is not required for the development of the procedure, but is included as a basis for the development of operating minima.

7.3 OBSTACLE CLEARANCE

See 5.4.4, “OCA/H for visual manoeuvring (circling)”, and Table I-4-7-3.

7.4 METHOD FOR REDUCING OCA/H

7.4.1 Area which can be ignored

A sector in the circling area where a prominent obstacle exists may be ignored for OCA/H calculations if it is outside the final approach and missed approach areas. This sector is bounded by the dimensions of the Annex 14 instrument approach surfaces. (See Figure I-4-7-3.)

7.4.2 Promulgation

When this option is exercised, the published procedure must prohibit the pilot from circling within the total sector where the obstacle exists. (See Figure I-4-7-4.)

7.5 MISSED APPROACH ASSOCIATED WITH THE VISUAL MANOEUVRE

A missed approach area specific to the visual manoeuvre is not constructed.

7.6 PROMULGATION

The general criteria in Chapter 9, "Charting/AIP" apply. The instrument approach chart for a visual manoeuvre shall be identified by the navigation aid type used for final approach lateral guidance, followed by a single letter suffix, starting with the letter A. The suffix letter shall not be used again for any procedures at that airport, at any other airport serving the same city or at any other airport in the same State, serving a city with the same name. The OCA/H values for the procedure shall be the OCA/H for approach or missed approach, whichever is greater and shall be published in accordance with Chapter 5, 5.5.6, "Publication of OCA/H" and 5.4.4, "OCA/H for visual manoeuvring (circling)".

Table I-4-7-1. Example of determining radii for visual manoeuvring (circling) area for aerodromes at 300 m MSL (SI-units)

Category of aircraft/IAS (km/h)	*A/185*	*B/250*	*C/335*	*D/380*	*E/445*
TAS at 600 m MSL + 46 km/h wind factor (km/h)	241	310	404	448	516
Radius (r) of turn (km)	1.28	2.08	3.46	4.34	5.76
Straight segment (km) (this is a constant value independent of aerodrome elevation)	0.56	0.74	0.93	1.11	1.30
Radius (R) from threshold (km)	3.12	4.90	7.85	9.79	12.82

Note.— Radius from threshold (R) = 2r + straight segment.

Table I-4-7-2. Example of determining radii for visual manoeuvring (circling) area for aerodromes at 1 000 ft MSL (non-SI units)

Category of aircraft/IAS (kt)	*A/100*	*B/135*	*C/180*	*D/205*	*E/240*
TAS at 2 000 ft MSL + 25 kt wind factor (kt)	131	168	215	242	279
Radius (r) of turn (NM)	0.69	1.13	1.85	2.34	3.12
Straight segment (NM) (this is a constant value independent of aerodrome elevation)	0.30	0.40	0.50	0.60	0.70
Radius (R) from threshold (NM)	1.68	2.66	4.20	5.28	6.94

Note.— Radius from threshold (R) = 2r + straight segment.

Table I-4-7-3. MOC and OCA/H for visual manoeuvring (circling) approach

Aircraft category	*Minimum obstacle clearance m (ft)*	*Lower limit for OCH above aerodrome elevation m (ft)*	*Minimum visibility km (NM)*
A	90 (295)	120 (394)	1.9 (1.0)
B	90 (295)	150 (492)	2.8 (1.5)
C	120 (394)	180 (591)	3.7 (2.0)
D	120 (394)	210 (689)	4.6 (2.5)
E	150 (492)	240 (787)	6.5 (3.5)

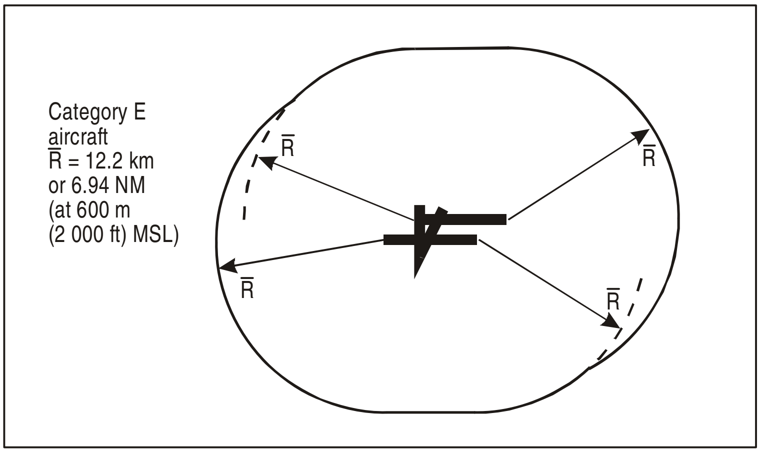

Figure I-4-7-1. Construction of visual manoeuvring (circling) area

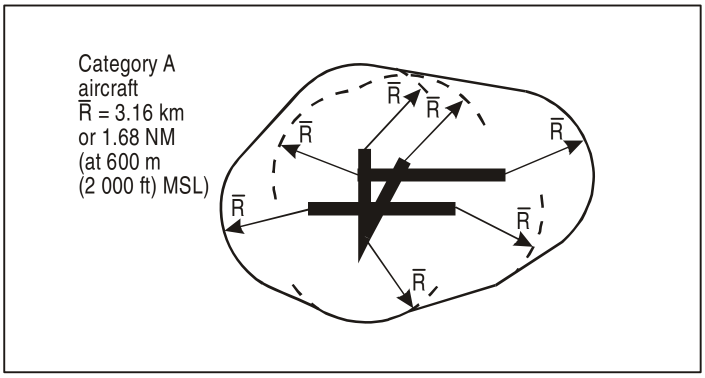

Figure I-4-7-2. Visual manoeuvring (circling) area

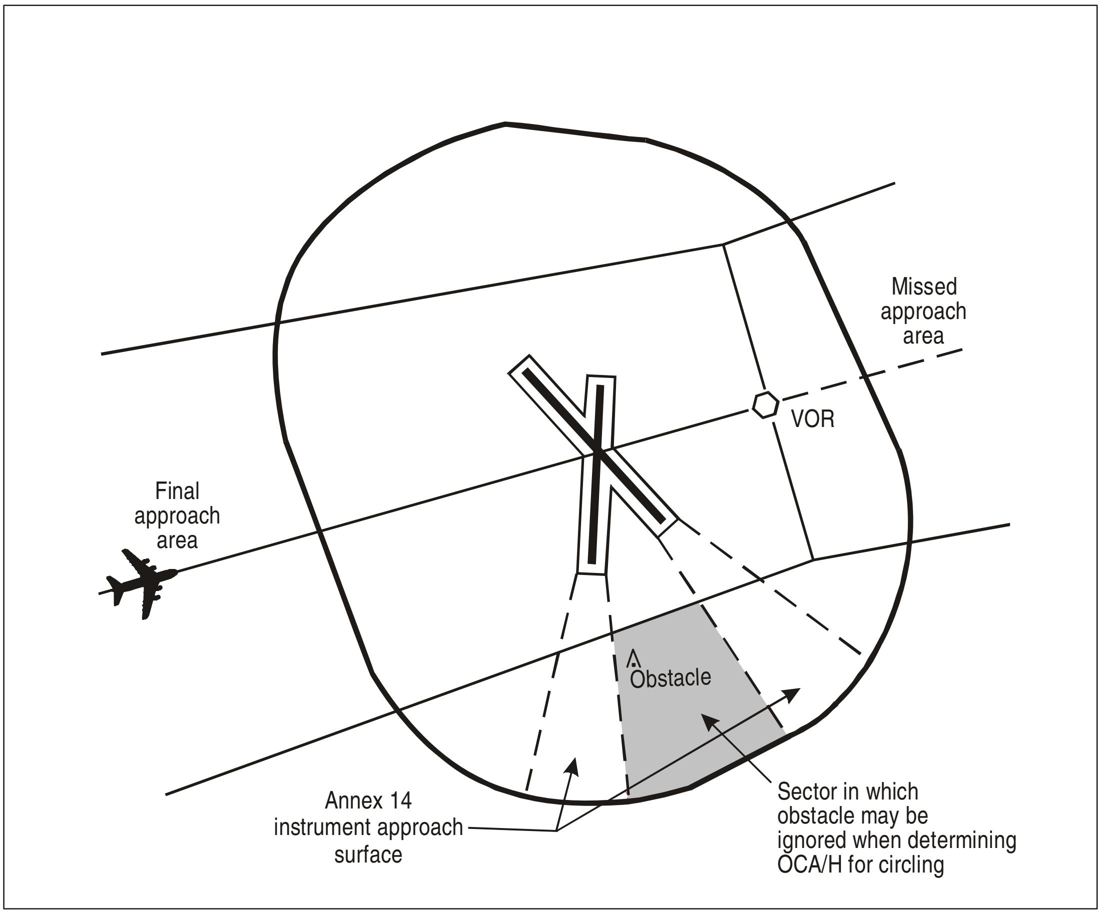

Figure I-4-7-3. Visual manoeuvring (circling) area — obstacle clearance

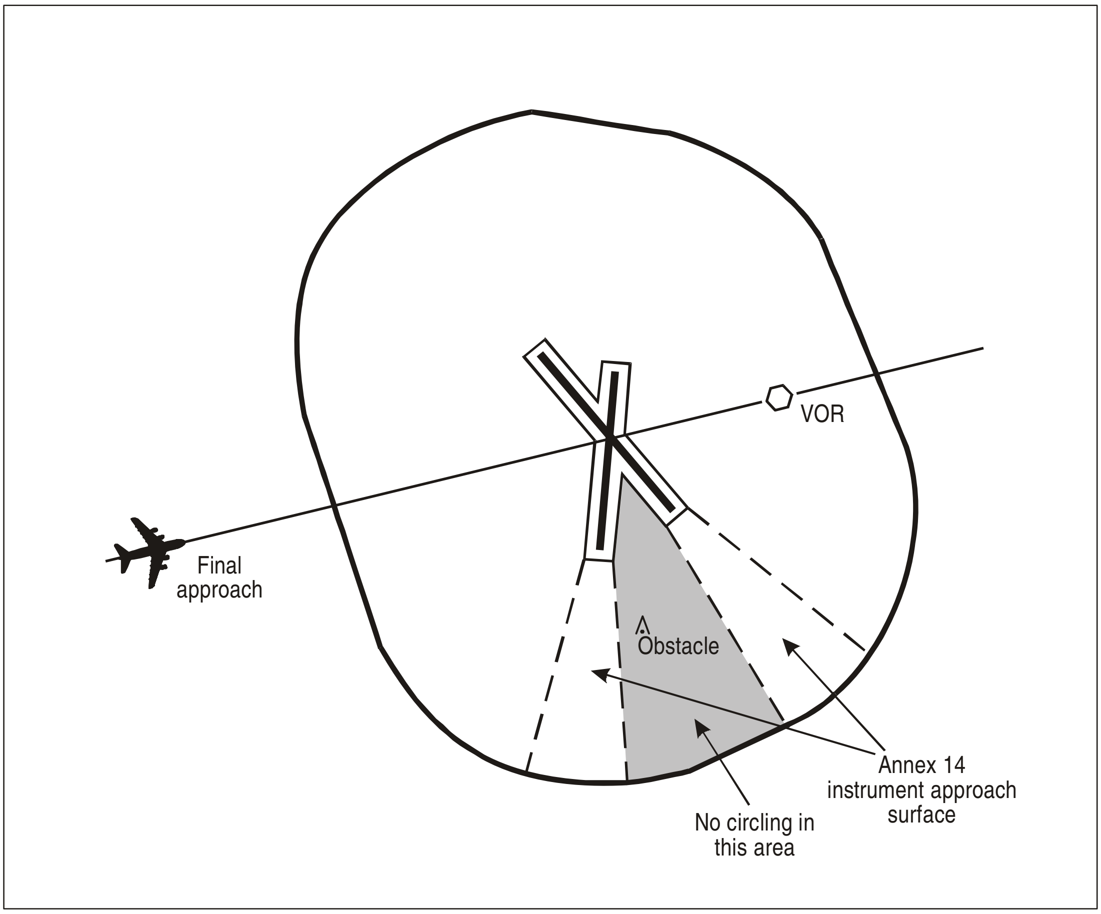

Figure I-4-7-4. Visual manoeuvring (circling) area — prohibition on circling

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Appendix to Chapter 7

VISUAL MANOEUVRING USING PRESCRIBED TRACK

1. GENERAL

1.1 In those locations where clearly defined visual features permit, and if it is operationally desirable, a specific track for visual manoeuvring may be prescribed (in addition to the circling area). This track should be included inside the limits of the circling area designed for the same aircraft categories. When it is not the case, the procedure should be named: "VISUAL approach procedure" instead of "VISUAL manoeuvering."

1.2 The visual features used to define the track and (if necessary) altitude changing points on the track may be complemented with radio fixes (i.e. VOR radial, DME distance, etc.). The tolerance of the radio fix must be equal to or better than the tolerance of the visual feature. A radio fix cannot be used if the corresponding visual feature does not exist.

1.3 At the end of the visual manoeuvring track, a go-around procedure for a second prescribed track manoeuvring is provided. In some cases, the go-around procedure can join the instrument missed approach procedure.

2. TRACK

2.1 Several kinds of tracks have to be considered and the more common cases are illustrated in Figure I-4-7-App-1.

2.2 *Gathering together of the tracks*. It is possible to develop one track for each aircraft category, but for the sake of simplicity, it is recommended that one track be used for all the categories or one for Cat A and B and another for Cat C, D, E, if this does not lead to operational constraints.

2.3 *Diverging point.* This point must be defined with a clearly identifiable visual feature (complemented if necessary by a radio fix with a tolerance less than 0.5 NM, i.e. middle marker or DME distance).

2.4 Diverging segment

2.4.1 This segment joins the final instrument approach segment to the downwind leg of the prescribed track. In some cases, this segment can be replaced by a turn (see Figure I-4-7-App-1 e)) or an S-type manoeuvre (see Figure I-4-7-App-1 c)).

2.4.2 In the case of Figure I-4-7-App-2, it is recommended that the end of the diverging segment occur before the point abeam the threshold used for the prescribed track.

2.4.3 The angle between the diverging segment and the runway used for the prescribed track must be less than or equal to 45°.

2.4.4 The length and magnetic orientation of the diverging segment must be published.

2.5 "Downwind" leg

This segment is parallel to the runway axis; its length is determined by the position of the diverging segment and the length of the final segment of the prescribed track. The length and magnetic orientation of the "downwind" leg must be published.

2.6 Radius of turn

The speed should be the true airspeed, calculated from the maximum indicated airspeed for visual manoeuvring (Tables I-4-1-1 and I-4-1-2 in Chapter 1) for:

a) *altitude*: aerodrome elevation + 300 m (1 000 ft); and

b) *temperature*: ISA + 15°C.

Note.— If necessary (because constraining obstacles have to be avoided) the indicated airspeed may be reduced to not less than the maximum indicated airspeed for the final segment (Tables I-4-1-1 and I-4-1-2) for the aircraft category. In such a case, the maximum indicated speed must be published on the chart.

2.7 Final segment (of the prescribed track)

The length of the final segment of the prescribed track is based on 30 s of flight at a speed which should be the true airspeed calculated from the maximum indicated airspeed for final approach (Tables I-4-1-1 and I-4-1-2) for:

a) *altitude:* aerodrome elevation + 300 m (1 000 ft); and

b) *temperature:* ISA + 15°C.

When a minimum altitude has to be maintained at the beginning of this segment, the procedures designer should check its length to allow a final descent gradient less than 10 per cent (optimum: 5.2 per cent/3°).

2.8 Bank

25° average achieved bank angle.

2.9 Go-around track

In all cases, the prescribed track provides for a go-around trajectory. In general, this manoeuvre consists of a 180° turn starting at the end of the runway and reaching the "downwind" leg of the prescribed track. When this kind of procedure is not appropriate, if there is a constraining obstacle under the 180° turn manoeuvre or if there is a special kind of prescribed track (Figure I-4-7-App-3), a go-around procedure to join the instrument missed approach will be prescribed.

3. AREA ASSOCIATED WITH PRESCRIBED TRACK

This area is based on the nominal track, plus a buffer area of width (w) on the outside of the nominal track. The buffer area starts at the "diverging" point and follows the track, including a go-around for a second visual manoeuvre with prescribed track. (See Table I-4-7-App-1 and Figure I-4-7-App-4.)

4. MINIMUM OBSTACLE CLEARANCE AND OCA/H

The OCA/H for visual manoeuvring on prescribed tracks shall provide the minimum obstacle clearance (MOC) over the highest obstacle within the prescribed track area. It shall also conform to the limits specified at Table I-4-7-App-2 and be not less than the OCA/H calculated for the instrument approach procedure which leads to the visual manoeuvre.

5. VISUAL AIDS

Visual aids associated with the runway used for the prescribed track (i.e. sequenced flashing lights, PAPI, VASIS) are shown on the approach chart with their main characteristics (i.e. slope of the PAPI or VASIS). Lighting on obstacles is specified on the approach chart.

Table I-4-7-App-1. Semi-width of the corridor

Aircraft category	*A*	*B*	*C*	*D*	*E*
semi-width of the corridor (w)					
metres	1 400	1 500	1 800	2 100	2 600
(feet)	4 593	4 921	5 905	6 890	8 530

Table I-4-7-App-2. Minimum OCA/H for visual manoeuvring using prescribed tracks

Aircraft category	*Obstacle clearance m (ft)*	*Lower limit for OCH above aerodrome elevation m (ft)*	*Minimum visibility km (NM)*
A	90 (295)	120 (394)	1.9 (1.0)
B	90 (295)	150 (492)	2.8 (1.5)
C	120 (394)	180 (591)	3.7 (2.0)
D	120 (394)	210 (689)	4.6 (2.5)
E	150 (492)	240 (787)	6.5 (3.5)

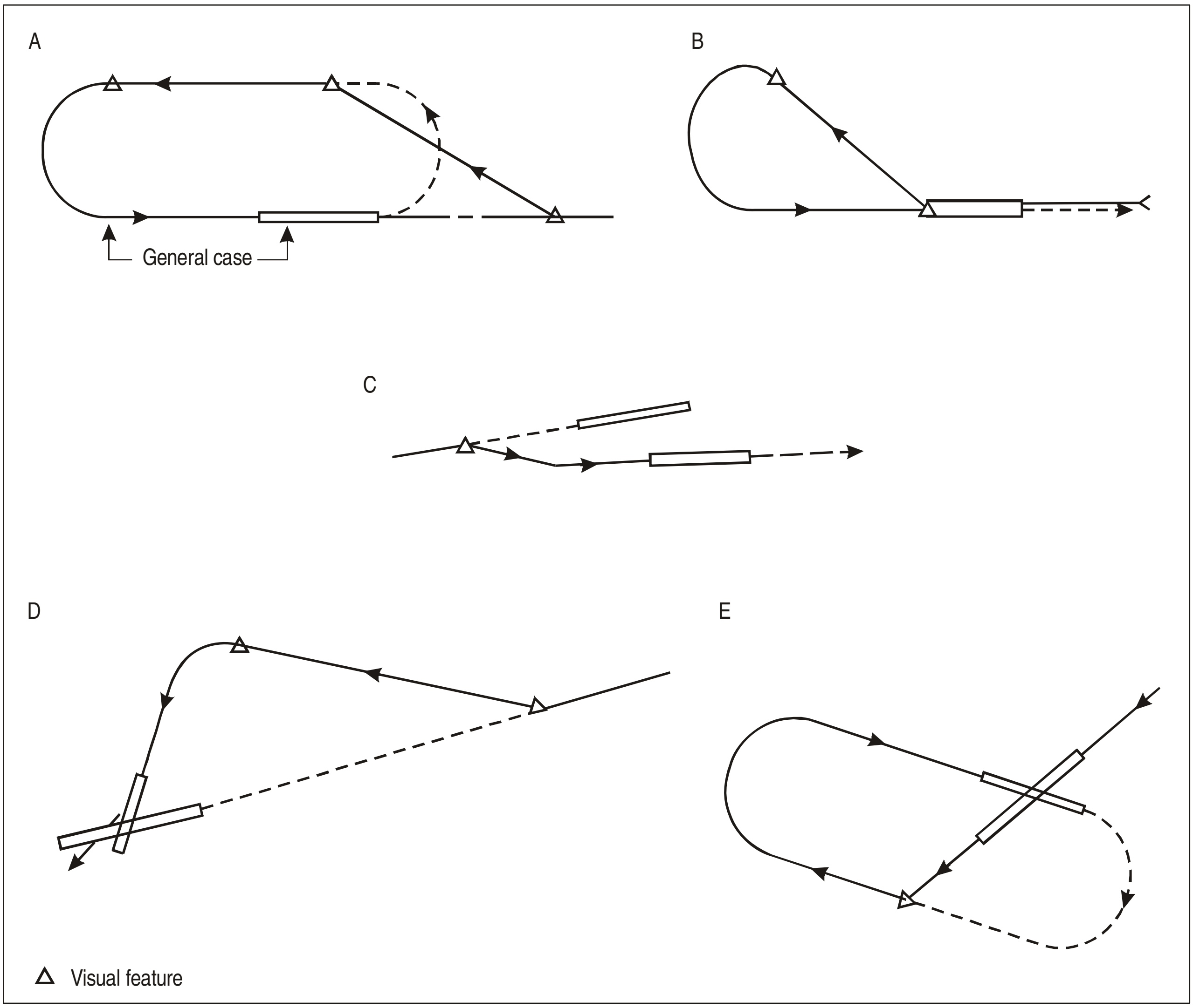


Figure I-4-7-App-1. Common cases of tracks

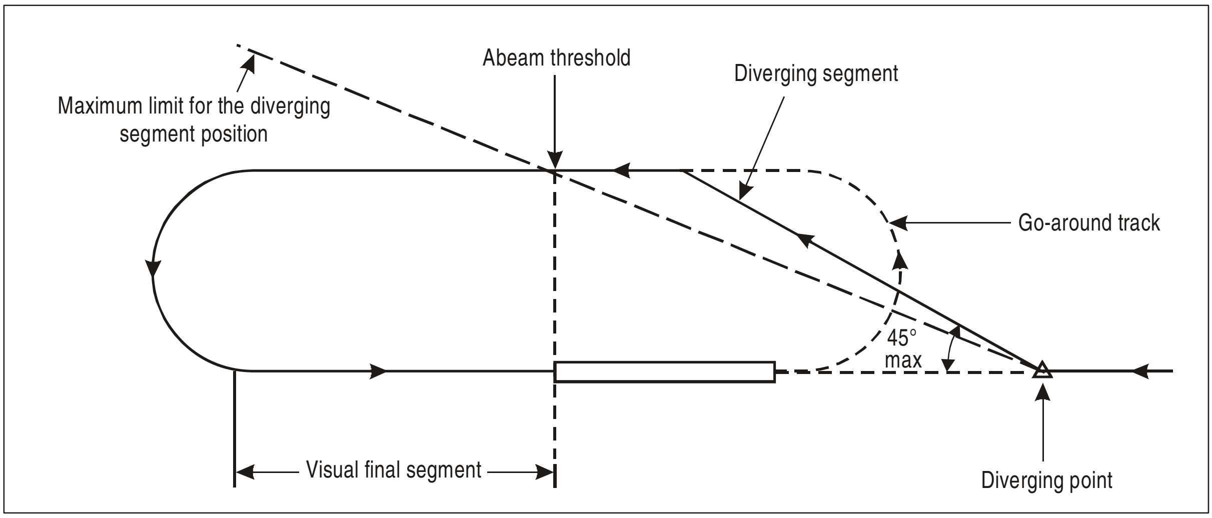


Figure I-4-7-App-2. Standard track general case

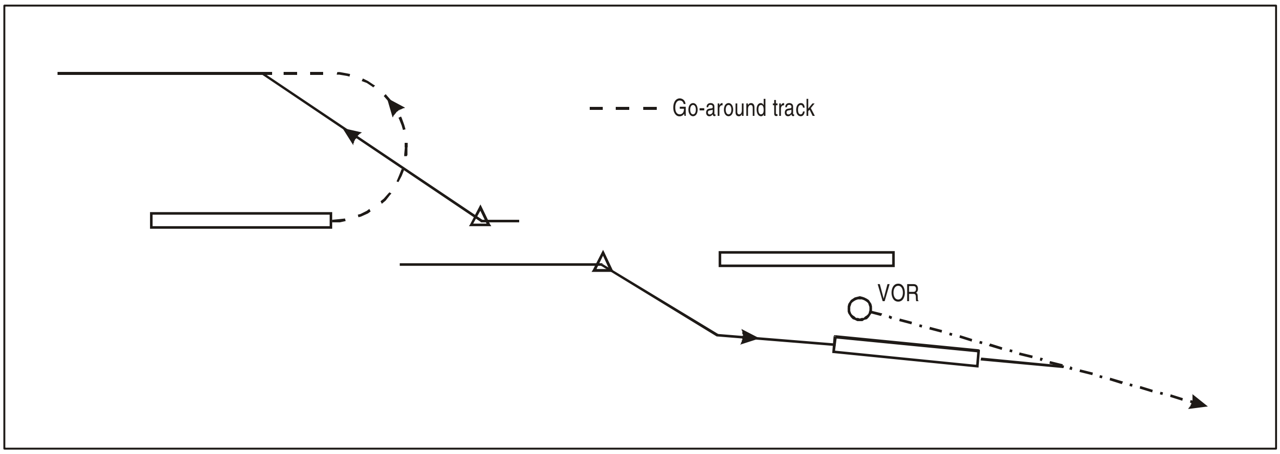


Figure I-4-7-App-3. Prescribed track for go-around

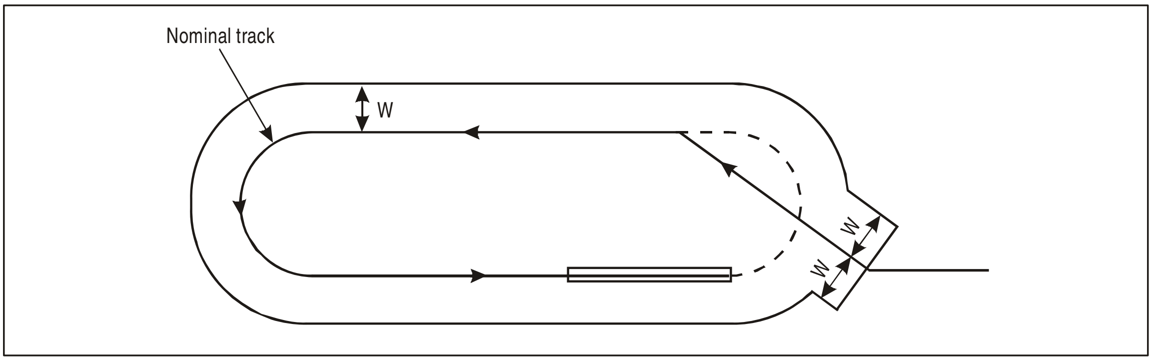


Figure I-4-7-App-4. Area

Chapter 8

MINIMUM SECTOR ALTITUDES (MSA)

8.1 GENERAL

8.1.1 Minimum sector altitudes shall be established for each aerodrome where instrument approach procedures have been established. Each minimum sector altitude shall be calculated by:

a) taking the highest elevation in the sector concerned;

b) adding a clearance of at least 300 m (1 000 ft); and

c) rounding the resulting value up to the next higher 50-m or 100-ft increment, as appropriate.

8.1.2 If the difference between sector altitudes is insignificant (i.e. in the order of 100 m or 300 ft as appropriate) a minimum altitude applicable to all sectors may be established.

8.1.3 A minimum altitude shall apply within a radius of 46 km (25 NM) of the homing facility on which the instrument approach is based. The minimum obstacle clearance when flying over mountainous areas should be increased by as much as 300 m (1 000 ft).

8.2 OBSTACLES IN BUFFER AREA

Obstacles within a buffer zone of 9 km (5 NM) around the boundaries of any given sector shall be considered as well. If such obstacles are higher than the highest obstacle within the sector, then the minimum sector altitude shall be calculated by:

a) taking the highest elevation in the buffer area concerned;

b) adding a clearance of at least 300 m (1 000 ft); and

c) rounding the resulting value up to the nearest 50 m (100 ft).

8.3 SECTOR ORIENTATION

The sectors should normally coincide with the quadrants of the compass. However, when topographical or other conditions make it desirable, the boundaries of the sectors may be chosen to obtain the most favourable minimum sector altitudes. See Figure I-4-8-1.

8.4 COMBINING SECTORS FOR ADJACENT FACILITIES

8.4.1 Where more than one facility provides instrument approaches to an aerodrome, and several minimum sector altitude diagrams are involved, individual diagrams shall be produced and minimum sector altitudes calculated.

8.4.2 If such facilities are located less than 9 km (5 NM) apart, the minimum sector altitude for any given sector should be the highest of all altitudes calculated for that specific sector for every facility serving the aerodrome.

8.5 SECTORS CENTERED ON A VOR/DME OR NDB/DME

8.5.1 In sectors centred on a VOR/DME or NDB/DME, it is possible to define an additional boundary (DME arc) within a sector, dividing the sector into two subsectors with the lower MSA in the inner area.

8.5.2 The DME arc radius (R) used should be between 19 and 28 km (10 and 15 NM) in order to avoid the use of a subsector of too small a size. The width of the buffer area between the subsectors remains 9 km (5 NM) (see Figure I-4-8-2).

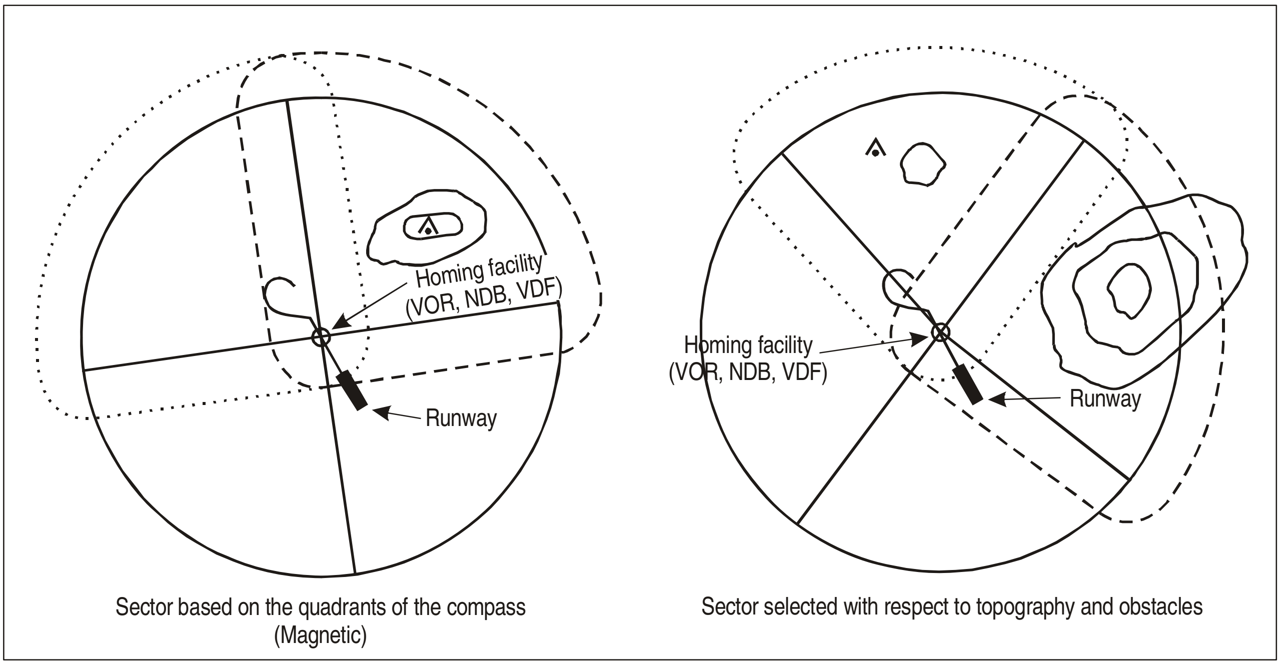


Figure I-4-8-1. Sector orientation

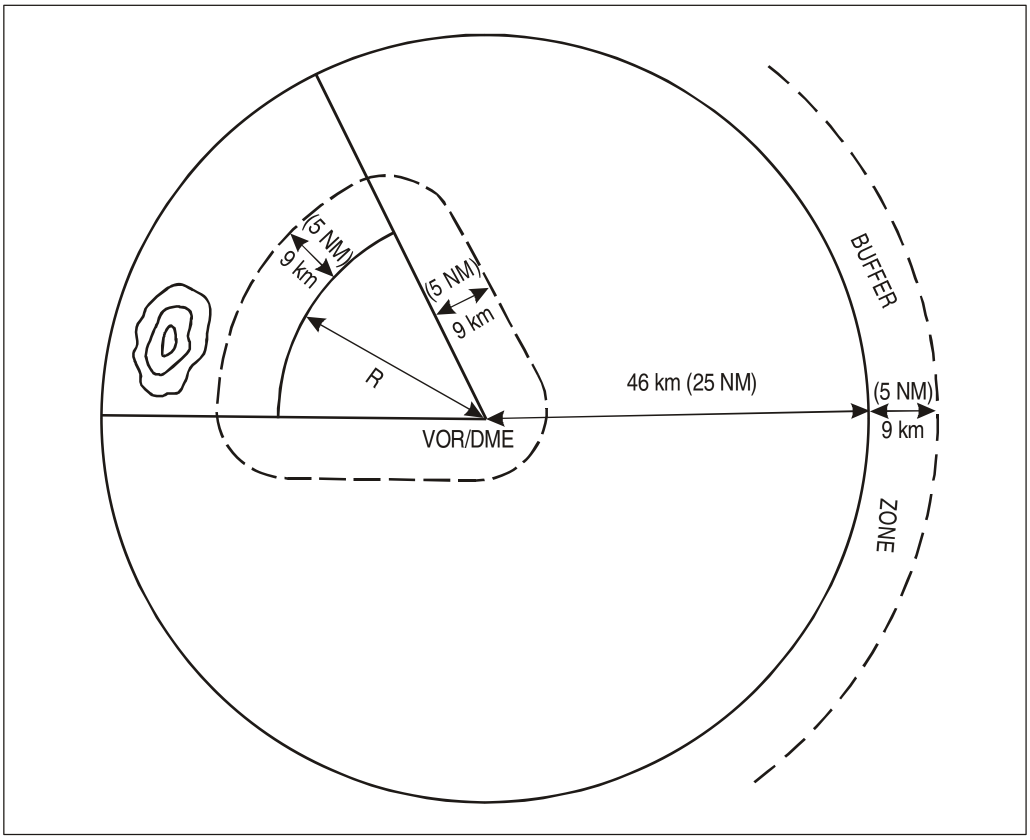


Figure I-4-8-2. Case of VOR/DME subsectors delimited by a DME arc

Chapter 9

CHARTING/AIP

9.1 GENERAL

Material relating to the publication of charts is contained in Annex 4 as follows:

a) Standard Departure Chart — Instrument (SID) — ICAO, in Annex 4, Chapter 9;

b) Standard Arrival Chart — Instrument (STAR) — ICAO, in Annex 4, Chapter 10; and

c) Instrument Approach Chart — ICAO, in Annex 4, Chapter 11.

9.2 CHARTED ALTITUDES/FLIGHT LEVELS

Altitude depiction. Arrival procedures may be developed to procedurally separate air traffic. In doing so, the procedure may be accompanied with altitudes/flight levels that are not associated with any obstacle clearance requirements, but are developed to separate arriving and departing air traffic procedurally. These altitudes/flight levels shall be charted as indicated in Table I-4-9-1. The method of charting of altitudes/flight levels to correctly depict the designed procedure may differ between avionics manufacturers.

9.3 ARRIVAL

In some cases it is necessary to designate arrival routes from the en-route structure to the initial approach fix. Only those routes which provide an operational advantage shall be established and published. These should take local air traffic flow into consideration.

9.4 APPROACH

9.4.1 General

9.4.1.1 Optimum and maximum descent gradients and angles are specified depending on the type of procedure and the segment of the approach. The descent gradient(s)/angles used in the construction of the procedure shall be published for the final approach segment. It is preferable that they also be published for the other approach segments, where appropriate.

9.4.1.2 Where distance information is available, descent profile advisory information for the final approach should be provided to assist the pilot to maintain the calculated descent gradient. This should be a table showing altitudes/heights through which the aircraft should be passing at each 2 km or 1 NM as appropriate.

9.4.2 Initial approach segment

9.4.2.1 Separate procedures shall be published when:

a) different minimum altitudes;

b) different timings; or

c) different outbound tracks

are specified for different categories of aircraft.

9.4.2.2 Speeds below the minimum value for initial approach in a given aircraft category shall not be specified (see Tables I-4-1-1 and I-4-1-2 of Chapter 1). If procedures are developed which exclude specific aircraft categories due to speed, this must be stated explicitly.

9.4.3 Final approach segment

9.4.3.1 An OCA and/or an OCH shall be published for each instrument approach and circling procedure. For non-precision approach procedures, values shall be expressed in 5-m or 10-ft increments by rounding up as appropriate.

9.4.3.2 A straight-in OCA/H shall not be published where final approach alignment or descent gradient criteria are not met. In this case, only circling OCA/H shall be published.

9.4.3.3 Procedures which require the use of forecast altimeter setting shall be suitably annotated on the approach charts.

9.4.4 Missed approach segment

9.4.4.1 Only one missed approach procedure shall be published for each approach procedure.

9.4.4.2 If the MAPt is defined by a facility or fix at the MAPt, the procedure must be annotated "timing not authorized for defining the MAPt".

9.4.4.3 If the MAPt is defined by a combination of timing over the distance from the nominal FAF to the nominal MAPt, in addition to a facility or fix at the missed approach point, the OCA/Hs for both timing and fix shall be published if an operational advantage can be obtained in this way. Alternatively a single OCA/H shall be published (which shall be the higher of the two).

9.4.4.4 The OCA/H for the nominal 2.5 per cent must always be published on the instrument approach chart. If additional gradients are specified in the construction of the missed approach procedure, they and their associated OCA/H values must be published as alternative options.

9.4.4.5 The speed for final missed approach is shown in Tables I-4-1-1 and I-4-1-2 of Chapter 1. However, where operationally required to avoid obstacles, reduced speeds as slow as the IAS for intermediate missed approach may be used, provided the procedure is annotated "Missed approach turn limited to _______ km/h (kt) IAS maximum."

9.4.4.6 When a gradient other than the nominal gradient is used in the construction of the missed approach procedure this must be indicated in the instrument approach chart and, in addition to the OCA/H for the specific gradient, the OCA/H applicable to the nominal gradient must also be shown.

9.4.5 Visual manoeuvring

9.4.5.1 A sector in the circling area where a prominent obstacle exists may be ignored for OCA/H calculations if it meets the criteria listed in Chapter 7, 7.4.1, "Area which can be ignored".

9.4.5.2 When this option is exercised, the published procedure must prohibit the pilot from circling within the total sector where the obstacle exists.

9.4.6 Visual manoeuvring with prescribed track

9.4.6.1 The length and magnetic orientation of the diverging segment must be published.

9.4.6.2 The length and magnetic orientation of the ''downwind'' leg must be published.

9.4.6.3 *Radius of turn.* If necessary (because constraining obstacles have to be avoided) the indicated airspeed may be reduced to not less than the maximum indicated airspeed for the final segment (Tables I-4-1-1 and I-4-1-2 of Chapter 1) for the aircraft category. In such a case, the maximum indicated speed must be published on the chart.

9.5 PROCEDURE NAMING FOR ARRIVAL AND APPROACH CHARTS

9.5.1 Instrument Flight Procedure Naming Convention

This paragraph describes the general aspects of instrument procedure naming. Specific aspects are covered in the appropriate chapters. A standardized naming convention is required to avoid ambiguity between charts, electronic cockpit displays and ATC clearances. This convention affects the following charting aspects:

a) procedure identification;

b) additional equipment requirements; and

c) minimum boxes.

9.5.2 Procedure identification

9.5.2.1 *General.* The procedure identification shall only contain the name describing the type of radio navigation aid providing the final approach lateral guidance. Precision approach systems such as ILS or MLS shall be identified by the system name (ILS, MLS, etc.). If two radio navigation aids are used for final approach lateral guidance, the title shall only include the last radio navigation aid used. For example:

if an NDB is used as the final approach fix and a VOR is used as the last navaid on the final approach to runway 06, the procedure shall be identified as VOR Rwy 06. If a VOR is used for the initial approach followed by a final approach to Rwy 24 using an NDB, the procedure shall be identified as NDB Rwy 24.

9.5.2.2 *Additional navaids*. If additional navigation aids are required (such as fix formations or transition routes) for the approach procedure, they shall be specified on the plan view of the chart, but not in the title.

9.5.2.3 *Multiple procedures.* A single approach chart may portray more than one approach procedure when the procedures for the intermediate, approach, final approach and missed approach segments are identical. If more than one approach procedure is depicted on the same chart, the title shall contain the names of all the types of navigation aids used for final approach lateral guidance, separated by the word “or”. There shall be no more than three types of approach procedure on one chart. For example:

ILS or NDB Rwy 35L

9.5.2.4 *Helicopter approach.* Helicopter approaches to a runway shall be identified in the same way as fixed wing approaches, with the Category H included in the Minimum Box. A helicopter approach to a point in space or a helipad shall be identified by the navigation aid type used for final approach guidance, followed by the final approach track or radial. For example:

VOR 235

9.5.2.5 *Circling approach.* When on a chart only circling minima are provided, the approach procedure shall be identified by the last navaid providing final approach guidance followed by a single letter, starting with the letter A. When there are two or more approaches at an airport (or a nearby airport), a different letter shall be used. If the IFR portion of the procedure is the same but there are different circling tracks for the same procedure, only one procedure with one title should be promulgated and the different circling procedures indicated in the procedure. The suffix letter shall not be used again for any procedures at that airport, at any other airport serving the same city, or at any other airport in the same State, serving a city with the same name. For example:

VOR-a

VOR-b

NDB-c

9.5.3 Duplicate procedure identification

9.5.3.1 A single letter suffix, starting with the letter Z following the radio navigation aid type shall be used if two or more procedures to the same runway cannot be distinguished by the radio navigation aid type only. For example:

VOR y Rwy 20

VOR z Rwy 20

9.5.3.2 The single letter suffix shall be used when:

a) two or more navigation aids of the same type are used to support different approaches to the same runway;

b) two or more missed approaches are associated with a common approach, each approach being identified by a single letter suffix;

c) different approach procedures using the same radio navigation type are provided for different aircraft categories;

d) two or more arrivals are used to a common approach and are published on different charts, each approach being identified by a single letter suffix. If additional radio navigation aids are required for the arrival they shall be specified on the chart's plan view. For example:

ILS y RWY 20 (“CAB VOR Arrival” shown in the plan view)

ILS z RWY 20 (“DNA VOR Arrival” shown in the plan view)

9.5.4 Additional equipment requirements

9.5.4.1 All navigation equipment that is required for the execution of the approach procedure and not mentioned in the procedure identification shall be identified in notes on the chart. For example:

“VOR required” on an NDB approach;

“Dual ADF required”, when required on an NDB approach where two ADFs are required;

“When inbound from XXX NDB, change over to YYY NDB at midpoint”;

“DME required” on a VOR/DME arc approach.

9.5.4.2 Optional carriage of equipment that may support lower minima shall be evident from the Minimum Box. In such a case it is not necessary to provide a note on the chart. See 9.5.2.4.

9.5.5 Minimum boxes

The OCA/H for each aircraft category shall be published in the minimum box on the chart. Where an OCA/H is predicated on a specific navigation aid (e.g. stepdown fixes), or a specific RNAV functionality (e.g. LNAV/VNAV), or an RNP value, this shall be clearly identified. For example:

OCA/(OCH)	CAT A	CAT B	CAT C	CAT D	CAT H
LNAV/VNAV	560 (250)	560 (250)	630 (320)	630 (320)	560 (250)
LNAV	710 (400)	710 (400)	810 (500)	810 (500)	710 (400)

or

OCA/(OCH)	CAT A	CAT B	CAT C	CAT D	CAT H
VOR/DME	610 (300)	610 (300)	610 (300)	610 (300)	610 (300)
VOR	660 (350)	660 (350)	660 (350)	660 (350)	660 (350)

or

OCA/(OCH)	CAT A	CAT B	CAT C	CAT D	CAT H
CAT I	210 (170)	210 (170)	220 (180)	230 (190)	210 (170)
RNP 0.3	290 (250)	290 (250)	290 (250)	290 (250)	290 (250)

Table I-4-9-1. Charted altitudes/flight levels

Altitude/flight level “Window”	$\overline{\text{17 000}}$ $\underline{\text{10 000}}$	$\overline{\text{FL220}}$ $\underline{\text{10 000}}$
“At or above” altitude/flight level	$\underline{\text{7 000}}$	$\underline{\text{FL60}}$
“At or below” altitude/flight level	$\overline{\text{5 000}}$	$\overline{\text{FL50}}$
“Mandatory” altitude/flight level	$\overline{\underline{\text{3 000}}}$	$\overline{\underline{\text{FL30}}}$
“Recommended” procedure altitude/flight level	5 000	FL50
“Expected” altitude/flight level	Expect 5 000	Expect FL50

Section 5

QUALITY ASSURANCE

(To be developed)

Procedures for
Air Navigation Services

AIRCRAFT OPERATIONS

Part II

CONVENTIONAL PROCEDURES

Section 1

PRECISION APPROACHES

Chapter 1

INSTRUMENT LANDING SYSTEM (ILS)

1.1 INTRODUCTION

1.1.1 Application

The ILS criteria detailed in this chapter are related to the ground and airborne equipment performance and integrity required to meet the Category I, II and III operational objectives described in Annex 10.

1.1.2 Procedure construction

The procedure from enroute to the precision segment of the approach and in the final missed approach phase conforms with the general criteria as presented in Part I, Section 1, 2 and 4. The differences are found in the physical requirements for the precision segment which contains the final approach segment as well as the initial and intermediate phases of the missed approach segment. These requirements are related to the performance of Cat I, II and III systems.

1.1.3 Standard conditions

The following list contains the standard assumptions on which procedures are developed. Provisions are made for adjustments where appropriate. Adjustments are mandatory when conditions differ adversely from standard conditions and are optional when so specified (see 1.4.8.7, "Adjustment of constants").

a) Maximum aircraft dimensions are assumed to be the following:

Aircraft category	*Wing span*	*Vertical distance between the flight paths of the wheels and the GP antenna (m)*
H	30	3
A, B	60	6
C, D	65	7
D_L	80	8

Note 1.— OCA/H for Cat D_L aircraft is published when necessary.

Note 2.— The dimensions shown are those which encompass current aircraft types. They are chosen to facilitate OCA/H calculations and promulgation of aircraft category related minima. It is assumed that these dimensions are not intended to be used for other purposes than the OCA/H calculations in other ICAO documents. The use of OAS *surfaces to calculate OCA/H may result in significant differences between aircraft categories because of small differences in size. For this reason, it is always preferable to use the Collision Risk Model (1.4.9) which will allow for more realistic assessment for both height and position of obstacles.*

Note 3.— Current Category E aircraft are not normally civil transport aircraft and their dimensions are not necessarily related to V_{at} at maximum landing mass. For this reason, they should be treated separately on an individual basis.

b) Category II flown with flight director.

c) Missed approach climb gradient 2.5 per cent.

d) ILS sector width 210 m at threshold.

e) Glide path angle:

   1) minimum: 2.5°;

   2) optimum: 3.0°;

   3) maximum: 3.5° (3° for Cat II/III operations).

f) ILS reference datum height 15 m (50 ft).

g) All obstacle heights are referenced to threshold elevation.

h) For Cat II and Cat III operations the Annex 14 inner approach, inner transitional and balked landing surfaces have not been penetrated. Where the Cat II OCA/H is higher than the level of the inner horizontal surface, but below 60 m, the inner approach and balked landing surfaces should be extended to the Cat II OCA/H level to accommodate Cat III operations.

1.1.4 Obstacle clearance altitude/height (OCA/H)

1.1.4.1 The ILS criteria enable an OCA/H to be calculated for each category of aircraft. See Part I, Section 4, Chapter 1, 1.8, "Categories of aircraft". Where statistical calculations were involved, the OCA/H values were designed against an overall safety target of 1×10^{-7} (1 in 10 million) per approach for risk of collision with obstacles.

1.1.4.2 The OCA/H ensures clearance of obstacles from the start of the final approach to the end of the intermediate missed approach segment.

Note.— This OCA/H is only one *of the factors to be taken into account in determining decision height as defined in Annex 6.*

1.1.4.3 Additional material is included to allow operational benefit to be calculated for the improved beam holding performance of autopilots meeting national certification standards (as opposed to flight directors) in Cat II, and for improved missed approach climb performance in Cat I, II and III.

1.1.4.4 Benefit may also be calculated for aircraft with dimensions other than the standard size assumed in the basic calculations. An OCA/H is not associated with Cat III operations. These are supported by the obstacle limitation surfaces defined in Annex 14, in association with overlapping protection from the Cat II criteria.

1.1.5 Methods of calculating OCA/H

1.1.5.1 *General.* Three methods of calculating OCA/H are presented, which involve progressive increases in the degree of sophistication in the treatment of obstacles. Standard conditions (as specified in 1.1.3) are assumed to exist unless adjustments for non-standard conditions have been made.

1.1.5.2 *First method.* The first method involves a set of surfaces derived from the Annex 14 precision approach obstacle limitation surfaces and a missed approach surface described in 1.4.7.2, "Definition of basic ILS surfaces". From this point forward, these are termed "basic ILS surfaces". Where the standard conditions exist as specified in 1.1.3 and where the basic ILS surfaces are free of penetrations (see 1.4.7.1), the OCA/H for Cat I and Cat II is defined by aircraft category margins, and there are no restrictions on Cat III operations. If the basic ILS surfaces are penetrated, then the OCA/H is calculated as described in 1.4.7.3, "Determination of OCA/H with ILS".

1.1.5.3 *Second method.* The second method involves a set of obstacle assessment surfaces (OAS) above the basic ILS surfaces (see 1.4.8.4, "Definition of obstacle assessment surfaces (OAS). If the OAS are not penetrated —and provided the obstacle density below the OAS is operationally acceptable (see 1.4.8.9, "Effect of obstacle density on OCA/H") — the OCA/H for Cat I and Cat II is still defined by the aircraft category margins, and Cat III operations remain unrestricted. However, if the OAS are penetrated, then an aircraft category-related margin is added to the height of the highest approach obstacle, or to the adjusted height of the largest missed approach penetration, whichever is greater. This value becomes the OCA/H.

1.1.5.4 *Third method.* The third method, using a collision risk model (CRM), is employed either as an alternative to the use of the OAS criteria (second method) or when the obstacle density below the OAS is considered to be excessive. The CRM accepts all objects as an input and assesses, for any specific OCA/H value, both the risk due to individual obstacles and the accumulated risk due to all the obstacles. It is intended to assist operational judgment in the choice of an OCA/H value.

Note.— The CRM does not take into account the characteristics of helicopters. The CRM can be used but the method should be conservative.

1.1.6 References

The following appendices relate to and amplify the material contained in this chapter:

a) background information relating to the derivation of the OAS material (Attachment to Part II, paragraph 1) and to airborne and ground equipment performance assumed in the derivation of the OAS (Attachment to Part II, paragraph 2);

b) turning missed approach after precision approach (Appendix A);

c) independent parallel approaches to closely spaces parallel runways (Appendix D);

d) determining ILS glide path descents/MLS elevation heights and distances (Appendix C); and

e) PANS-OPS OAS CD-ROM.

Examples of OCA/H calculations can be found in the *Instrument Flight Procedures Construction Manual* (Doc 9368).

1.1.7 ILS with glide path inoperative

The ILS with glide path inoperative is a non-precision approach procedure. The principles of Section 2, Chapter 1, "LLZ only", apply.

1.2 INITIAL APPROACH SEGMENT

1.2.1 General

The initial approach segment must ensure that the aircraft is positioned within the operational service volume of the localizer on a heading that will facilitate localizer interception. For this reason, the general criteria which apply to the initial segment (see Part I, Section 4, Chapter 3) are modified in accordance with 1.2.2, "Initial approach segment alignment" and 1.2.3, "Initial Approach Segment Area". For RNAV initial approach segments, the criteria in the applicable RNAV chapters apply.

1.2.2 Initial approach segment alignment

The angle of interception between the initial approach track and the intermediate track should not exceed 90°. In order to permit the autopilot to couple on to the localizer, an interception angle not exceeding 30° is desirable. When the angle exceeds 70° a radial, bearing, radar vector, or DME or RNAV information providing at least 4 km (2 NM) (Cat H, 1.9 km (1 NM)) of lead shall be identified to assist the turn onto the intermediate track. When the angle exceeds 90°, the use of a reversal, racetrack, or dead reckoning (DR) track procedure should be considered (see Part I, Section 4, Chapter 3, "Initial Approach Segment" and Part I, Section 4, Appendix A to Chapter 3, "Initial approach using dead reckoning").

1.2.3 Initial approach segment area

The area is as described in the general criteria (see Part I, Section 4, Chapter 3, 3.3.3, "Area"). The difference is that the intermediate approach fix (IF) must be located within the service volume of the ILS localizer course signal, and normally at a distance not exceeding 46 km (25 NM) from the localizer antenna. When radar is used to provide track guidance to the IF, the area shall be in accordance with 6.2,"Initial approach segment" (Section 2, Chapter 6, "SRE").

1.3 INTERMEDIATE APPROACH SEGMENT

1.3.1 General

1.3.1.1 The intermediate approach segment for ILS differs from the general criteria in that:

a) the alignment coincides with the localizer course;

b) the length may be reduced; and

c) in certain cases the secondary areas may be eliminated.

1.3.1.2 The primary and secondary areas at the FAP are defined in terms of the ILS surfaces. Consequently, the general criteria in Part I, Section 4, Chapter 4, "Intermediate Approach Segment" are applied except as modified or amplified in the paragraphs below with regards to alignment, area length and width, and for obstacle clearance. For RNAV initial approach segments, the criteria in the applicable RNAV chapters apply.

1.3.2 Intermediate approach segment alignment

The intermediate approach segment of an ILS procedure shall be aligned with the localizer course.

1.3.3 Intermediate approach segment length

1.3.3.1 The optimum length of the intermediate approach segment is 9 km (5 NM) (Cat H, 3.7 km (2 NM)). This segment shall allow interception with the localizer course and with the glide path.

1.3.3.2 Segment length should be sufficient to permit the aircraft to stabilize and establish on the localizer course prior to intercepting the glide path, taking into consideration the angle of interception with the localizer course.

1.3.3.3 Minimum values for distance between localizer and interception of glide path are specified in Table II-1-1-1; however, these minimum values should only be used if usable airspace is restricted. The maximum length of the segment is governed by the requirement that it be located wholly within the service volume of the localizer signal and normally at a distance not exceeding 46 km (25 NM) from the localizer antenna.

1.3.4 Intermediate approach segment area width

1.3.4.1 The total width at the beginning of the intermediate approach segment is defined by the final total width of the initial approach segment. It tapers uniformly to match the horizontal distance between the OAS X surfaces at the FAP (see 1.4.8.4, "Definition of obstacle assessment surfaces (OAS)").

1.3.4.2 For obstacle clearance purposes the intermediate approach segment is usually divided into a primary area bounded on each side by a secondary area. However, when a DR track is used in the initial approach segment, the primary area of the intermediate approach segment extends across its full width and secondary areas are not applied.

1.3.4.3 The primary area is determined by joining the primary initial approach area with the final approach surfaces (at the FAP). At the interface with the initial approach segment the width of each secondary area equals half the width of the primary area. The secondary area width decreases to zero at the interface with the final approach surfaces. See Figures II-1-1-1, II-1-1-2 and II-1-1-3.

1.3.4.4 Where a racetrack or reversal manoeuvre is specified prior to intercepting the localizer course the provisions in Part I, Section 4, Chapter 4, 4.4.4, "Turn not at the facility" apply, the facility being the localizer itself and the FAF being replaced by the FAP. (See Figure II-1-1-4.)

1.3.5 Intermediate approach segment obstacle clearance

The obstacle clearance is the same as defined in Part I, Section 4, Chapter 4, "Intermediate approach segment" except where the procedure permits a straight-in approach in which the aircraft is stabilized on the localizer course prior to crossing the IF. In this case, obstacles in the secondary areas need not be considered for the purpose of obstacle clearance.

1.4 PRECISION SEGMENT

1.4.1 General

The precision segment is aligned with the localizer course and contains the final descent for landing as well as the initial and intermediate phases of the missed approach segment See Figure II-1-1-5.

1.4.2 Origin

The precision segment starts at the final approach point (FAP), that is, the intersection of the nominal glide path and the minimum altitude specified for the preceding segment. The FAP should not normally be located more than 18.5 km (10.0 NM) before threshold, unless adequate glide path guidance beyond the minimum specified in Annex 10 is provided.

1.4.3 Descent fix

1.4.3.1 A descent fix may be located at the FAP to overcome certain obstacles located before the FAP as an alternative to increasing the glide path (GP) angle. When so located, it becomes the final approach fix. The extension of the precision surfaces into the precision segment is then terminated. The descent fix should not normally be located more than 18.5 km (10.0 NM) before threshold, unless adequate GP guidance beyond the minimum specified in Annex 10 is provided. The maximum fix tolerance is ± 0.9 km (± 0.5 NM). Where DME is used to identify the fix, the range shall be stated in tenths of kilometres (nautical miles).

Note.— Guidance material for determining the distance to the descent fix from the threshold is contained in Appendix C.

1.4.3.2 *Obstacle clearance at the descent fix.* When a descent fix is provided, the precision approach surfaces start at the earliest point of the FAF tolerance area (see Figure II-1-1-2). The provisions of Part I, Section 2, Chapter 2, 2.7.4, "Obstacle close to a final approach fix or stepdown fix" which allow obstacles close to the fix to be ignored, apply in the area below the 15 per cent gradient within the precision surfaces (Cat H, 15 per cent gradient or the nominal gradient multiplied by 2.5, whichever is greater). Where a descent fix is not provided at the FAP, no curtailment of the precision surfaces is permitted (see Figure II-1-1-3). If the precision surfaces are extended into the preceding segment, they shall not be extended beyond the intermediate approach segment.

1.4.4 Glide path verification check

A fix (outer marker or DME) is necessary so as to permit comparison between the indicated glide path and the aircraft altimeter information. The fix shall not have a fix tolerance exceeding ± 0.9 km (± 0.5 NM). When DME is used to identify the fix, the range shall be stated in tenths of kilometres (nautical miles).

Note.— Guidance material for determining the height crossing the outer marker is contained in Appendix C.

1.4.5 Missed approach

The missed approach point is defined by the intersection of the nominal glide path and the decision altitude/height (DA/H). The DA/H is set at or above the OCA/H, which is determined as specified in 1.4.7 to 1.4.9 and 1.5.

1.4.6 Termination

The precision segment normally terminates at the point where the final phase of the missed approach commences (see Part I, Section 4, Chapter 6, 6.1.2, "Phases of missed approach segment") or where the missed approach climb surface Z (starting 900 m past threshold) reaches a height of 300 m (984 ft) above threshold, whichever is lower.

1.4.7 Obstacle clearance of the precision segment application of basic ILS surfaces

1.4.7.1 *General.* The area required for the precision segment is bounded overall by the basic ILS surfaces defined in 1.4.7.2, below. In standard conditions there is no restriction on objects beneath these surfaces (see 1.1.3, "Standard conditions"). Objects or portions of objects that extend above these surfaces must be either:

a) minimum mass and frangible; or

b) taken into account in the calculation of the OCA/H.

1.4.7.2 *Definition of basic ILS surfaces.* The surfaces to be considered correspond to a subset of Annex 14 obstacle limitation surfaces as specified for precision approach runway code numbers 3 or 4 (see Figure II-1-1-6). These are:

a) the approach surface continuing to the final approach point (FAP) (first section 2 per cent gradient, second section 2.5 per cent as described in Annex 14);

b) the runway strip assumed to be horizontal at the elevation of the threshold;

c) the missed approach surface. This is a sloping surface which:

   1) starts at a point 900 m past the threshold (Cat H, a starting point of 700 m past the threshold can be considered if necessary) at threshold elevation;

   2) rises at a 2.5 per cent gradient; and

   3) splays so as to extend between the transitional surfaces. It extends with constant splay to the level of the inner horizontal surface. Thereafter, it continues at the same gradient but with a 25 per cent splay until the termination of the precision segment; and

d) the extended transitional surfaces, which continue longitudinally along the sides of the approach and missed approach surfaces and up to a height of 300 m above threshold elevation.

1.4.7.3 *Determination of OCA/H with basic ILS surfaces*

1.4.7.3.1 Where the basic ILS surfaces specified in 1.4.7.2 are not penetrated, the OCA/H for Category I and Category II is defined by the margins specified in Table II-1-1-2, and Category III operations are not restricted. Obstacles may be excluded when they are below the transitional surface defined by Annex 14 for runways with code numbers 3 and 4, regardless of the actual runway code number (i.e., the surfaces for code numbers 3 and 4 are used for the obstacle assessment on runways with code numbers 1 and 2).

1.4.7.3.2 If the basic ILS surfaces listed above are penetrated by objects other than those listed in Table II-1-1-3, the OCA/H may be calculated directly by applying height loss/altimeter margins to obstacles (see 1.4.8.8, "Determination of OCA/H with OAS or basic ILS surfaces").

1.4.7.3.3 The obstacles in Table II-1-1-3 may only be exempted if the following two criteria are met:

a) the localizer course sector has the standard width of 210 m (see 1.1.3, "Standard conditions"); and

b) the Category I decision height is not less than 60 m (200 ft) or the Category II decision height is not less than 30 m (100 ft).

1.4.7.3.4 An object that penetrates any of the basic ILS surfaces and becomes the controlling obstacle, but must be maintained because of its function with regards to air navigation requirements, may be ignored under certain circumstances in calculating the OCA/H, with the following provision. It must be established by the appropriate authority that the portion which penetrates the surface is of minimum mass and frangibly mounted and would not adversely affect the safety of aircraft operations.

1.4.8 Obstacle clearance of the precision segment using obstacle assessment surface (OAS) criteria

1.4.8.1 *General*

1.4.8.1.1 This section describes the OAS surfaces, the constants which are used to define these surfaces, and the conditions under which adjustments may or must be made. The OAS dimensions are related to:

a) the ILS geometry (localizer-threshold distance, glide path angle, ILS RDH, localizer sector width);

b) the category of ILS operation; and

c) other factors, including aircraft geometry, missed approach climb gradient.

Thus, a table of OCA/H values for each aircraft category may be calculated for Cat I and II ILS operations at the particular airfield.

1.4.8.1.2 Additional material is included to enable appropriate authorities to assess realistic benefits for claims of improved performance and associated conditions. See 1.4.8.7, "Adjustment of OAS constants".

1.4.8.1.3 Note that the OAS are not intended to replace Annex 14 surfaces as planning surfaces for unrestricted obstacle growth. The obstacle density between the basic ILS surfaces and the OAS must be accounted for (see 1.4.8.9, "Effect of obstacle density on OCA/H").

1.4.8.2 *Frame of reference*

Positions of obstacles are related to a conventional x, y, z coordinate system with its origin at threshold. See Figure II-1-1-10. The x-axis is parallel to the precision segment track: positive x is distance before threshold and negative x is distance after threshold. The y-axis is at right angles to the x-axis. Although shown conventionally in Figure II-1-1-10, *in all calculations associated with OAS geometry, the y coordinate is always counted as positive.* The z-axis is vertical, heights above threshold being positive. All dimensions connected with the OAS are specified in metres only. The dimensions should include any adjustments necessary to cater for tolerances in survey data (see Part I, Section 2, Chapter 1, 1.8, "Charting accuracy").

1.4.8.3 *OAS constants — specification*

For Category I and II operations the constants A, B and C for each sloping surface are obtained from the PANS-OPS OAS CD-ROM. The PANS-OPS OAS CD-ROM gives coefficients for glide path angles between 2.5 and 3.5 degrees in 0.1 degree steps, and for any localizer-threshold distance between 2 000 m and 4 500 m. Extrapolation outside these limits is not permitted. If a localizer threshold distance outside this range is entered, the PANS-OPS OAS CD-ROM gives the coefficients for 2 000 m or 4 500 m as appropriate, which must be used. For an example of the PANS-OPS OAS CD-ROM results see Figure II-1-1-12.

1.4.8.4 *Definition of obstacle assessment surfaces (OAS)*

1.4.8.4.1 The OAS consist of six sloping plane surfaces (denoted by letters W, X, Y, and Z) arranged symmetrically about the precision segment track, together with the horizontal plane which contains the threshold (see Figures II-1-1-8 and II-1-1-9). The geometry of the sloping surfaces is defined by four linear equations of the form $z = Ax + By + C$. In these equations x and y are position coordinates and z is the height of the surface at that position (see Figure II-1-1-7).

1.4.8.4.2 For each surface a set of constants (A, B and C) are obtained from the PANS-OPS OAS CD-ROM for the operational range of localizer threshold distances and glide path angles. Separate sets of constants are specified for Category I and II. These constants may be modified by the programme (see 1.4.8.7, "Adjustment of OAS constants").

1.4.8.4.3 The Category I OAS are limited by the length of the precision segment and, except for the W and X surfaces, by a maximum height of 300 m. The Category II OAS are limited by a maximum height of 150 m.

1.4.8.4.4 Where the Annex 14 approach and transitional obstacle limitation surfaces for code numbers 3 and 4 precision approach runways penetrate inside the OAS, the Annex 14 surfaces become the OAS (i.e. the surfaces for code numbers 3 and 4 are used for obstacle assessment on runways with code numbers 1 and 2). The Annex 14 inner approach, inner transitional and balked landing obstacle limitation surfaces protect Category III operations, provided the Category II OCA/H is at or below the top of those surfaces which may be extended up to 60 m if necessary) (see Figure II-1-1-6).

1.4.8.5 *Calculation of OAS heights*

To calculate the height z of any of the sloping surfaces at a location x', y', the appropriate constants should be first obtained from the PANS-OPS OAS CD-ROM. These values are then substituted in the equation $z = Ax' + By' + C$. If it is not clear which of the OAS surfaces is above the obstacle location this should be repeated for the other sloping surfaces. The OAS height is the highest of the plane heights (zero if all the plane heights are negative).

Note.— The PANS-OPS OAS CD-ROM also contains an OCH calculator that will show the height of the OAS surface z above any x, y location. It includes all the adjustments specified for ILS geometry, aircraft dimensions, missed approach climb gradient and ILS reference datum height.

1.4.8.6 *OAS template construction*

1.4.8.6.1 Templates, or plan views of the OAS contours to map scale, are sometimes used to help identify obstacles for detail survey (see Figure II-1-1-11). The OAS data in the PANS-OPS CD-ROM includes the coordinates of the points of intersection:

a) of the sloping surfaces at threshold level. The intersection coordinates are labeled as C, D and E (Figure II-1-1-9);

b) at 300 m above threshold level for Cat I; and

c) at 150 m for Cat II.

1.4.8.7 *Adjustment of OAS constants*

1.4.8.7.1 *General.* The following paragraphs describe the adjustments that the PANS-OPS OAS CD-ROM programme makes to the OAS constants. These adjustments are mandatory when the standard conditions are not met (see 1.1.3, “Standard conditions”). Optional adjustments may be made when so specified. For examples of calculations see the *Instrument Flight Procedures Construction Manual* (Doc 9368).

1.4.8.7.2 *Reasons for adjusting constants.* The constants may be modified to account for the following:

a) missed approach climb gradient (see 1.4.8.7.7, below);

b) dimensions of specific aircraft (see 1.4.8.7.3, below);

c) the height of the ILS reference datum (see 1.4.8.7.4, below);

d) improved beam holding performance due to use of autopilots certified for Category II operations (see 1.4.8.7.6, below); and

e) certain Category I localizers having a sector width greater than the nominal 210 m at threshold (see 1.4.8.7.5, below).

1.4.8.7.3 *Specific aircraft dimensions.* An adjustment is mandatory where aircraft dimensions exceed those specified in 1.1.3, “Standard conditions” and is optional for aircraft with smaller dimensions. The PANS-OPS OAS CD-ROM adjust the OAS coefficients and template coordinates for the standard dimensions of Category A, B, C, D and D_L aircraft automatically. It will do the same for specific aircraft dimensions in any category. It uses the following correction formula to adjust the coefficient C for the W, W*, X and Y surfaces:

W surface: $C_w corr = C_w - (t - 6)$

W* surface: $C_w{}^*corr = C_w{}^* - (t - 6)$

X surface: $C_x corr = C_x - B_x \cdot P$

Y surface: $C_y corr = C_y - B_y \cdot P$

where: $$P = \left[\frac{t}{B_x} \text{ or } S + \frac{t-3}{B_x}\text{, whichever is the maximum}\right] - \left[\frac{6}{B_x} \text{ or } 30 + \frac{3}{B_x}\text{, whichever is the maximum}\right]$$

and s = semi-span

t = vertical distance between paths of the GP antenna and the lowest part of the wheels.

1.4.8.7.4 *Height of the ILS reference datum (RDH).* This is based on a reference datum height (RDH) of 15 m. An adjustment to the OAS constants is mandatory for an RDH less than 15 m, and is optional for an RDH greater than 15 m. The PANS-OPS OAS CD-ROM adjusts the OAS coefficients and template coordinates by correcting the tabulated values of the coefficient C for the W, W*, X and Y surfaces as follows:

$$C_{corr} = C + (RDH - 15)$$

where: C_{corr} = corrected value of coefficient C for the appropriate surface

C = tabulated value.

1.4.8.7.5 *Modification for Cat I localizers with course width greater than 210 m at threshold.* Where the ILS localizer sector width at threshold is greater than the nominal value of 210 m, the collision risk model (CRM) method described in 1.4.9 shall be used. Adjustments for sector widths less than 210 m shall not be made, and are inhibited in the PANS-OPS OAS CD-ROM.

1.4.8.7.6 *Use of autopilot (autocoupled) in Cat II.* The Cat II OAS may be reduced to reflect the improved beam holding of autopilots where these are certificated for the operation by the appropriate authority. This reduction is achieved in the PANS-OPS OAS CD-ROM by the use of modified A, B and C constants for the X surface, and the introduction of an extra surface (denoted by W*) (see Figure II-1-1-11 c)). The use of these reduced surfaces should not be authorized for non-autocoupled approaches.

1.4.8.7.7 *Missed approach climb gradient.* If equipment is capable of missed approach climb gradients better than the nominal 2.5 per cent, the Y and Z surfaces may be adjusted. This is done by using the desired missed approach climb gradient in the PANS-OPS OAS CD-ROM. The programme then adjusts the Y and Z surface coefficients.

1.4.8.8 *Determination of OCA/H with OAS or basic ILS surfaces*

1.4.8.8.1 *General.* The OCA/H is determined by accounting for all obstacles which penetrate the basic ILS surfaces defined in 1.4.7.2 and the OAS surfaces applicable to the ILS category of operation being considered. The exemptions listed in 1.4.7.3, "Determination of OCA/H with basic ILS surfaces" for obstacles penetrating the basic ILS surfaces may be applied to obstacles penetrating the OAS, providing the criteria listed in that paragraph are met. The surfaces which apply to each category of operations are:

a) *ILS Cat I*: ILS Cat I OAS;

b) *ILS Cat II:* ILS Cat II OAS and those portions of ILS Cat I which lie above the limits of ILS Cat II; and

c) *ILS Cat III:* Same as ILS Cat II.

1.4.8.8.2 *Calculation of OCA/H values with OAS.* Accountable obstacles, as determined below in 1.4.8.8.2.3, "OCA/H Calculation steps" are divided into approach and missed approach obstacles. The standard method of categorization is as follows: Approach obstacles are those between the FAP and 900 m after threshold (Cat H, 700 m if necessary). Missed approach obstacles are those in the remainder of the precision segment (see Figure II-1-1-13). However, in some cases this categorization of obstacles may produce an excessive penalty for certain missed approach obstacles (see Attachment to Part II, 1.9). Where desired by the appropriate authority, missed approach obstacles may be defined as those above a plane surface parallel to the plane of the glide path and with origin at –900 m (Cat H, –700 m if necessary) (see Figure II-1-1-14), i.e. obstacle height greater than [(900 + x) $\tan\theta$].

1.4.8.8.2.1 *OCA/H Calculation steps*

a) Determine the height of the highest approach obstacle.

b) Convert the heights of all missed approach obstacles (h_{ma}) to the heights of equivalent approach obstacles (h_a) by the formula given below, and determine the highest equivalent approach obstacle.

c) Determine which of the obstacles identified in steps a) and b) is the highest. This is the controlling obstacle.

d) Add the appropriate aircraft category related margin (Table II-1-1-2) to the height of the controlling obstacle.

$$h_a = \frac{h_{ma} \cot Z + (x_z + x)}{\cot Z + \cot\theta}$$

where: h_a = height of equivalent approach obstacle

h_{ma} = height of missed approach obstacle

θ = angle of glide path (elevation angle)

Z = angle of missed approach surface

x = range of obstacle relative to threshold (negative after threshold)

x_z = distance from threshold to origin of Z surface (900 m (700 m Cat H))

1.4.8.8.3 *Adjustment for high airfield elevations and steep glide path angles*

1.4.8.8.3.1 *Height loss (HL)/altimeter margins.* The margins in Table II-1-1-2 shall be adjusted as follows:

a) for airfield elevation higher than 900 m (2 953 ft), the tabulated allowances shall be increased by 2 per cent of the radio altimeter margin per 300 m (984 ft) airfield elevation; and

b) for glide path angles greater than 3.2° in exceptional cases, the allowances shall be increased by 5 per cent of the radio altimeter margin per 0.1° increase in glide path angle between 3.2° and 3.5°.

1.4.8.8.3.1.1 Procedures involving glide paths greater than 3.5° or any angle when the nominal rate of descent (V_{at} for the aircraft type x´ the sine of the glide path angle) exceeds 5 m/sec (1 000 ft/min), are non-standard. They require the following:

a) increase of height loss margin (which may be aircraft type specific);

b) adjustment of the origin of the missed approach surface;

c) adjustment of the slope of the W surface;

d) re-survey of obstacles; and

e) the application of related operational constraints.

Such procedures are normally restricted to specifically approved operators and aircraft, and are associated with appropriate aircraft and crew restrictions. They are not to be used as a means to introduce noise abatement procedures.

1.4.8.8.3.1.2 Appendix B shows the procedure design changes required and the related operational/certification considerations.

Example: Aircraft Category C — Aerodrome elevation: 1 650 m above MSL; glide path angle 3.5°.

Tabulated allowances: radio altimeter 22 m

(Table II-1-1-2) pressure altimeter 46 m

Correction for aerodrome elevation:

$$22 \times \frac{2}{100} \times \frac{1\,650}{300} = 2.42 \text{ m}$$

Correction for glide path angle:

$$22 \times \frac{5}{100} \times \frac{3.5 - 3.2}{0.1} = 3.30 \text{ m}$$

Total correction 5.72 m rounded up to 6 m.

Corrected radio altimeter margin 22 + 6 = 28 m.

Corrected pressure altimeter margin 46 + 6 = 52 m.

1.4.8.8.3.2 *Exceptions and adjustments to values in Table II-1-1-2.* Values in Table II-1-1-2 are calculated to account for aircraft using normal manual overshoot procedures from OCA/H on the nominal approach path. The values in Table II-1-1-2 do not apply to Cat III operations. The values do not consider the lateral displacement of an obstacle nor the probability of an aircraft being so displaced. If consideration of these joint probabilities is required, then the CRM discussed in 1.4.9 shall be used. Values in Table II-1-1-2 may be adjusted for specific aircraft types where adequate flight and theoretical evidence is available, i.e. the height loss value corresponding to a probability of 1×10^{-5} (based on a missed approach rate 10^{-2}).

1.4.8.8.3.3 *Radio altimeter verification.* If the radio altimeter OCA/H is promulgated, operational checks shall have confirmed the repeatability of radio altimeter information.

1.4.8.8.3.4 *Height loss (HL)/altimeter margins for a specific speed at threshold.* If a height loss/altimeter margin is required for a specific V_{at}, the following formulae apply (see also Table II-1-1-4):

Use of radio altimeter:

Margin = (0.096 V_{at} – 3.2) metres where V_{at} in km/h

Margin = (0.177 V_{at} – 3.2) metres where V_{at} in kt

Use of pressure altimeter:

Margin = (0.068 V_{at} + 28.3) metres where V_{at} in km/h

Margin = (0.125 V_{at} + 28.3) metres where V_{at} in kt

where V_{at} is the speed at threshold based on 1.3 times stall speed in the landing configuration at maximum certificated landing mass.

Note.— The equations assume the aerodynamic and dynamic characteristics of the aircraft are directly related to the speed category. Thus, the calculated height loss/altimeter margins may not realistically represent small aircraft with V_{AT} at maximum landing mass exceeding 165 kt.

1.4.8.8.3.5 *Height loss (HL)/altimeter margins for a specific speed at threshold (Helicopters).* For helicopter operations the concept of V_{at} is not applicable. Height loss margins are listed in Table II-1-1-2.

1.4.8.9 *Effect of obstacle density on OCA/H.* To assess the acceptability of obstacle density below the OAS, the CRM described in 1.4.9 may be used. This can provide assistance by comparing aerodrome environments and by assessing risk levels associated with given OCA/H values. It is emphasized that it is not a substitute for operational judgement.

1.4.9 Obstacle clearance of the precision segment — application of collision risk model (CRM)

1.4.9.1 *General.* The CRM is a computer programme that establishes the numerical risk which can be compared to the target level of safety for aircraft operating to a specified OCA/H height. A description of the programme and instructions on its use, including the precise format of both the data required as input and the output results, are given in the *Manual on the Use of the Collision Risk Model (CRM) for ILS Operations* (Doc 9274).

1.4.9.2 *Input.* The CRM requires the following data as input:

a) *aerodrome details*: name, runway threshold position and runway orientation in threshold elevation above MSL, details of proceeding segment;

b) *ILS parameters:* category, glide slope angle, localizer-threshold distance, localizer course width, height of ILS reference datum above threshold;

c) *missed approach parameters*: decision height (obstacle clearance height) and missed approach turn point;

d) *aircraft parameters*: type, wheel height (antenna to bottom of wheel), and wing semi-span, aircraft category (A, B, C, D or D_L) missed approach climb gradient; and

Note.— The CRM does not consider Category E aircraft.

e) *obstacle data*: obstacle boundaries (either as x and y coordinates relative to the runway threshold or as map grid coordinates) and obstacle height (either above threshold elevation or above MSL). For density assessment, all obstacles penetrating the basic ILS surfaces described in 1.4.7.2 must be included.

1.4.9.3 *Output and application.* The output of the programme is:

a) the overall (total) risk of collision with obstacles for aircraft operating to a specified OCA/H; and

b) the minimum OCA/H which will provide the target level of safety.

The user, by rerunning the CRM with the appropriate parameters, can assess the effect on the safety of operations of any alteration in the parameters, typically varying the glide path angle or remaining obstacles.

1.5 MISSED APPROACH SEGMENT

1.5.1 General

1.5.1.1 The criteria for the final missed approach are based on those for the general criteria (see Part I, Section 4, Chapter 6). Certain modifications have been made to allow for the different areas and surfaces associated with the precision segment and for the possible variation in OCA/H for that segment with aircraft category. Area construction is according to the navigation system specified for the missed approach.

1.5.1.2 The datum used for calculation of distances and gradients in obstacle clearance calculations is termed “start of climb” (SOC). It is defined by the height and range at which the plane GP’— a plane parallel with the glide path and with origin at –900 m (Cat H, –700 m) at threshold level — reaches the altitude OCA/H – HL. OCA/H and HL must both relate to the same category of aircraft.

1.5.1.3 If obstacles identified in the final missed approach segment result in an increase in any of the OCA/H calculated for the precision segment, a higher gradient of the missed approach surface (Z) may be specified in addition if this will provide clearance over those obstacles at a specified lower OCA/H (see Part I, Section 4, Chapter 6, 6.2.3.1, "Climb gradient in the final phase").

1.5.2 Straight missed approach

1.5.2.1 *General.* The precision segment terminates at the point where the Z surface reaches a height 300 m above threshold. The width of the Z surface at that distance defines the initial width of the final missed approach area which splays at an angle of 15 degrees from that point, as shown in Figure II-1-1-15. There are no secondary areas.

1.5.2.2 *Straight missed approach obstacle clearance.* (See Figure II-1-1-16.) Obstacle elevation/height in this final missed approach area shall be less than

$$(OCA/H_{ps} – HL) + d_o \tan Z$$

where:

a) OCA/H of the precision segment (OCA/H_{ps}) and HL (Table II-1-1-2 value) both relate to the same aircraft category.

b) d_o is measured from SOC parallel to the straight missed approach track; and

c) Z is the angle of the missed approach surface with the horizontal plane.

If this requirement cannot be met, a turn shall be prescribed to avoid the obstacle in question. If a turn is not practical, the OCA/H shall be raised.

1.5.3 Turning missed approach

1.5.3.1 *General.* Turns may be prescribed at a designated turning point (TP), at a designated altitude/height, or "as soon as practicable". The criteria used depend on the location of the turn relative to the normal termination of the precision segment (see 1.4.6, "Termination") and are as follows:

a) *turn after normal termination of the precision segment.* If a turn is prescribed after normal termination of the precision segment, the general criteria of Part I, Section 4, Chapter 6, 6.4.5, "Turn initiated at a designated altitude/height" and Part I, Section 4, Chapter 6, 6.4.6, "Turn initiated at a designated turning point" apply with the following exceptions:

   1) OCA/H is replaced by (OCA/H – HL) as in 1.5.2.2, "Straight missed approach obstacle clearance"; and

   2) because SOC is related to OCA/H, it is not possible to obtain obstacle clearance by the means used in non-precision approaches (that is, by independent adjustment of OCA/H or MAPt); and

b) *turn before normal termination of the precision segment.* If a turn is prescribed at a designated altitude/height which is less than 300 m above threshold, or at a designated TP such that the earliest TP is within the normal termination range, the criteria specified in 1.5.3.2 and 1.5.3.3 below shall be applied.

Note.— Adjustments to designated TP location or to the designated turn altitude may involve redrawing the associated areas and recalculating the clearances. This can exclude some obstacles or introduce new ones. Thus, when it is necessary to obtain the minimum value of OCA/H – particularly when constraints due to obstacles are very high — it may be necessary to adjust the designated TP or turn altitude by trial and error. (See Appendix A).

1.5.3.2 *Turn at a designated altitude/height less than 300 m above threshold*

1.5.3.2.1 The general criteria apply (see Part I, Section 4, Chapter 6, 6.4.5, "Turn initiated at a designated altitude/height") as amplified and modified by the contents of this section. Construction of the turn initiation area and the subsequent turn are illustrated in Figure II-1-1-17.

1.5.3.2.2 *Turn altitude/height*

The general criteria apply, modified as follows. The precision segment terminates (and the final missed approach segment begins) at the TP. This allows the calculation of OCA/H_{ps} and (OCA/H_{ps} – HL). SOC is then determined, and turn altitude/height (TNA/H) is computed from the following relationship:

$$TNA/H = OCA/H_{ps} - HL + d_z \tan Z$$

where: d_z is the horizontal distance from SOC to the TP and

OCA/H_{ps} = OCA/H calculated for the precision segment.

If the TP is located at the SOC, the chart shall be annotated "turn as soon as practicable to ... (heading or facility)" and shall include sufficient information to identify the position and height of the obstacles dictating the turn requirement.

1.5.3.2.3 *Areas*

1.5.3.2.3.1 *Turn initiation area.* (See Figure II-1-1-17). The turn initiation area is bounded by the 300 m Category I Y surface contour, and terminates at the TP.

*Note.— The earliest TP is considered to be at the beginning of the 300 m Category I Y surface contour (point D") unless a fix is specified to limit early turns (see 1.5.3.2.6, "*Safeguarding of early turns"*).*

1.5.3.2.3.2 *Turn boundary construction.* Turn boundaries are constructed as specified in Section 2, Chapter 3, "Turn area construction"

1.5.3.2.4 *Obstacle clearance*

a) *Obstacle clearance in the turn initiation area.* Obstacle elevation/height in the turn initiation area shall be less than:

1) turn altitude/height – 50 m (164 ft) (Cat H, 40 m (132 ft)) for turns more than 15°; and

2) turn altitude/height – 30 m (98 ft) for turns 15° or less,

except that obstacles located under the Y surface on the outer side of the turn need not be considered when calculating turn altitude/height.

b) *Obstacle clearance in the turn area.* Obstacle elevation/height in the turn area and subsequently shall be less than:

turn altitude/height + $d_o \tan Z$ – MOC where d_o is measured from the obstacle to the nearest point on the turn initiation area boundary and MOC is:

1) 50 m (164 ft) (Cat H, 40 m (132 ft)) for turns more than 15°; and

2) 30 m (98 ft) for turns 15° or less,

reducing linearly to zero at the outer edge of the secondary areas, if any.

1.5.3.2.5 *Turn altitude/height adjustments.* If the criteria specified in 1.5.3.2.4, "Obstacle clearance", above cannot be met, the turn altitude/height shall be adjusted. This can be done in two ways:

a) *adjust turn altitude/height without changing OCA/H*: this means that the TP will be moved and the areas redrawn accordingly; and

b) *raise turn altitude/height by increasing OCA/H:* this results in a higher turn altitude over the same TP. The turn areas remain unchanged.

1.5.3.2.6 *Safeguarding of early turns.* Where the published procedure does not specify a fix to limit turns for aircraft executing a missed approach from above the designated turn altitude/height, an additional check of obstacles shall be made. The general criteria of Part I, Section 4, Chapter 6, 6.4.5.6, "Safeguarding of early turns" and general principles of Part I, Section 4, Chapter 6, Figure I-4-6-14 apply with the following modifications:

a) the limit of the final approach area is replaced by the line DD" of the OAS surfaces and its extension;

b) the FAF is replaced by the FAP;

c) the earliest MAPt is replaced by the line D"D" (earliest limit of the turn initiation area); and

d) if the criterion cannot be met, then the procedure must prohibit turns before a point equivalent to the MAPt and a note must be added on the profile view of the approach chart.

1.5.3.3 *Turn at a designated TP with earliest TP before normal termination of precision segment*

1.5.3.3.1 Where a turn is specified at a designated TP, and the earliest TP is before the normal termination range of the precision segment, the precision segment terminates at the earliest TP. This allows the calculation of OCA/H_{ps} and $(OCA/H_{ps} – HL)$; SOC is then determined.

1.5.3.3.2 *Turn area.* The turn area is constructed as specified in Part I, Section 4, Chapter 6, 6.4.6.3, "Construction of the turn area" except that it is based on the width of the 300 m OAS Y surface contours at the earliest and latest TP (see Figure II-1-1-18).

1.5.3.3.3 *Obstacle clearance.* Obstacle elevation/height shall be less than:

$$(OCA/H_{ps} – HL) + d_o \tan Z – MOC$$

where: d_o = d_z + shortest distance from obstacle to line K-K,

d_z = horizontal distance from SOC to the earliest TP, and MOC is:

50 m (164 ft) (Cat H, 40 m (132 ft)) for turns more than 15° and

30 m (98 ft) for turns 15° or less.

If the obstacle elevation/height exceeds this value, the OCA/H must be increased, or the TP moved to obtain the required clearance (see Appendix A).

1.6 SIMULTANEOUS PRECISION APPROACHES TO PARALLEL OR NEAR-PARALLEL INSTRUMENT RUNWAYS

Note.— Guidance material is contained in the Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways *(Doc 9643).*

1.6.1 General

When it is intended to use precision approach procedures to parallel runways simultaneously, the following additional criteria shall be applied in the design of both procedures:

a) the maximum intercept angle with the final approach course is 30°. The point of intercepting final approach course should be located at least 3.7 km (2.0 NM) prior to the point of intercepting the glide path;

b) the minimum altitudes of the intermediate approach segments of the two procedures differ by at least 300 m (1 000 ft); and

c) the nominal tracks of the two missed approach procedures diverge by at least 30°. Associated missed approach turns shall be specified as "as soon as practicable".

1.6.2 Obstacle clearance

The obstacle clearance criteria for precision approaches, as specified in the designated chapters apply for each of the parallel precision procedures. In addition to these criteria, a check of obstacles shall be made in the area on the far side of the parallel runway in order to safeguard early turns required to avoid potential intruding aircraft from the adjacent runway. This check can be made using a set of separately defined parallel approach obstacle assessment surfaces (PAOAS). An example of a method to assess obstacles for these procedures is included in Appendix D.

1.7 PROMULGATION

1.7.1 General

1.7.1.1 The general criteria in Part I, Section 2, Chapter 1, 1.9, "Promulgation" apply. The instrument approach chart for an ILS approach procedure shall be identified by the title ILS Rwy XX. If Category II and/or III minima are included on the chart, the title shall read ILS Rwy XX CAT II or ILS Rwy XX CAT II & III, as appropriate. If more than one ILS approach is published for the same runway, the Duplicate Procedure Title convention shall be applied, with the approach having the lowest minima being identified as ILS Z RWY XX.

1.7.1.2 If more than one ILS approach is published for the same runway and some segments of the two approaches are not equal, the Duplicate Procedure Title convention shall be applied. As an example, when considering two ILS approaches to the same runway that have different missed approach procedures, the Duplicate Procedure Title convention shall be applied. When two different approaches to the same runway are published, the approach having the lowest minima should be identified as ILS Z Rwy XX.

1.7.1.3 When a final approach fix is identified at the FAP, a warning shall be appended to the procedure stating that descent on the glidepath below the FAF altitude is not permitted until passing the FAF.

1.7.2 Promulgation of OCA/H values

1.7.2.1 *Promulgation of OCA/H for Cat I and II approach procedures*

1.7.2.1.1 The OCA or OCH values, as appropriate, shall be promulgated for those categories of aircraft for which the procedure is designed. The values shall be based on the following standard conditions:

a) Cat I flown with pressure altimeter;

b) Cat II flown autocoupled with radio altimeter;

c) standard aircraft dimensions (see 1.1.3, "Standard conditions"); and

d) 2.5 per cent missed approach climb gradient.

1.7.2.1.2 Additional values of OCA/H may be agreed upon between operators and the appropriate authority and be promulgated, provided that modifications have been carried out using the guidelines and algorithms defined in 1.4.8.7, "Adjustment of OAS constants".

1.7.2.1.3 Use of OCA/H values for Category I approach procedures based on radio altimeter height loss margins may be agreed upon between operators and the appropriate authority, and the values promulgated, if the requirement of 1.4.8.8.3.3, "Radio altimeter verification" is met.

1.7.2.2 *Promulgation of Category III approach procedures*

Category III operations may be permitted subject to the appropriate Category II OCA/H being below the height of the Annex 14 inner horizontal surface. Category III operations may also be permitted with a Category II OCA/H between the height of the inner horizontal surface and 60 m provided the Annex 14 Category II inner approach, inner transitional and balked landing surfaces are extended to protect that OCA/H.

1.7.3 Turn at a designated altitude/height (missed approach)

If the TP is located at the SOC, the chart shall be annotated "turn as soon as practicable to ... (heading or facility)" and shall include sufficient information to identify the position and height of the obstacles dictating the turn requirement.

1.7.4 Turn at a designated TP (missed approach)

Where the procedure requires that a turn be executed at a designated TP, the following information must be published with the procedure:

a) the TP, when it is designated by a fix; or

b) the intersecting VOR radial, NDB bearing, or DME distance where there is no track guidance (see Part I, Section 2, Chapter 2, 2.6.5, "Missed approach fixes").

1.7.5 Procedures involving non-standard glide path angles

Procedures involving glide paths greater than 3.5° or any angle when the nominal rate of descent exceeds 5 m/sec (1 000 ft/min), are non-standard and subject to restrictions (see 1.4.8.8.3.1, "Height loss (HL)/altimeter margins". They are normally restricted to specifically approved operators and aircraft, and are promulgated with appropriate aircraft and crew restrictions annotated on the approach chart.

1.7.6 Additional gradient for the final missed approach segment

If obstacles identified in the final missed approach segment result in an increase in any of the OCA/H calculated for the precision segment, a higher gradient of the missed approach surface (Z) may be specified in addition if this will provide clearance over those obstacles at a specified lower OCA/H (see Part I, Section 4, Chapter 6, 6.2.3.1, "Climb gradient in the final phase").

Table II-1-1-1. Minimum distance between localizer and glide path interceptions

Intercept angle with localizer (degrees)	*Cat A/B/H*	*Cat C/D/E*
0 — 15	2.8 km (1.5 NM)	2.8 km (1.5 NM)
16 —30	3.7 km (2.0 NM)	3.7 km (2.0 NM)
31 — 60	3.7 km (2.0 NM)	4.6 km (2.5 NM)
61 — 90 or within a racetrack or reversal procedure	3.7 km (2.0 NM)	5.6 km (3.0 NM)

Table II-1-1-2. Height loss/altimeter margin

	Margin using radio altimeter		*Margin using pressure altimeter*	
Aircraft category (V_{at})	*Metres*	*Feet*	*Metres*	*Feet*
A – 169 km/h (90 kt)	13	42	40	130
B – 223 km/h (120 kt)	18	59	43	142
C – 260 km/h (140 kt)	22	71	46	150
D – 306 km/h (165 kt)	26	85	49	161
H – 167 km/h (90 kt)	8	25	35	115

Note 1.— Cat H speed is the maximum final approach speed, not V_{at}.

Note 2.— For Category E aircraft refer directly to the equations given in 1.4.8.8.3.4.

Table II-1-1-3. Objects which may be ignored in OCA/H calculations

	Maximum height above threshold	*Minimum lateral distance from runway centre line*
GP antenna	17 m (55 ft)	120 m
Aircraft taxiing	22 m (72 ft)	150 m
A/C in holding bay or in taxi holding position at a range between threshold and –250 m	22 m (72 ft)	120 m
A/C in holding bay or in taxi holding position at a range between threshold and –250 m (Cat I only)	15 m (50 ft)	75 m

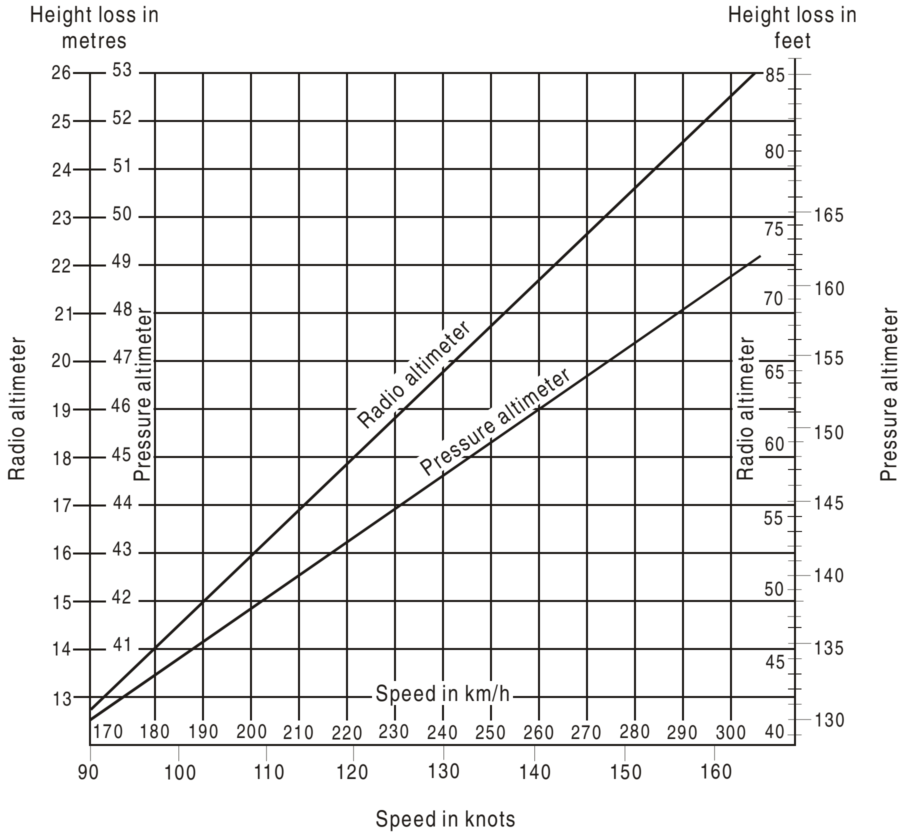


Table II-1-1-4. Height loss altimeter setting vs. speed

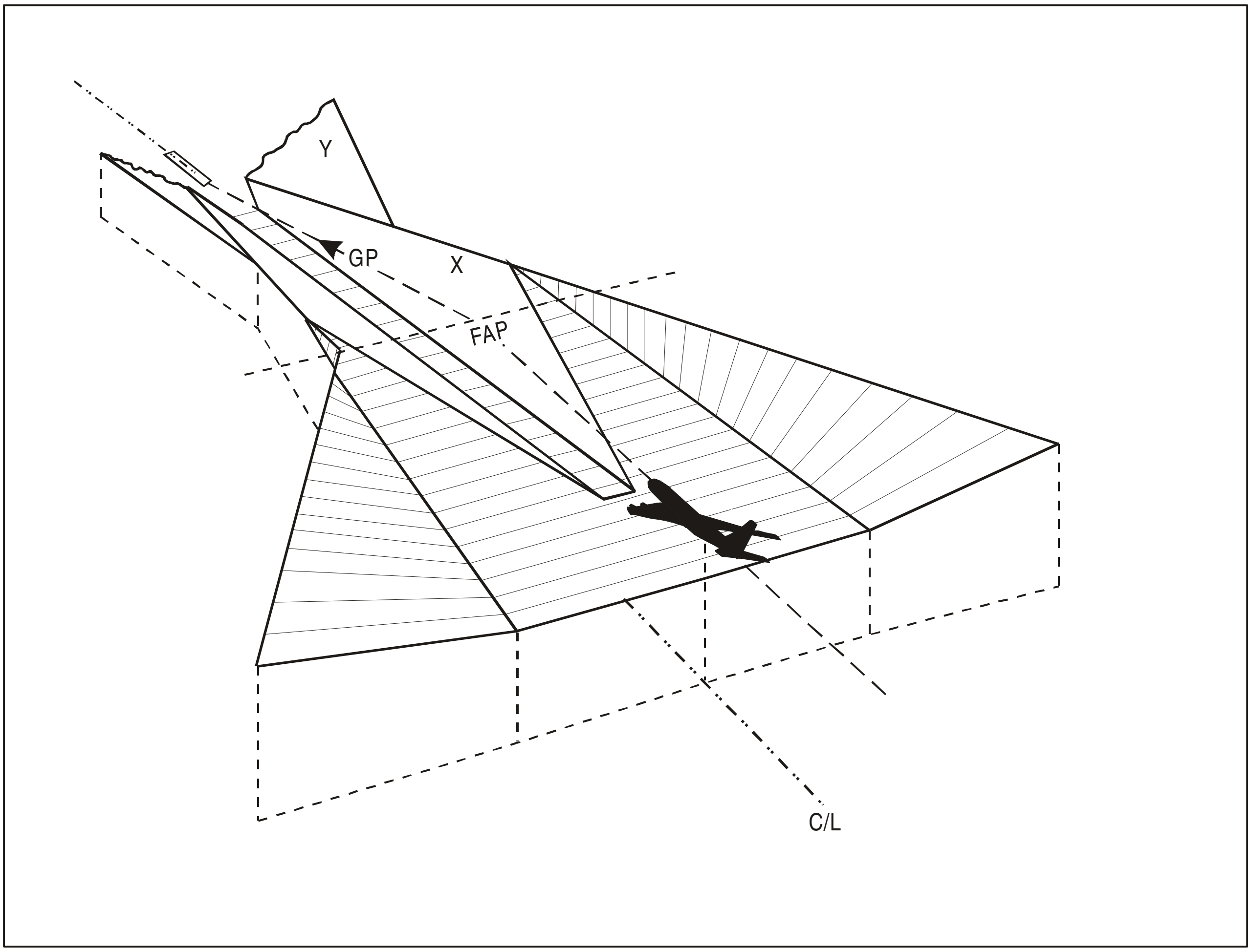


Figure II-1-1-1. Interface — final approach/preceding segment perspective view

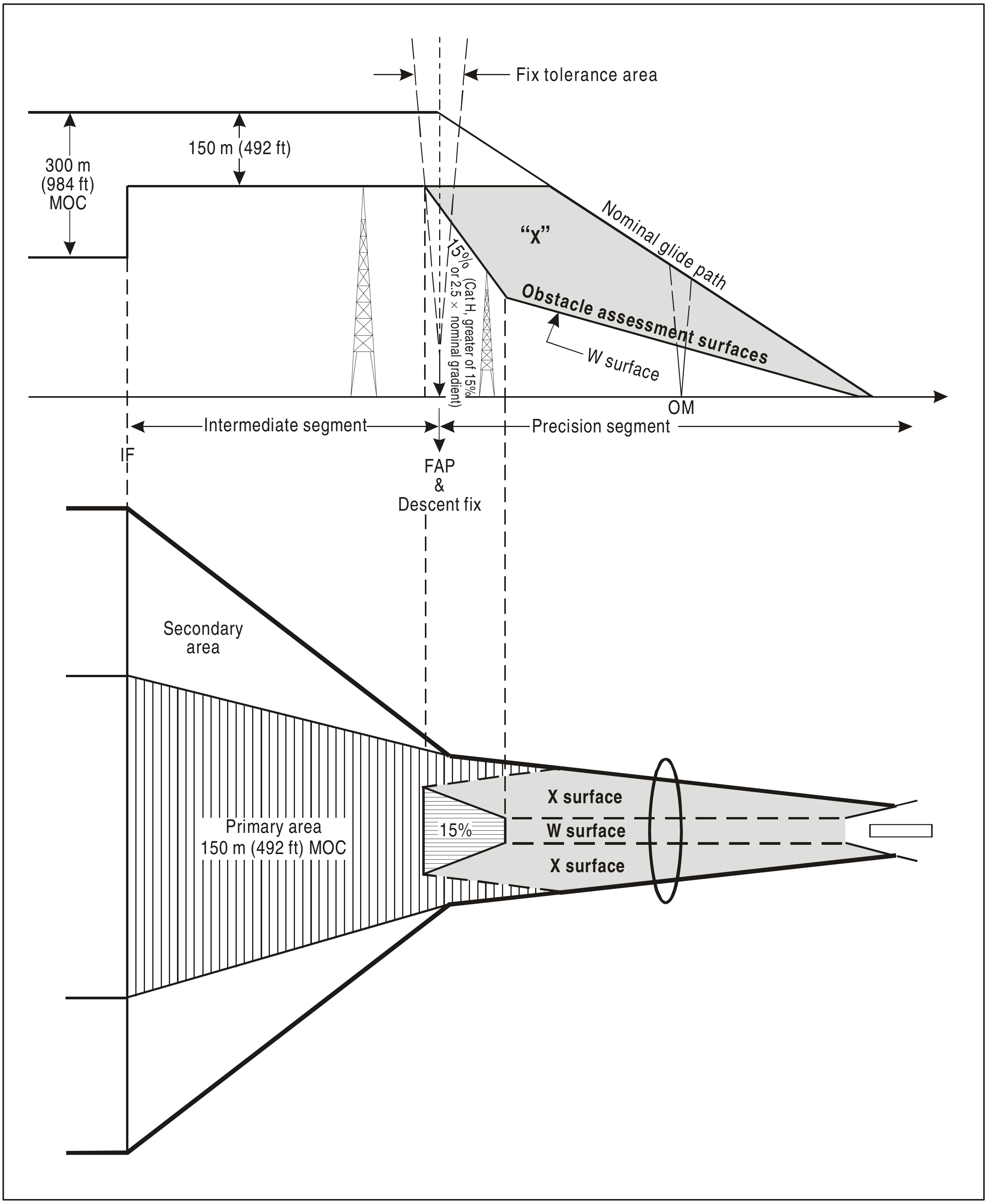


Figure II-1-1-2. Final approach fix defined by descent fix located at final approach point

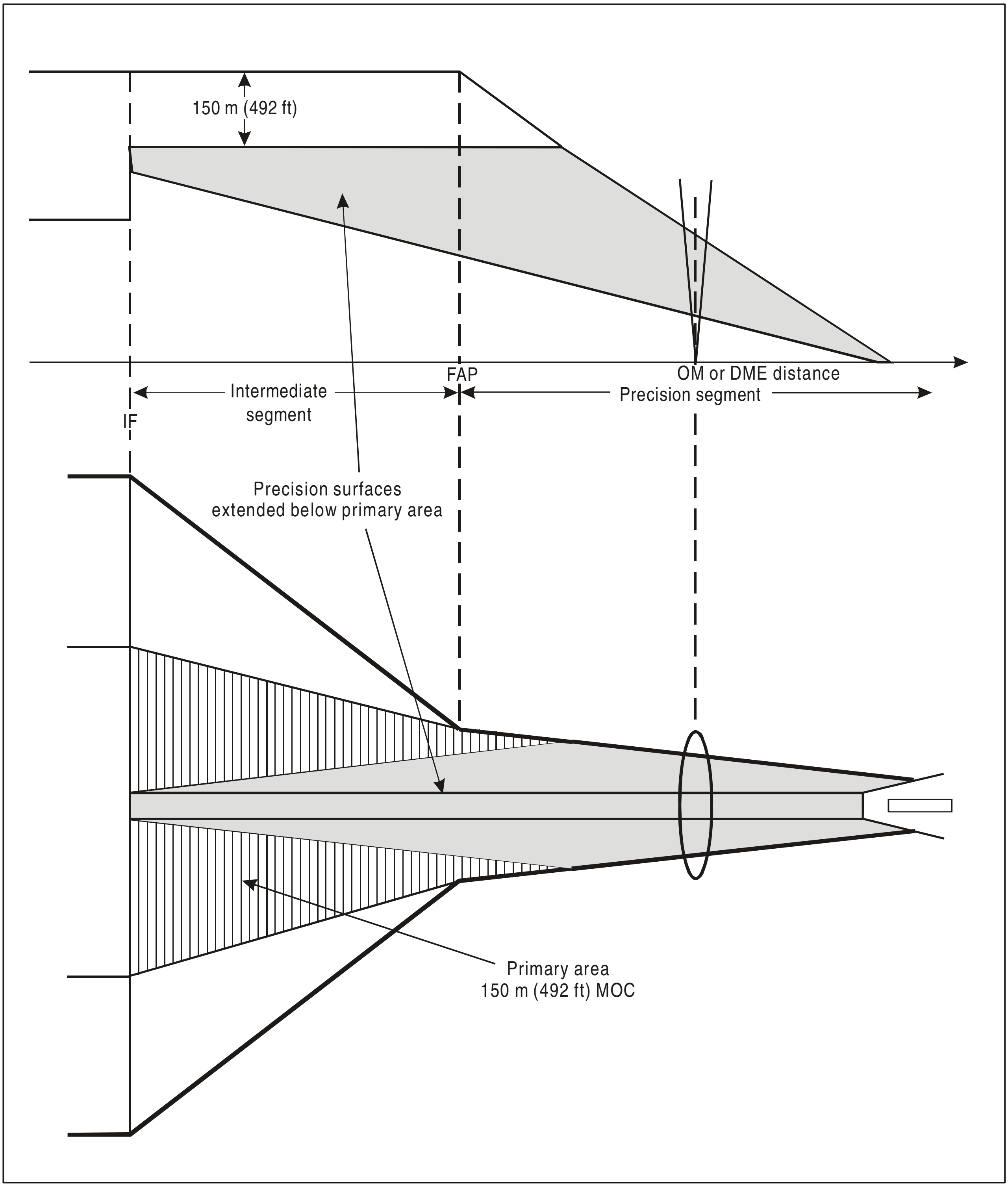


Figure II-1-1-3. Precision segment with no final approach fix

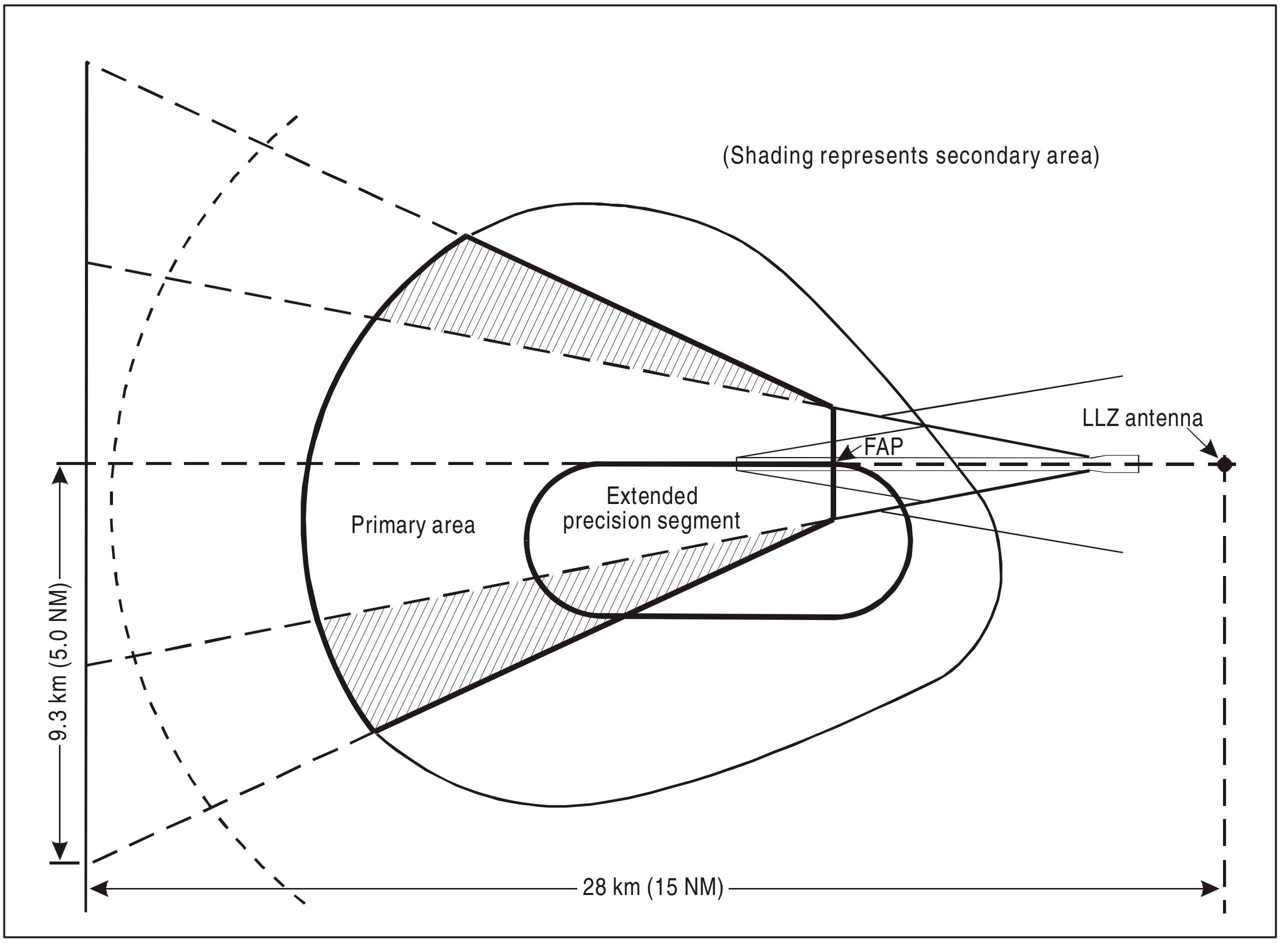


Figure II-1-1-4. Intermediate approach area. ILS approach using reversal or racetrack procedure

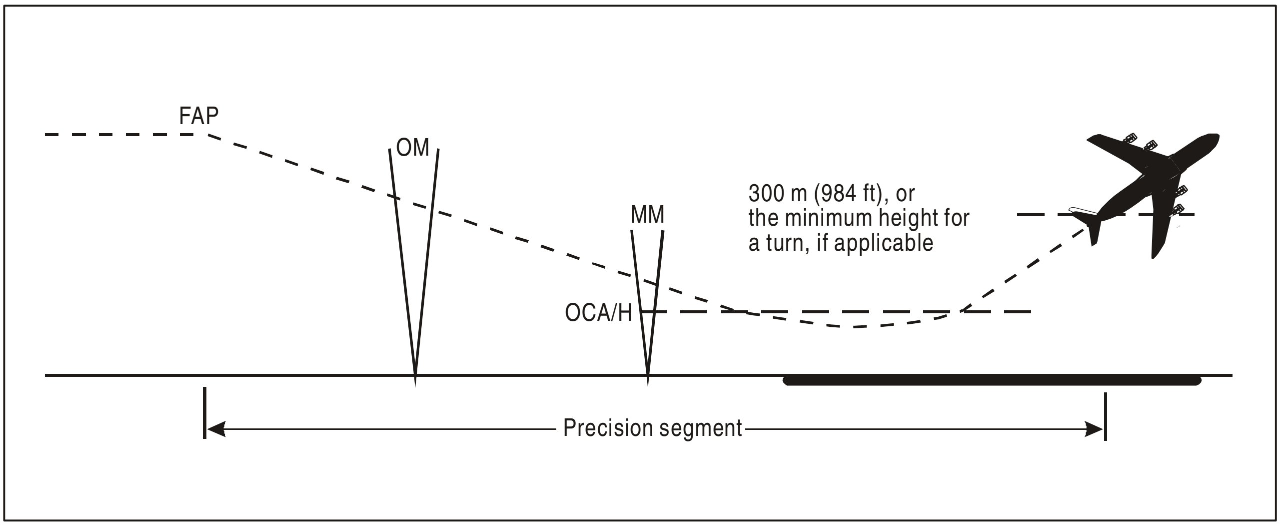


Figure II-1-1-5. Precision segment

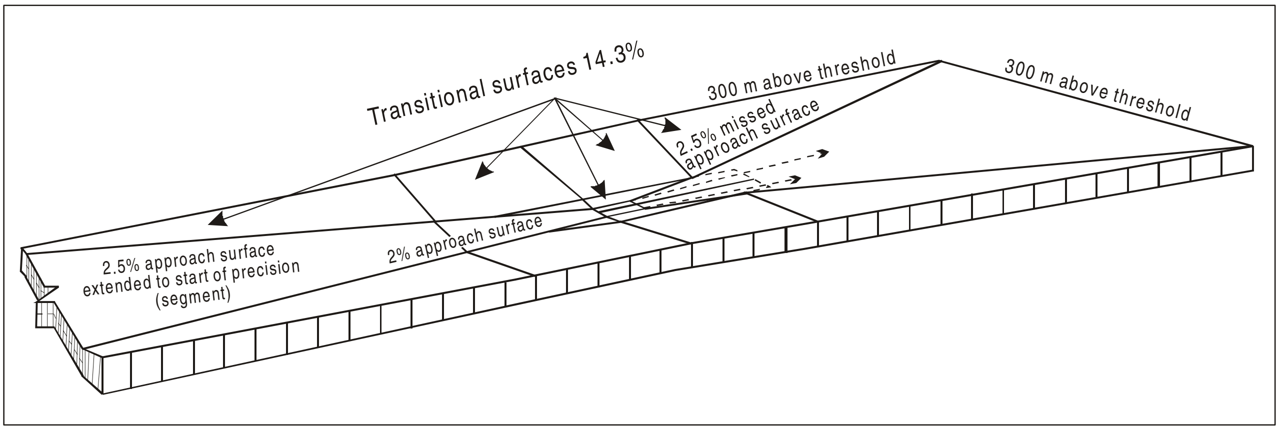
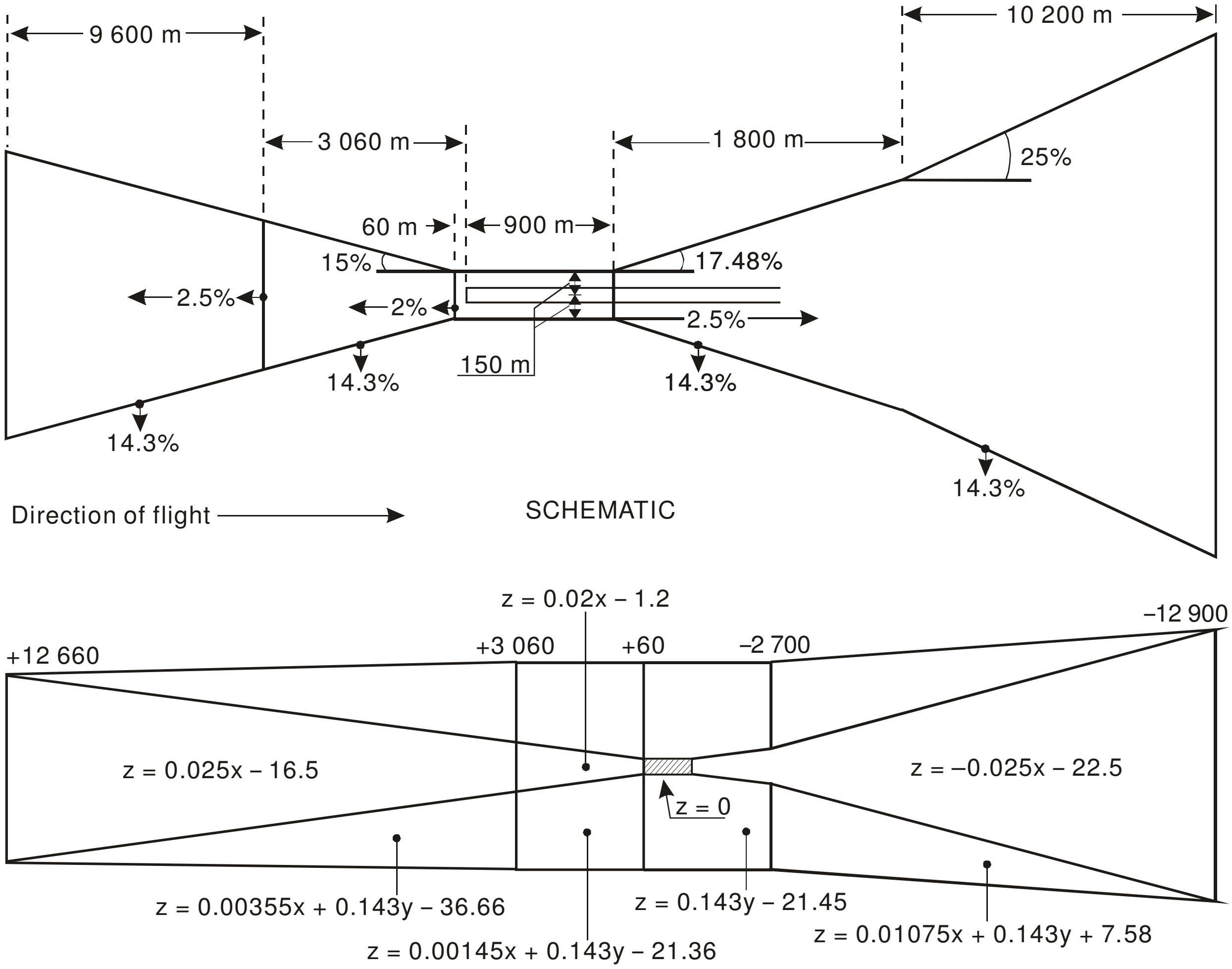


Figure II-1-1-6. Illustration of basic ILS surfaces as described in 1.4.7.2



Note.— The surface equations shown use the same frame of reference and notation as the OAS. See 1.4.8.2, 1.4.8.3 and 1.4.8.5. The equations assume the runway is horizontal. (All values are in metres.)

Figure II-1-1-7. Surface equations — basic ILS surfaces

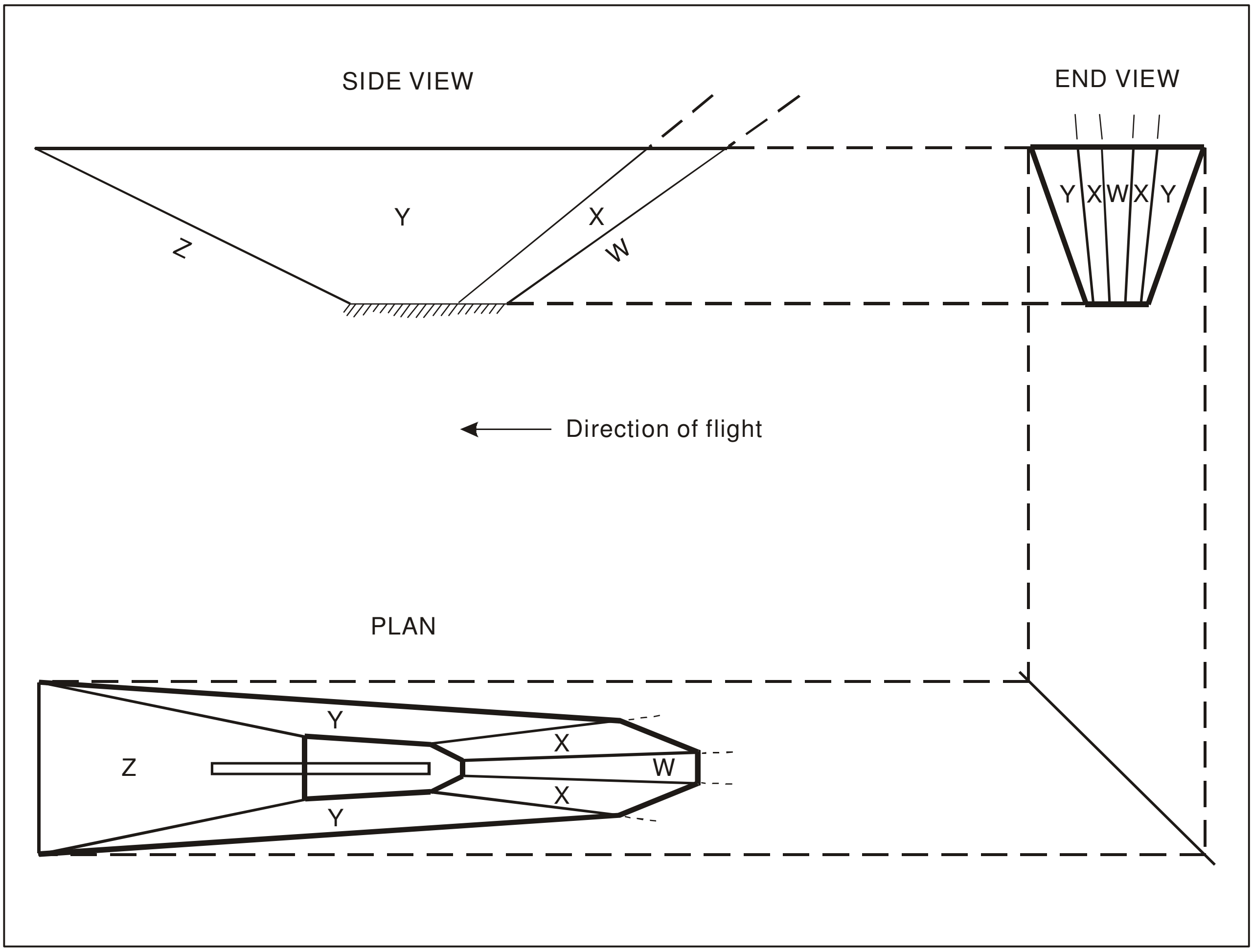


Figure II-1-1-8. Illustrations of ILS obstacle assessment surfaces

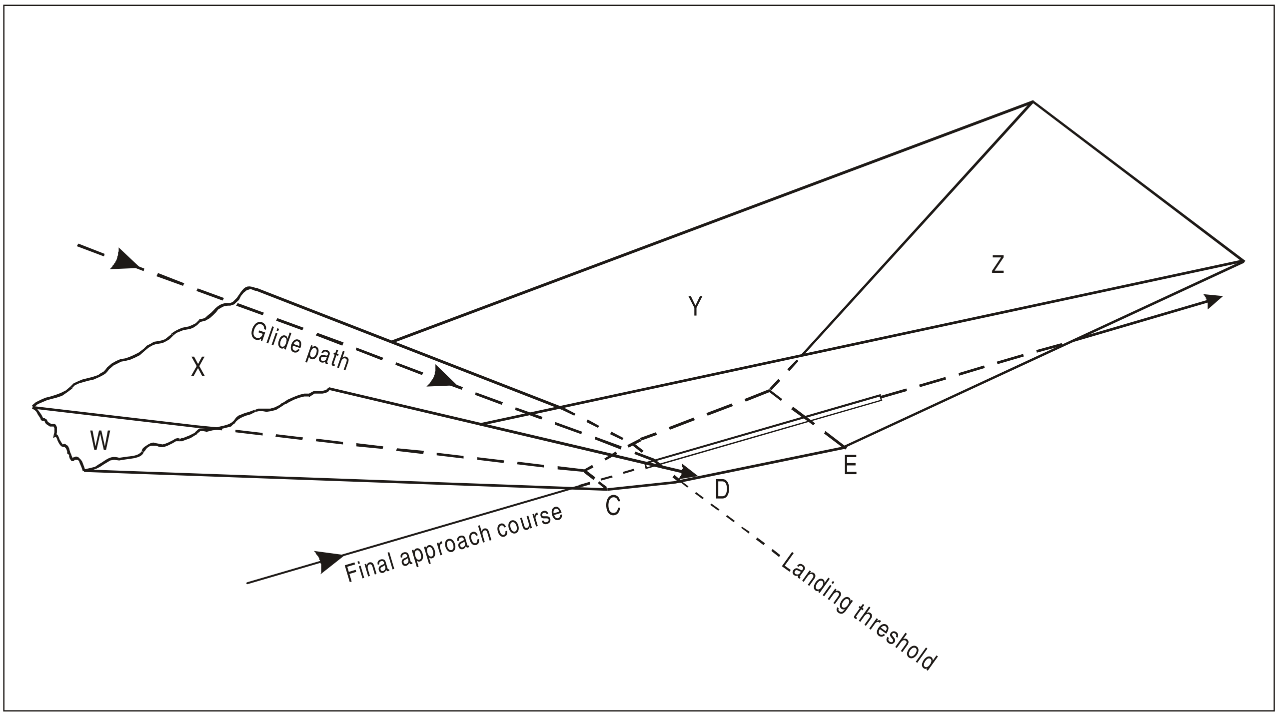


Figure II-1-1-9. Illustrations of ILS obstacle assessment surfaces — perspective view

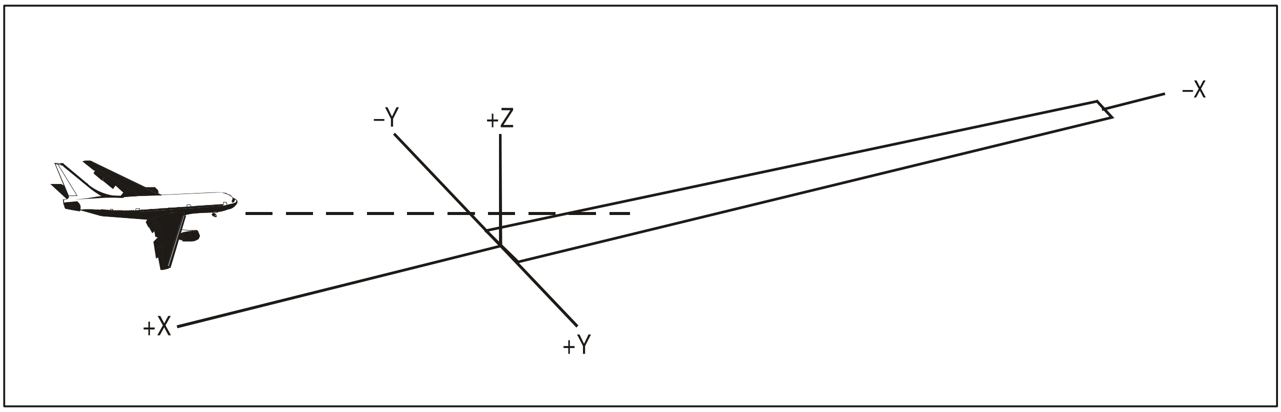
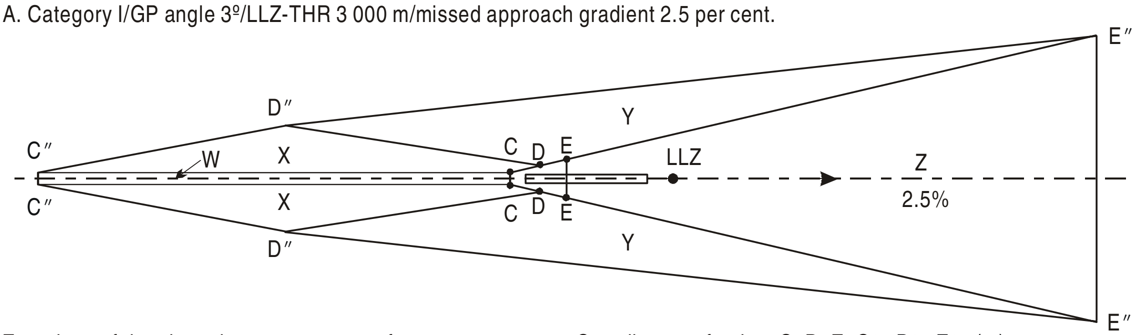


Figure II-1-1-10. System of coordinates

A. Category I/GP angle 3º/LLZ-THR 3 000 m/missed approach gradient 2.5 per cent.



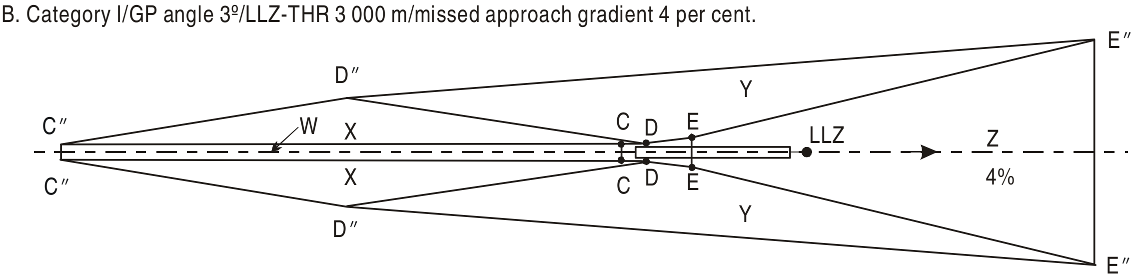
Equations of the obstacle assessment surfaces:

W I $z = 0.0285x - 8.01$
X I $z = 0.027681x + 0.1825y - 16.72$
Y I $z = 0.023948x + 0.210054y - 21.51$
Z I $z = -0.025x - 22.50$

Coordinates of points C, D, E, C″, D″, E″, (m)

	C	D	E	C″	D″	E″
x	281	-286	-900	10 807	5 438	-12 900
y	49	135	205	96	910	3 001
z	0	0	0	300	300	300

B. Category I/GP angle 3º/LLZ-THR 3 000 m/missed approach gradient 4 per cent.



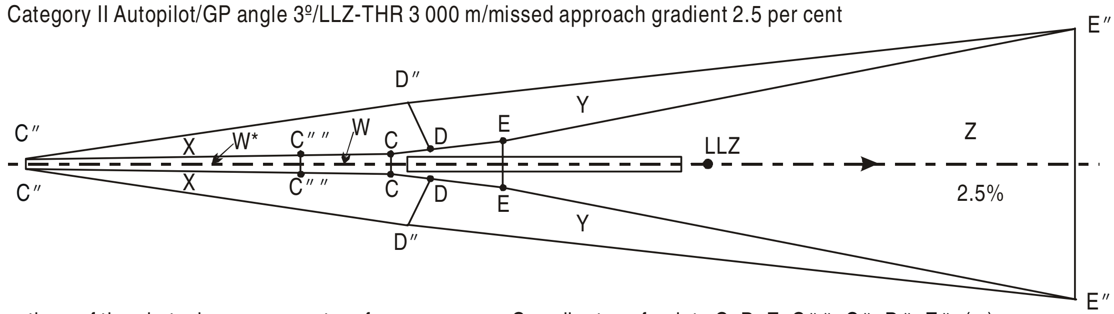
Equations of the obstacle assessment surfaces:

W I $z = 0.0285x - 8.01$
X I $z = 0.027681x + 0.1825y - 16.72$
Y I $z = 0.020158x + 0.238021y - 26.37$
Z I $z = -0.04x - 36.00$

Coordinates of points C, D, E, C″, D″, E″, (m)

	C	D	E	C″	D″	E″
x	281	-286	-900	10 807	5 438	-8 400
y	49	135	187	96	910	2 082
z	0	0	0	300	300	300

C. Category II Autopilot/GP angle 3º/LLZ-THR 3 000 m/missed approach gradient 2.5 per cent



Equations of the obstacle assessment surfaces:

W I $z = 0.0358x - 6.19$
W* I $z = 0.042x - 12.39$
X I $z = 0.041370x + 0.2752y - 25.32$
Y I $z = 0.031955x + 0.280291y - 28.70$
Z I $z = -0.025x - 22.50$

Coordinates of points C, D, E, C″″, C″, D″, E″, (m)

	C	D	E	C″″	C″	D″	E″
x	173	-286	-900	1 000	3 866	-13	-6 900
y	66	135	205	49	55	639	1 424
z	0	0	0	29.6	150	150	150

Figure II-1-1-11. Typical OAS contours for standard size aircraft

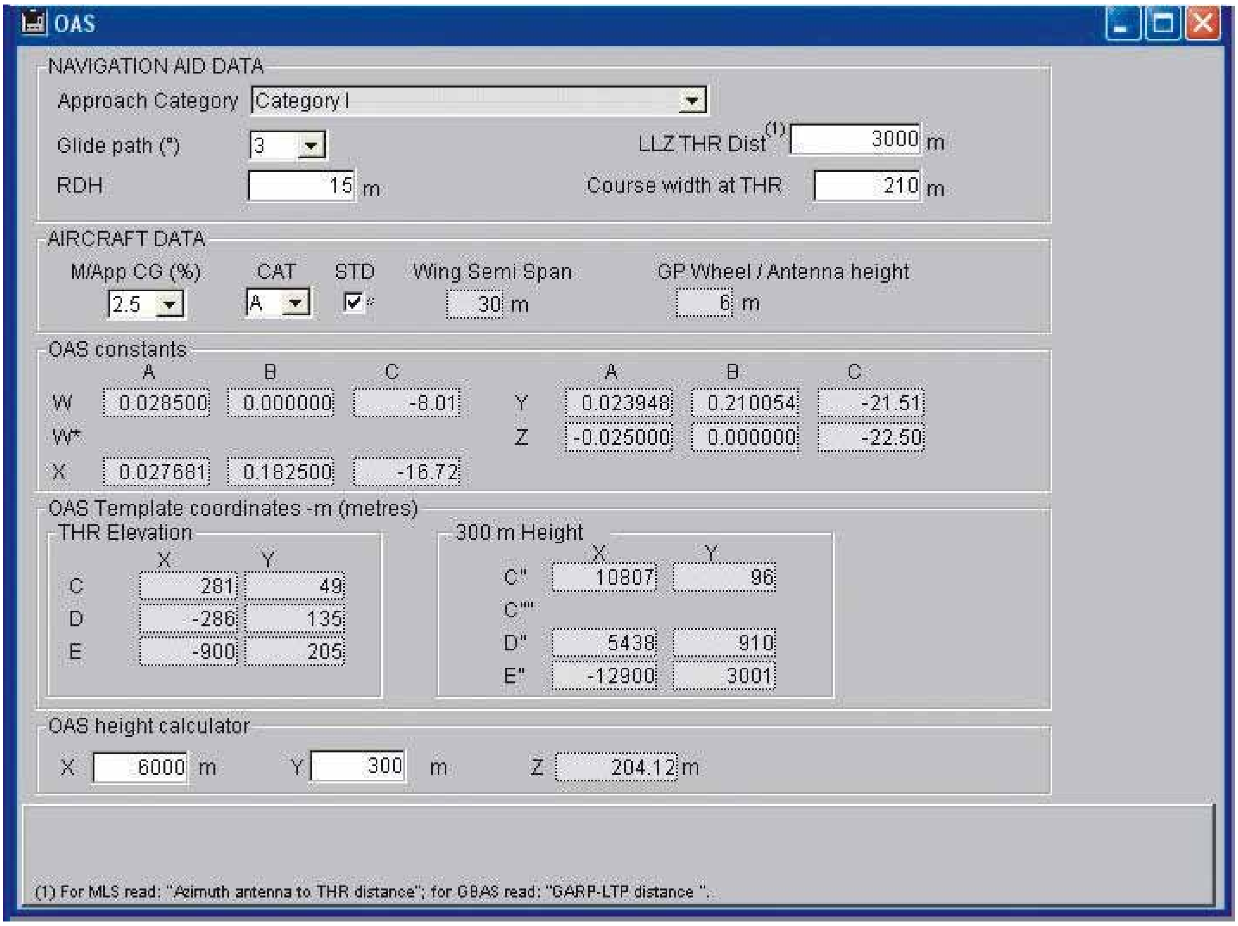


Figure II-1-1-12. OAS output data generated by the PANS-OPS OAS CD-ROM