CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

National Policy

ORDER
8260.3E CHG
RTD DP

Effective Date:
MM/DD/YYYY

SUBJ: United States Standard for Terminal Instrument Procedures (TERPS)

1. Purpose. This change incorporates administrative and criteria updates.

2. Who this change affects. All personnel who are responsible for instrument flight procedure (IFP) development and/or evaluation.

3. Disposition of Transmittal Paragraph. Significant areas of new direction, guidance, policy, and criteria as follows:

a. Table of Contents. Updated page and paragraph numbers.

b. Chapter 10. Added reference to criteria to compensate for high-temperature effects.

c. Chapter 13.

(1) Added criteria for the evaluation of changeover points (COP).

(2) Updated and added criteria for determination of turn radii.

(3) Added criteria for inside and outside turn protection.

d. Appendix H. Added a new appendix to provide process for fix location adjustment for high-temperature compensation.

PAGE CHANGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
2-13 and 2-14	03/08/22	2-13 and 2-14	MM/DD/YY
2-37 and 2-38	03/18/22	2-37 and 2-38	MM/DD/YY
2-91 and 2-92	03/08/22	2-91 and 2-92	MM/DD/YY
10-5 and 10-6	09/17/20	10-5 and 10-6	MM/DD/YY
11-5 and 11-6	09/17/20	11-5 and 11-6	MM/DD/YY
12-9 and 12-10	03/08/22	12-9 and 12-10	MM/DD/YY
13-1 through 13-10	03/08/22	13-1 through 13-10	MM/DD/YY
13-19 through 13-50	03/08/22	13-19 through 13-52	MM/DD/YY
A-1 through A-5	03/08/22	A-1 through A-5	MM/DD/YY
B-7 and B-8	03/08/22	B-7 and B-8	MM/DD/YY
B-11 and B-12	03/08/22	B-11 and B-12	MM/DD/YY
New Material	--/--/--	H-1 through H-4	MM/DD/YY

4. Distribution. This change is distributed electronically only.

Lawrence Fields
Acting Executive Director, Flight Standards Service

restriction located prior to the fix. If the approach procedure contains a speed restriction, then establish a mandatory speed restriction with the same numerical airspeed at or prior to the termination of the STAR.

e. For the portion of a STAR underlying a Class B airspace area, do not establish a speed restriction that requires aircraft to exceed 200 KIAS.

2-2-10. Deceleration. Deceleration is required to support sufficient distance and a reduced descent gradient prior to any fix with a speed restriction. When an altitude restriction exists at a fix that could place an aircraft below Class B airspace, deceleration is required to ensure sufficient distance for the aircraft to comply with the 200 KIAS airspeed restriction even though it is not charted. STARs not meeting the requirements of this paragraph may be authorized with Flight Standards approval (see paragraph 1-4-2).

a. Where deceleration is required but descent is not permitted (for example, between two fixes with the same mandatory altitudes) or is not required (for example, between two fixes with the same minimum altitudes), provide a minimum distance of at least 4 NM prior to a fix with a speed reduction of 40 KIAS or less. For deceleration greater than 40 KIAS, allow 1 NM between fixes for every 10 knots of deceleration required. For example, a deceleration of 10, 20, 30, or 40 KIAS requires a minimum length of 4 NM; a deceleration of 50 KIAS requires a minimum length of 5 NM; a deceleration of 60 KIAS requires 6 NM.

b. When descent is permitted, the descent gradient leading to the fix with the speed restriction must be reduced. Apply Formula 2-2-2 to determine the minimum deceleration distance ($Decel_D$) required before the fix; the greater distance leads to a reduced descent gradient.

(1) In determining the applicable formula gradient value, "G," use 330 ft/NM (approximately 3.11 degrees) when the ending speed restriction is greater than or equal to 250 KIAS; use 318 ft/NM (approximately 3.0 degrees) when the ending speed restriction is less than 250 KIAS but greater than 220 KIAS; use 250 ft/NM (approximately 2.36 degrees) when the ending speed restriction is 220 KIAS or less.

(2) In determining "K," use 310 KIAS, or the previous speed restriction if less than 310 KIAS, as the reference speed at or above 10000 feet MSL. For the reference speed below 10000 feet MSL, use 250 KIAS or the previous speed restriction if less. For a block altitude, use the minimum altitude when selecting 310 or 250 to use to determine the "K" value.

(3) The first altitude restriction that is below 10000 feet MSL requires a deceleration evaluation unless an airspeed restriction of 250 KIAS or less exists prior to the point where descent below 10000 feet MSL occurs. If no speed is published at the first altitude restriction that is below 10000 feet MSL, then use the lower of 250 KIAS or the previous speed restriction (if applicable). When the first fix that allows descent below 10000 feet MSL has no charted speed restriction and the altitude constraint allows continued flight above 10000 feet MSL, the calculation is extended to the subsequent fix using the total descent and total distance for the applicable fixes.

(4) Some examples are as follows: If deceleration from a fix with no speed restriction to 280 KIAS is required above 10000 feet MSL, then "K" is equal to 3 NM(K = 310-280 / 10). If an aircraft is decelerating from a fix with a speed restriction of 280 KIAS to a fix with no speed restriction that is below 10000 feet MSL, use 250 KIAS as the reference airspeed; then "K" is equal to 3 NM(K = 280-250 / 10). If an aircraft is decelerating from a fix with no speed restriction that is below 10000 feet MSL, use 250 KIAS as the reference airspeed for the deceleration to the next fix; if the deceleration is to a fix with a speed restriction of 230 KIAS, then "K" is equal to 2 NM(K = 250-230 / 10).

Formula 2-2-2. Minimum Deceleration Distance (NM)

$$Decel_D = \frac{Alt_1 - Alt_2}{G} + K$$

Where:
Alt_1 = Minimum altitude at the fix prior to the speed restriction
Alt_2 = Minimum altitude at the fix with the speed restriction
G = Applicable gradient value (330/318/250)
K = 1 NM for every 10 KIAS of deceleration required

Example 1: If the termination fix has a mandatory altitude of 3000 and a published speed restriction of 210 KIAS and is preceded by a fix with a minimum altitude of 7500 and a published speed restriction at or before that fix of 230 KIAS, the values are: Alt_1 - Alt_2 = 4500 (7500-3000); G = 250, based on an ending speed of 220 KIAS or less; K = 2 NM (K = 230-210 / 10); $Decel_D$ = 20 NM ($Decel_D$ = 4500/250 + 2) and the resulting descent gradient will be no more than 225.0 ft/NM (DG = 4500 / 20).

Example 2: In example 1, if the preceding fix has no speed restriction, use 250 KIAS based on the altitude of 7500 being below 10000 feet MSL (or previous speed restriction if less than 250 KIAS). The values are: Alt_1 - Alt_2 = 4500; G = 250, K = 4 NM (K = 250-210 / 10); $Decel_D$ = 22 NM ($Decel_D$ = 4500/250 + 4). The resulting descent gradient will be no more than 204.5 ft/NM (DG = 4500 / 22).

2-5-3. Intermediate Approach Segment Based on Straight Courses.

a. Alignment. The course to be flown in the intermediate segment must be the same as the FAC, except when the PFAF is the navigation facility and it is not practical for the courses to be identical. In such cases, the intermediate course must not differ from the FAC by more than 30 degrees.

b. Area.

(1) Length. The length of the intermediate segment is measured along the course to be flown. Where the initial segment joins the intermediate segment at angles up to and including 96 degrees, the minimum length is 5 NM for CAT A/B and 6 NM for CAT C/D/E (see Chapters 8, 10, 11, and 12 for exceptions). Table 2-5-1 lists the minimum segment length where the initial approach course joins the intermediate course at angles greater than 96 degrees. The maximum segment length is 15 NM. The optimum length is 10 NM. A distance greater than 10 NM should not be used unless an operational requirement justifies a greater distance.

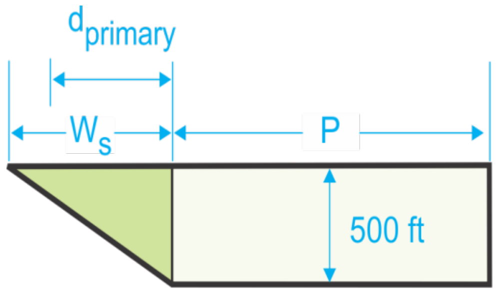
(2) Width. The width of the intermediate segment is the same as the width of the segment it joins. When the intermediate segment is aligned with initial or final approach segments, the width of the intermediate segment is determined by joining the outer edges of the initial segment with the outer edges of the final segment. When the intermediate segment is not aligned with the initial or final approach segments, the resulting gap on the outside of the turn is a part of the preceding segment and is closed by the appropriate arc (see Figure 2-5-1). For obstacle clearance purposes, the intermediate segment is divided into a primary and a secondary area.

Table 2-5-1. Minimum Intermediate Course Length

Angle (Degrees)	Minimum Length (NM) based on CAT	
	A/B	C/D/E
0 - 96	5	6
> 96 - 102	6	7
>102 - 108	6	8
>108 - 114	6	9
>114 - 120	7	10

c. Obstacle clearance. The minimum ROC in the primary area is 500 feet. The minimum ROC in the secondary area is 500 feet at the primary boundary, tapering uniformly to zero feet at the outer edge (see Figure 2-5-2). The minimum ROC at any given point in the secondary area is determined by Formula 2-5-1. Apply adjustments as specified in paragraph 3-2-2.

Figure 2-5-2. Intermediate Segment Secondary ROC



Formula 2-5-1. Intermediate Segment Secondary ROC

$$ROC_{secondary} = 500 \times \left(1 - \frac{d_{primary}}{W_S}\right)$$

Where:
$d_{primary}$ = Perpendicular distance (feet) from primary area edge
W_S = Total width of the secondary area (feet)

d. Descent gradients. Because the intermediate segment is used to prepare the aircraft speed and configuration for entry into the final approach segment, the gradient should be as flat as possible. A descent gradient no greater than 150 ft/NM is optimum. The maximum gradient between the IF and the PFAF is 318 ft/NM. When one or more stepdown fixes are established, ensure the gradient from each simplified directional facility (SDF) to the PFAF does not exceed 318 ft/NM. Higher gradients resulting from arithmetic rounding are permissible.

2-5-4. Intermediate Approach Segment Based on an Arc. DME Arcs with a radius of less than 7 NM or more than 30 NM from the navigation facility must not be used. Arc courses must be predicated on DME collocated with a facility providing omnidirectional course information.

a. Alignment. The same arc must be used for the intermediate and the final approach segments. No turns are permitted over the PFAF.

b. Area.

(1) Length. The intermediate segment must not be less than 5 NM or more than 15 NM in length, measured along the arc. The optimum length is 10 NM. A distance greater than 10 NM should not be used unless an operational requirement justifies the greater distance.

(2) Width. The total width of an arc intermediate segment is 6 NM on each side of the arc. For obstacle clearance purposes, this width is divided into a primary and a secondary area. The primary area extends 4 NM laterally on each side of the arc segment. The secondary areas extend 2 NM laterally on each side of the primary area (see Figure 2-5-1).

c. Obstacle clearance. Apply criteria in paragraph 2-5-3.c.

d. Descent gradients. Apply criteria in paragraph 2-5-3.d.

Figure 2-9-9. Final Segment Stepdown Fix

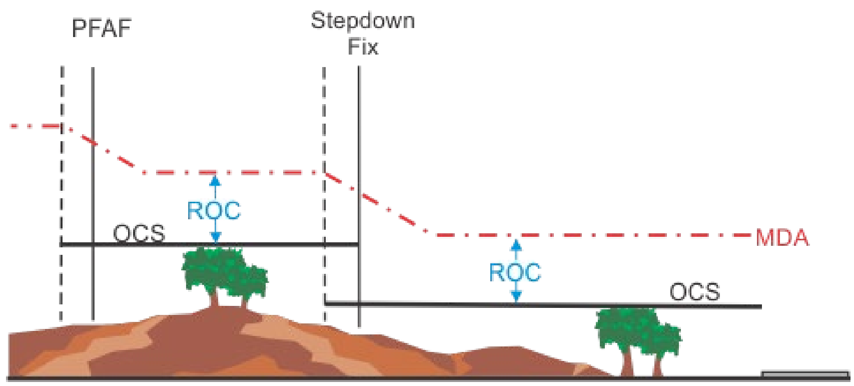


Table 2-9-1. Stepdown Fixes in Initial Segment

Length of Segment	Number of Fixes
5-10 NM	1 stepdown fix
over 10-15 NM	2 stepdown fixes
over 15 NM	3 stepdown fixes

2-9-10. Obstacles Close to a PFAF or a Final Approach Segment Stepdown Fix. Obstacles close to the PFAF/Stepdown Fix (located within the FAS) may be eliminated from consideration if the following conditions are met:

a. The obstacle is in the final approach trapezoid within 1 NM past the point the PFAF/stepdown fix can first be received, and

b. The obstacle does not penetrate a 7:1 (fixed-wing) or 3.5:1 (helicopter) OIS. The surface begins at the earliest point the fix can be received and extends toward the MAP 1 NM. The beginning surface height is determined by subtracting the final segment ROC (and adjustments from paragraph 3-2-2 as applicable) from the minimum altitude required at the fix. The surface slopes downward 1-foot vertically for each seven-feet horizontally (fixed-wing) or one-foot vertically for each 3.5-feet horizontally (helicopter) toward the MAP (see Figure 2-9-10).

c. Formula 2-9-3 and Formula 2-9-4 may be used to determine the OIS height at the obstacle or the minimum fix altitude based on applying the surface to an obstacle which must be eliminated. To determine fix error, see paragraphs 2-9-5, 2-9-6, and 2-9-7.

Formula 2-9-3. OIS Height Calculation

$$OIS_{height} = FixAlt - ROC - \left(\frac{d}{s}\right)$$

Where:
$FixAlt$ = Published MSL fix altitude
ROC = Required obstacle clearance plus adjustments
d = Distance from earliest fix reception to obstacle (feet)
s = 7 for fixed-wing, 3.5 for helicopter-only

Formula 2-9-4. Minimum Fix Altitude Calculation

$$MinFix_{alt} = ObstElev + ROC + \left(\frac{d}{s}\right)$$

Where:
$ObstElev$ = Obstacle elevation
ROC = Required obstacle clearance plus adjustments
d = Distance from earliest fix reception to obstacle (feet)
s = 7 for fixed-wing, 3.5 for helicopter-only

Figure 2-9-10. Obstacles Close-In to a Fix

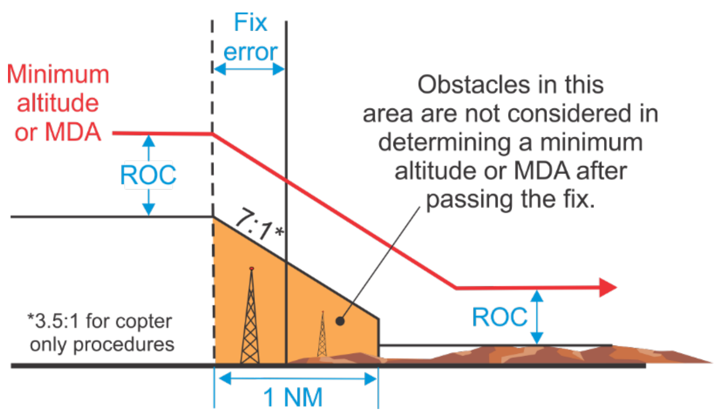


Table 10-1-1. TCH Requirements

Representative Aircraft Type	Glidepath-to-Wheel Height (approximate)	Recommended TCH	Remarks
HEIGHT GROUP 1 General Aviation, Small Commuters, Corporate Turbojets, T-38, C-12, C-20, C-21, T-1, Fighter Jets, UC-35, T-3, T-6	10 ft or less	40 ft	Normally runways < 6000 long with reduced widths and/ or limited weight bearing, limiting larger aircraft use.
HEIGHT GROUP 2 F-28, B-737, C-9, DC-9, C-130, T-43, B-2	15 ft	45 ft	Regional airport with limited air carrier service.
HEIGHT GROUP 3 B-727/707/720/757, B-52, C-135, C-141, C-17, E-3, P-3, E-8, C-32	20 ft	50 ft	Runways not normally used by aircraft with ILS glidepath-to-wheel heights > 20 feet.
HEIGHT GROUP 4 B-747/767/777, DC-10, A-300, B-1, KC-10, E-4, C-5, VC-25	25 ft	55 ft	Most primary runways at major airports.

Note: To determine the minimum allowable TCH, add 20 feet to the glidepath-to-wheel height and to determine the maximum allowable TCH, add 50 feet to the glidepath-to-wheel height (not to exceed 60 feet).

c. PFAF. Calculate the along-track distance in feet from the LTP/FTP to the PFAF using Formula 10-1-5.

Formula 10-1-5. Distance LTP/FTP to PFAF

$$D_{PFAF} = r \times \frac{\ln\left(\frac{r + PFAF_{alt}}{r + LTP_{elev} + TCH}\right)}{\tan(GPA)}$$

Where:

LTP_{elev} = LTP/FTP MSL elevation

$PFAF_{alt}$ = Minimum intermediate segment altitude

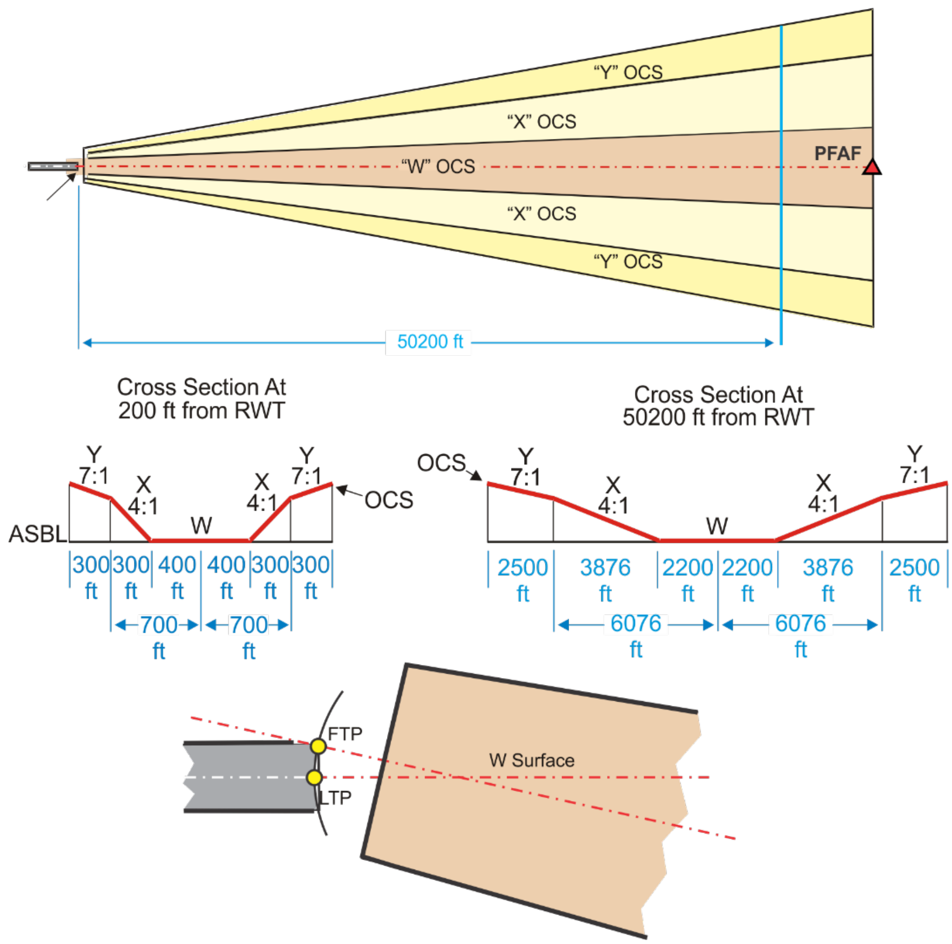
Note: Appendix H may be utilized to adjust the PFAF location to compensate for high-temperature effects.

Section 10-2. Final Approach Segment

10-2-1. Final Segment.

a. Area. The area originates 200 feet from LTP or FTP and extends to the PFAF. The primary area consists of the "W" and "X" OCS, and the secondary area consists of the "Y" OCS (see Figure 10-2-1).

Figure 10-2-1. Final Segment OEA/OCS



b. Alignment.

(1) ILS. The final course is normally aligned with the RCL extended (±0.03 degrees) through the LTP (± 5 feet). Where a unique operational requirement indicates a need to offset the course from RCL, the offset must not exceed three degrees. The offset course must intersect the runway centerline at a point no closer than 1100 feet inside the DA point (see Figure 10-2-2). The DA point for this evaluation is the point on the glideslope where the altitude is equal to the published DA less any RASS and precipitous terrain adjustments. For offset courses the minimum HAT is 250 feet and the minimum RVR is 2400.

11-2-5. ASR FAS. Use the highest applicable MVA to determine the PFAF location when there is no preceding segment.

a. General. Apply the current non-vertically guided final segment general criteria.

b. Alignment. Align the FAC with the extended runway centerline for a straight-in approach, or to the ARP for a circling approach. When an operational advantage can be achieved, the FAC for circling approaches may be aligned to pass through any portion of the usable landing surface.

c. Area. The final approach begins at the applicable radar fix displacement prior to the PFAF and ends at the FEP or the appropriate radar fix displacement beyond the MAP, whichever is encountered last. Determine the primary area half-width (½W_p) using Formula 11-2-1. When the distance of any point on FAC centerline is greater than 20 NM, the primary area ½W_p is 3 NM. Connect the width calculated at the PFAF to the width calculated at the FEP (straight line connection). The width at the early or late fix displacement points is equal to the width at the PFAF and FEP (see Figure 11-2-2).

Formula 11-2-1. Final Area Half-Width at PFAF and RWT/FEP

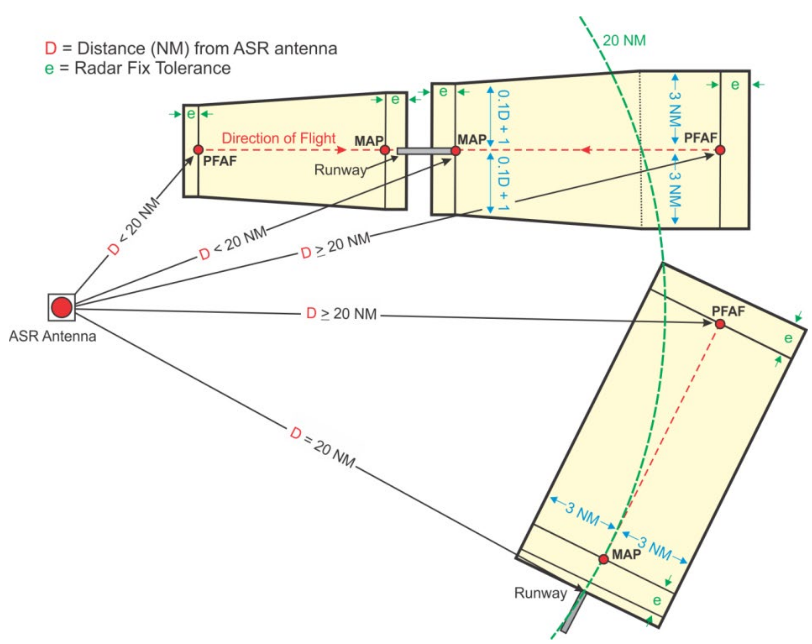
$$\frac{1}{2}W_P = 0.1 \times D + 1$$

Where:

D = Distance, FAC point to Antenna (NM)

Note: ½ W_P = 3 NM where D > 20 NM

Figure 11-2-2. ASR Final Approach Segment



d. Length. The segment must provide sufficient length to accommodate required altitude loss. The minimum length is 3 NM and maximum length is 10 NM.

e. Obstacle clearance. The minimum ROC is 250 feet. Apply paragraph 3-2-2 adjustments.

f. Vertical Descent Angle (VDA). Apply paragraphs 2-6-2 and 2-6-4 criteria, except do not publish the VDA.

g. Recommended altitudes (RecAlt). Determine recommended altitudes at each mile on final approach for ATC use. RecAlt values below the MDA are not issued. Round recommended altitudes to the nearest 20-foot increment. Determine RecAlt values using Formula 11-2-2.

Formula 11-2-2. Recommended Altitudes (RecAlt)

$$RecAlt = A - DG$$

Where:

A = PFAF altitude or last RecAlt (unrounded)
DG = (1852/0.3048) x tan(VDA calculated per paragraph 2-6-4)

Example:

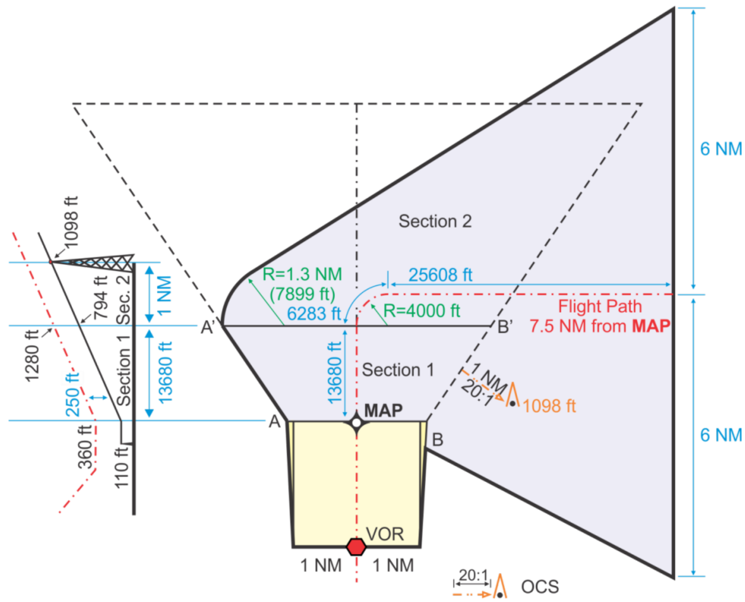
PFAF altitude = 2000 ft MDA = 660 ft, VDA = 3.00 (318.436/NM)
6 NM (PFAF) = 2000 ft
5 NM recommended altitude: 2000 - 318.436 = 1681.564 (1680)
4 NM recommended altitude: 1681.564 - 318.436 = 1363.128 (1360)
3 NM recommended altitude: 1363.128 - 318.436 = 1044.692 (1040)
2 NM recommended altitude: 1044.692 - 318.436 = 726.256 (720)
1 NM recommended altitude: 726.256 - 318.436 = 407.82 (Not issued)

Note: RecAlt with Stepdown Fix above the VDA. When the minimum altitude at a stepdown fix is above the vertical path of the VDA, calculate RecAlt using the appropriate VDA for each sub-segment (VDA from PFAF to stepdown altitude prior to stepdown fix, and VDA from stepdown altitude to TCH after the stepdown fix).

Example:

PFAF altitude = 3300 ft, MDA = 1400 ft, VDA PFAF to stepdown fix = 3.00 (318.436/NM), VDA at 4 NM stepdown fix to TCH = 3.39° (359.924/NM)
6 NM (PFAF) = 3300
5 NM recommended altitude: 3300 - 318.436 = 2981.564 (2980)
4 NM recommended altitude: 2981.564 - 318.436 = 2663.128 (2660)
3 NM recommended altitude: 2663.128 - 359.924 = 2303.204 (2300)
2 NM recommended altitude: 2303.204 - 359.924 = 1943.280 (1940)
1 NM recommended altitude: 1943.280 - 359.924 = 1583.356 (1580)

Figure 12-2-5. Combination Missed Approach Area



Example:

Given:

1. MDA is 360 feet MSL based on obstacles in the approach area
2. 1098 feet MSL obstacle is 1 NM from the near edge of section 1

Determine:

1. Section 1 length
2. Minimum turn altitude
3. Missed approach instructions

Solution:

1. Section 1 length
   a. $\frac{1\ NM}{20\ feet} = \frac{1852}{20 \times 0.3048} \approx 304\ ft$
   b. 1098 feet - 304 feet = 794 feet MSL, required section 1 end height
   c. MDA – (ROC + Adjustments) = 110 feet MSL, section 1 start height
   d. 794 feet – 110 feet = 684 feet, required section 1 rise
   e. 684 feet x 20 = 13680 feet, required length of section 1

2. Minimum turn altitude
   a. $\left(\frac{13680}{15.19}\right) + MDA = 1261$
   b. Round to next higher 20-foot increment = 1280 feet MSL

3. Missed approach instructions "Climb to 1280 then turn right direct…"

Section 12-3. Takeoff and Landing Minimums

12-3-1. Application. The minimums specified in this section apply to helicopter-only procedures.

12-3-2. Altitudes. Apply Section 3-2, except do not establish a CMDA for helicopter only procedures.

12-3-3. Visibility. Apply Section 3-3, except as follows:

a. Non-precision approaches.

(1) Approach to a runway. The minimum visibility may be one-half the computed straight-in value from Table 3-3-3, but not less than 1/4 SM/1200 RVR.

(2) Approach to a landing area that supports IFR procedures (landing area within 2600 feet of MAP). The minimum visibility required prior to applying credit for lights may not be less than the visibility associated with the HAL, as specified in Table 12-3-1. Do not apply paragraph 3-3-2.

b. Precision and APV approaches.

(1) Approach to runway. The minimum visibility may be one-half the computed value specified in Table 3-3-1, but not less than 1/4 SM/1200 RVR.

(2) Approach to a landing area that supports IFR procedures (landing within 2600 feet of MAP). The minimum visibility required prior to applying credit for lights may not be less than the visibility associated with the HAL, as specified in Table 12-3-1. Do not apply paragraph 3-3-2.

c. PinS approaches. The minimum visibility is 3/4 SM day / 1 SM night. If the HAS exceeds 800 feet, the minimum visibility is 1 SM. No credit for lights will be authorized. Alternate minimums are not authorized. Do not apply Table 12-3-1.

Table 12-3-1. Effect of HAL Height on Visibility Minimums

HAL	200-600 feet	601-800 feet	More than 800 feet
Visibility Minimum (SM)	1/2	3/4	1

d. When aligned to a runway, apply paragraph 3-3-2.c(4) and apply visibility adjustments as applicable.

12-3-4. Visibility Credit. Where visibility credit for lighting facilities is allowed for fixed-wing operations, the same type credit should be considered for helicopter operations. The approving authority will grant credit on an individual case basis, until such time as a standard for

Chapter 13. Departure Procedure Construction

Section 13-1. General Criteria

13-1-1. General. IFR departure procedures may be designed and published for all runways authorized by the approving authority. For civil procedures, runway/taxiway separations, and airport obstacle free zones (OFZ) must meet the standards in AC 150/5300-13 or appropriate military directives for military procedures for specified departure visibility minimums. Criteria for RNAV-equipped aircraft are provided in Order 8260.58.

a. Helicopter departures. Development of departures depends on the certification of the departure area. RNAV or non-RNAV departures may be developed based on the departure location as defined below:

(1) Departures from an IFR heliport are developed from the helipad. (Deferred pending development of applicable IFR heliport design standards. See paragraph 1-2-1.d.)

(2) Departures from IFR airports will utilize the developed IFR procedure(s) from the airport. Copter DPs will not be developed from airports with established ODPs unless an obstacle survey of the departure route is accomplished.

(3) PinS departure procedures are authorized from VFR helipads, VFR runways, or unmarked landing areas in accordance with Section 13-7.

(4) Throughout this chapter, the following references are modified for helicopter departure procedures:

(a) 200 ft/NM is replaced by 400 ft/NM.

(b) 40:1 primary slope is replaced by 20:1 slope.

(c) Runway centerline is replaced by departure course.

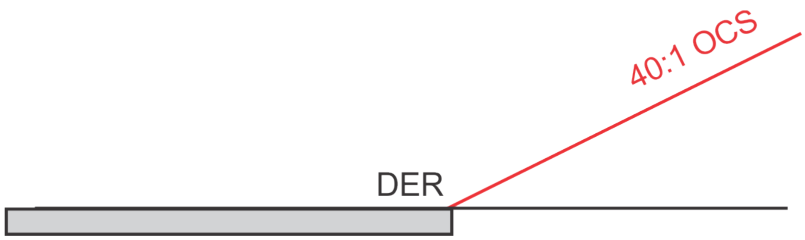
(d) Departure end of runway (DER) is replaced by heliport departure reference point (HDRP). The HDRP is the point of intersection of the FATO and departure course.

(5) The standard CG for helicopters is 400 ft/NM, resulting in a 20:1 OCS slope. ROC is 96 ft/NM as described in paragraph 2-1-4.b(1)(b).

13-1-2. Departure Criteria Application. Evaluate runways or heliports for IFR departure operations (see Order 8260.46). At locations served by radar with an operational control tower, air traffic control may request development of diverse vector areas to aid in radar vectoring departure traffic (see Section 13-5).

13-1-3. Departure OCS Application. Evaluate the 40:1 departure OCS originating at the DER at DER elevation (see Figure 13-1-1). For helicopter departures from a takeoff area that supports IFR procedures, evaluate the 20:1 OCS originating at the HDRP at TLOF elevation. Departure operations are unrestricted if the OCS is clear. Where obstructions penetrate the OCS, see Order 8260.46 for required actions.

Figure 13-1-1. OCS Starting Elevation



a. Low, close-in OCS penetrations. Do not publish a CG to a height of 200 feet (400 feet for helicopters) or less above the OCS start elevation.

b. Calculating OCS height. The OCS height is based on the distance measured from the OCS origin along the shortest distance to an obstacle within the segment (see paragraph 13-1-6.b(3) for measuring obstacles located within the ICA).

(1) Primary area. The OCS slope is 40:1 (20:1 for helicopters). Use Formula 13-1-1 to calculate the OCS elevation.

Formula 13-1-1. Primary OCS Elevation

$$h_{OCS} = \frac{d}{s} + e$$

Where:
d = shortest distance (feet) from OCS origin to obstacle
s = 40 (20 for helicopters)
e = OCS origin elevation

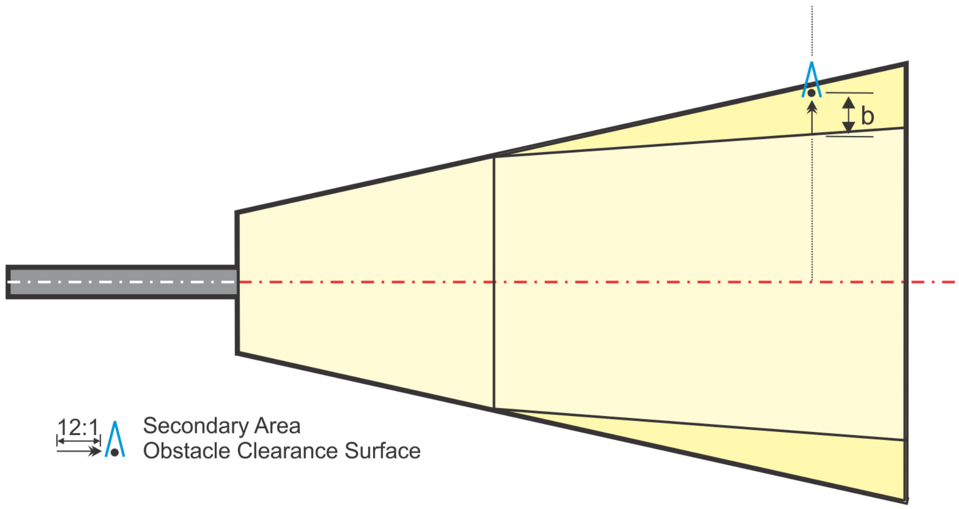
(2) Secondary area. (Applicable only when PCG is identified.) The OCS slope is 12:1. The secondary OCS elevation is the sum of the 40:1 (20:1 for helicopters) OCS rise in the primary area to a point the obstacle is perpendicular to the departure course, and the secondary OCS rise from the edge of the primary OCS to the obstacle (see Figure 13-1-2). Use Formula 13-1-2 to calculate the secondary OCS elevation.

Formula 13-1-2. Secondary OCS Elevation

$$h_{SECONDARY} = h_{OCS} + \frac{b}{12}$$

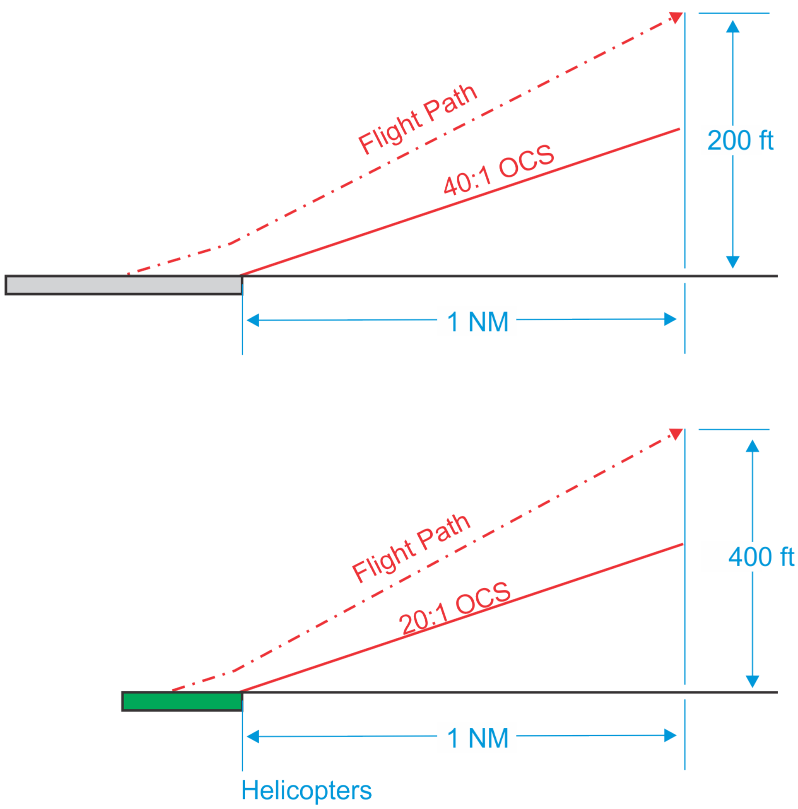
Where:
h_{OCS} = primary OCS height
b = perpendicular distance (feet) from edge of primary

Figure 13-1-2. Secondary OCS



13-1-4. Climb Gradients. Departure procedure obstacle clearance is based on a minimum climb gradient performance of 200 ft/NM [(400 ft/NM for helicopters), see Figure 13-1-3].

Figure 13-1-3. Standard Climb Gradient



a. Calculating climb gradients to clear obstacles. Climb gradients in excess of 500 ft/NM (600 ft/NM for helicopters) require approval (see paragraph 1-4-2). Calculate climb gradients using Formula 13-1-3.

Formula 13-1-3. Standard/Military Option Climb Gradient

Standard Formula	Military Option*
$CG = \frac{O-E}{0.76 \times D}$	$CG = \frac{(48 \times D + O) - E}{D}$

Where:
O = Obstacle MSL elevation
E = OCS start elevation
D = Distance (NM) OCS origin to obstacle
* For use by military aircraft only. Not for civil use.

b. Calculating the CG termination altitude. When the aircraft achieves an altitude that provides the required obstacle clearance, the CG restriction may be lifted. This altitude is called the "climb to" altitude (A). Calculate the climb to altitude using Formula 13-1-4.

Formula 13-1-4. Climb to Altitude

$$A = E + (CG \times D)$$

Where:
E = Climb gradient starting elevation (MSL)
D = Distance (NM) from OCS origin to obstacle

Example: 1221 + (352 x 3.1) = 2312.20 round to 2400

c. Climb gradients to altitudes for other than obstacles. Calculate the climb gradient to the stated "climb to" altitude using Formula 13-1-5.

Formula 13-1-5. Climb to Altitude for Other than Obstacles

$$CG = \frac{A - E}{D}$$

Where:
A = CG termination altitude
E = Climb gradient starting elevation (MSL)
D = Distance (NM) from OCS origin to point where altitude is required

Example: $CG = \frac{3000-1221}{5}$ = 355.8 round to 356 ft/NM

Note: The climb gradient must be equal to or greater than the gradient required for obstacles along the route of flight.

d. Reduced Takeoff Runway Length (RTRL). Where required to provide an option to reduce takeoff runway length (see Order 8260.46, Table 2-1-1), calculate the RTRL by applying . An RTRL may only be used to mitigate a penetration within the initial climb area (extended); see paragraph 13-1-6.b(1). The RTRL value must be rounded up to the next higher 100-ft increment.

Formula 13-1-6. Reduced Takeoff Runway Length

$$RWY_{reduction} = 30.38 \times (p + 35)$$

Where:
p = OCS penetration (feet)

e. Effect of DER-to-obstacle distance (see Order 8260.46).

13-1-5. Ceiling and Visibility. A ceiling and visibility may be specified to see and avoid penetrating obstacles within the ICA (extended) 3 SM or less from the DER.

a. Ceiling. Specify a ceiling value equal to or higher than the height of the obstruction above the airport elevation. Ceilings must be specified in 100-foot increments, round upwards when necessary. Do not specify ceilings of 200 feet or less.

b. Visibility. Specify a visibility value equal to the distance measured directly from the DER to the obstruction, rounded to the next higher reportable value. The minimum value that may be specified is 1 SM (1/2 for helicopters); the maximum value that may be specified is 3 SM.

13-1-6. Initial Climb Area (ICA). The ICA is an area centered on the runway centerline extended used to evaluate obstacle clearance during the climb to 400 feet above DER rounded to the nearest foot, with a minimum climb gradient of 200 ft/NM (400 ft/NM for helicopters).

a. ICA terms.

(1) ICA baseline (ICAB). The ICAB is a line extending perpendicular to the RCL ± 500 feet at DER (departure course ± 250 feet at HDRP for helicopters). It is the origin of the ICA (see Figure 13-1-4 or Figure 13-1-5 for helicopters).

(2) ICA end-line (ICAE). The ICAE is a line at the end of the ICA perpendicular to the RCL extended (departure course for helicopters). The splay of 15 degrees and length of the ICA determine its width (see Figure 13-1-4 or Figure 13-1-5 for helicopters).

b. Area.

(1) Length. The ICA length is normally 2 NM (1 NM for helicopters), measured from the ICAB to the ICAE along RCL extended (departure course for helicopters). It may be less than 2 NM (1 NM for helicopters) in length for early turns by publishing a climb gradient. The ICA may be extended to maximum length of 10 NM. A specified altitude (typically 400 feet above DER) or the interception of PCG route must identify the ICAE.

(2) Width. The ICA origin width is 1000 feet (± 500 feet perpendicular to RCL) for departures from a runway and 500 feet (± 250 feet perpendicular to the departure course) for helicopter departures. The area splays outward at a rate of 15 degrees relative to the departure course (normally RCL extended or departure course for helicopters).

Figure 13-1-4. Initial Climb Area: Standard

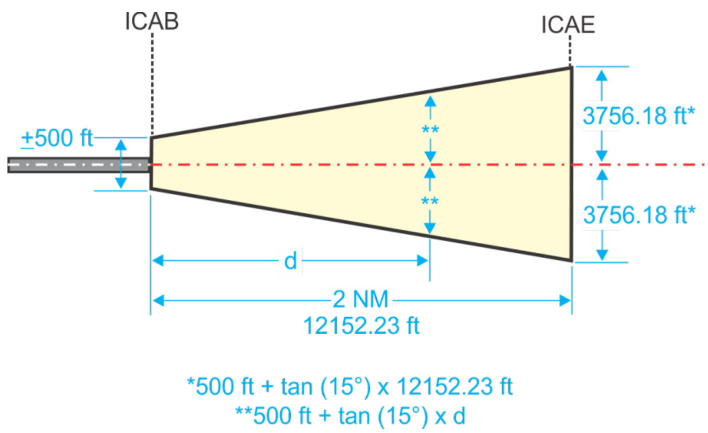
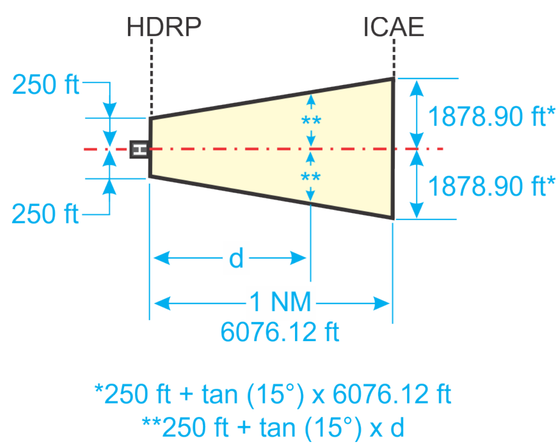


Figure 13-1-5. Initial Climb Area: Helicopters



(3) OCS. The OCS originates at the ICAB, at the OCS start elevation (see paragraph 13-1-3). Apply the OCS by measuring along the RCL from the ICAB to a point where the obstacle is perpendicular to the RCL and evaluate per paragraph 13-1-3. The MSL elevation of the ICAE is calculated using Formula 13-1-7.

Formula 13-1-7. ICAE Elevation

$$ICAE_{elev} = a + \left(\frac{b}{c}\right)$$

Where:

a = OCS start elevation
b = ICA length (feet)
c = OCS slope (normally 40:1 for other than helicopters; 20:1 for helicopters)

Section 13-2. Diverse Departure Assessment

13-2-1. General. Assess diverse “A” and “B” areas to a distance of 25 NM. Extend the assessment to a distance of 46 NM if any part of the assessment area includes mountainous areas (see Figure 13-2-1 or Figure 13-2-2 for helicopters).

a. Area. The diverse departure assessment covers three areas.

Figure 13-2-1. Diverse Departure Assessment Areas

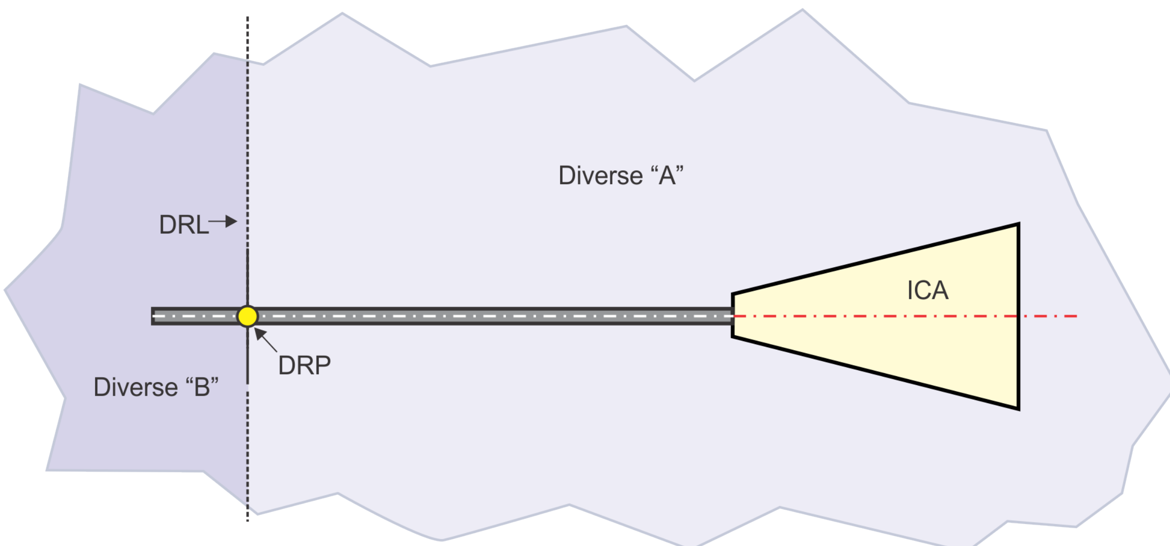
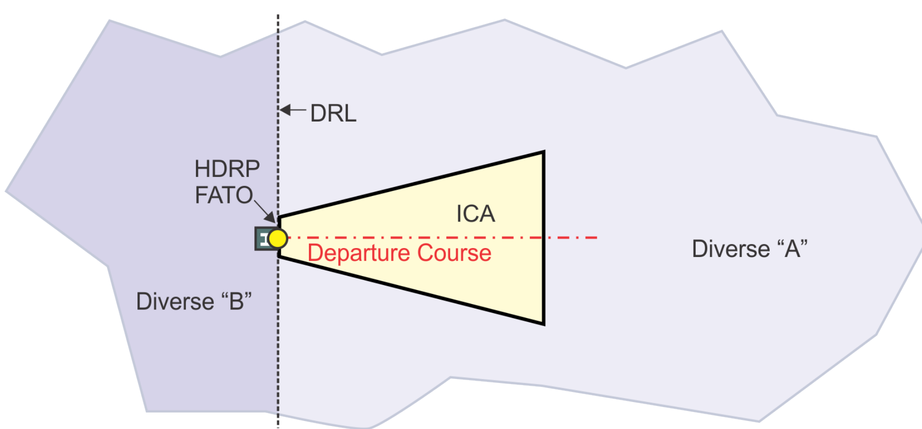


Figure 13-2-2. Heliport Diverse Departure Assessment Areas



(1) ICA. Assess the ICA under paragraph 13-1-6 using a 40:1 OCS slope (see Figure 13-2-1).

(2) Diverse "A" area. Diverse “A” consists of all area on the DER side of the departure reference line (DRL), excluding the ICA. The DRL is a line perpendicular to the RCL that passes

through the departure reference point (DRP) which is established on RCL 2000 feet from the start end of the runway (collocated with the FATO for helicopters). Calculate the elevation of the OCS at any given location in the diverse "A" by applying Formula 13-2-1. Measure the distance from the obstacle to the closest point on the centerline of the runway between the DRP and ICAB, or the closest point on ICA boundary lines as appropriate (see Figure 13-2-3 or Figure 13-2-4 for helicopters). The beginning OCS elevation is equal to the MSL elevation of the ICAE.

Formula 13-2-1. OCS Height Diverse "A" Area

$$h = a + \frac{d}{s}$$

Where:

- h = OCS MSL elevation at obstacle
- d = distance (feet) from obstacle to closest point
- a = ICAE MSL elevation
- s = 40 (20 for helicopters)

Figure 13-2-3. Diverse "A" Area Evaluation

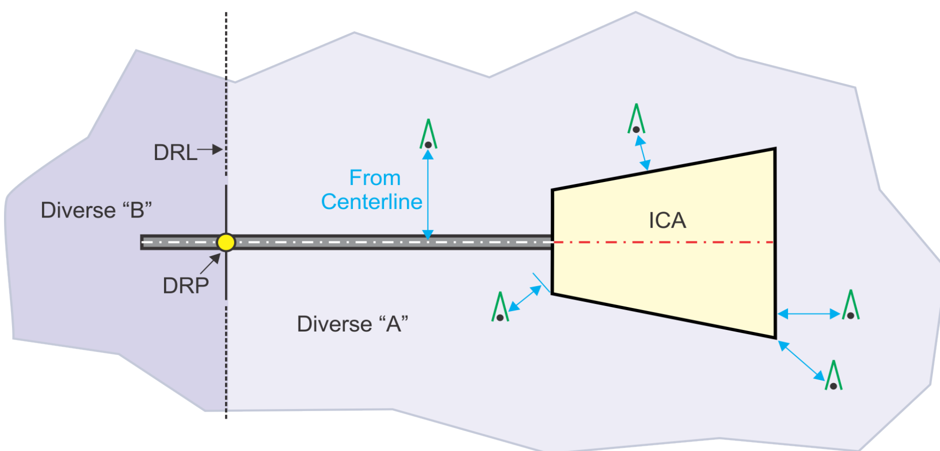
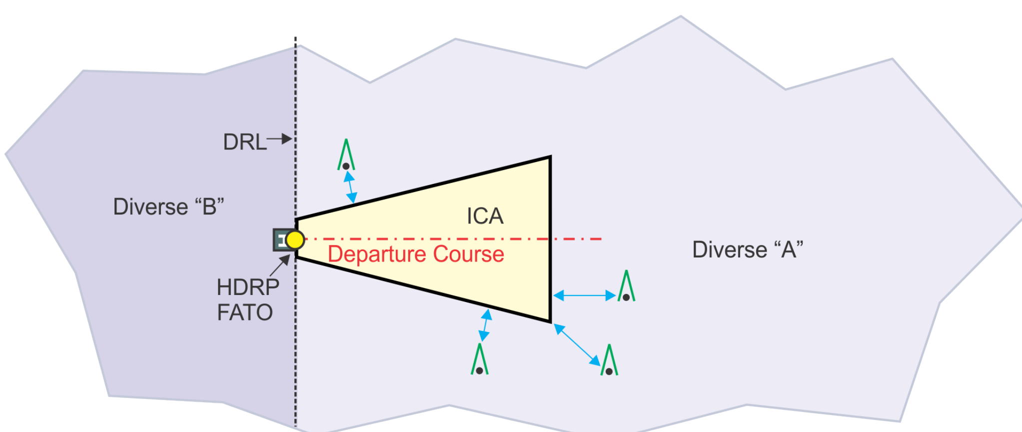


Figure 13-2-4. Heliport Diverse "A" Area Evaluation



(3) Diverse "B" area. All areas on the start end of runway side (non-departure side for helicopters) of the DRL. Evaluate obstacles in the Diverse "B" area by measuring the distance in feet from the obstacle to the DRP (see Figure 13-2-5 or Figure 13-2-6 for helicopters). Calculate the OCS MSL elevation at the obstacle using Formula 13-2-2.

Formula 13-2-2. OCS Height Diverse “B” Area

$$h = \frac{d}{s} + (b + 400)$$

Where:

h = OCS MSL elevation at obstacle
d = distance (feet) from obstacle to DRP
b = Airport MSL elevation
s = 40 (20 for helicopters)

Figure 13-2-5. Diverse “B” Area

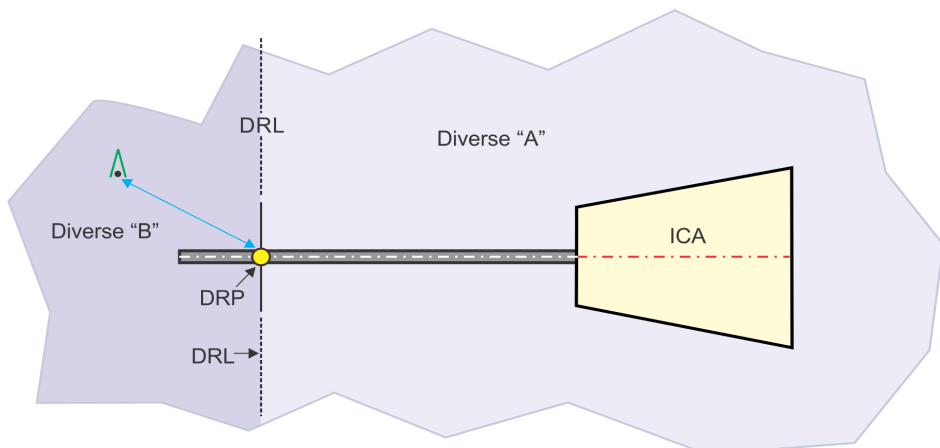
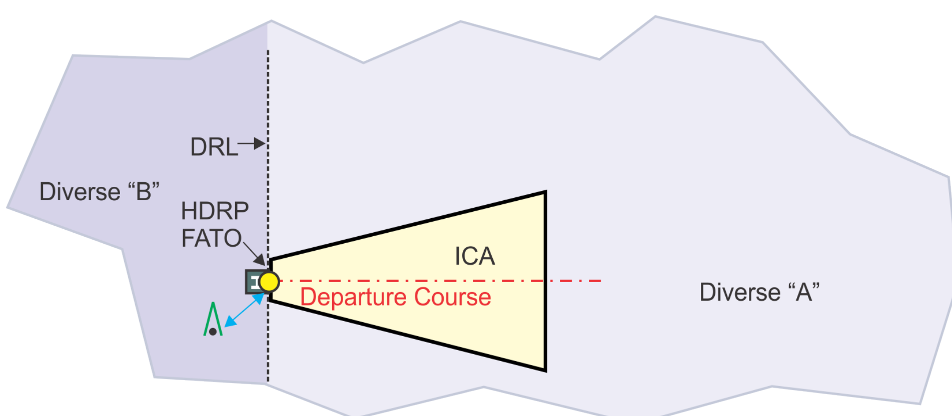
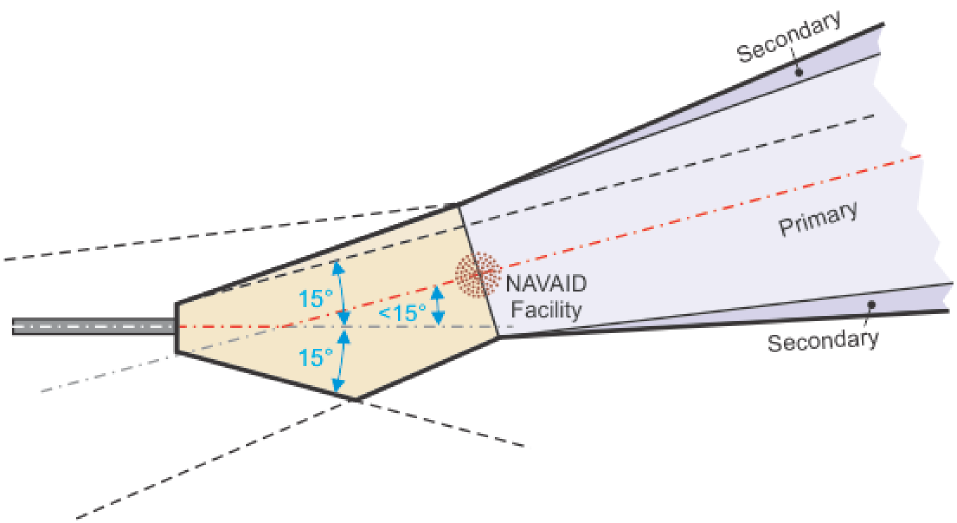


Figure 13-2-6. Heliport Diverse “B” Area



d. Secondary area obstructions. Secondary areas may be constructed and employed where PCG is provided.

Figure 13-3-6. Facility Area Relationship



13-3-4. Changeover Point (COP). Apply criteria in paragraph 14-1-7 except as follows:

a. The widths of the primary and secondary areas at the COP are determined by Formulas 13-3-1 and 13-3-2, and Table 13-3-1.

b. If the COP is offset, the primary and secondary boundary lines will extend from the farthest facility to a position abeam the COP. The primary and secondary boundaries to the facility nearest the COP will extend from the primary and secondary boundary points of the farthest facility abeam the COP, and extend to the points designated by the appropriate distance A from Table 13-3-1.

13-3-5. Turning Segment Construction. Construct turning segments when the course change is more than 15 degrees. Establish an ICA. For turn radii use Table 13-3-2 and apply paragraphs 13-3-5.a through 13-3-5.f, as appropriate. Use next higher airspeed in Table 13-3-2 if specific speed is not given.

a. Turns below 10000 feet MSL. Use 250 KIAS unless a speed restriction other than 250 KIAS is noted on the procedure for that turn. Use 200 KIAS for a minimum speed for CAT C and 230 KIAS for CAT D aircraft.

b. Turns at 10000 feet and above. Use 310 KIAS unless a speed restriction not less than 250 KIAS above 10000 through 15000 feet is noted on the procedure for that turn. Above 15000 feet, speed reduction below 310 KIAS is not permitted.

c. When speeds greater than 250 KIAS are authorized below 10000 feet MSL and speeds greater than 310 KIAS are authorized at or above 10000 feet MSL, use the appropriate speed in Table 13-3-2.

d. Use the following standard note to publish a speed restriction: "Do not exceed (speed) until BRONI (fix)."

e. For helicopter departures, use Table 13-3-2 radii for 90 KIAS for turns below 10000 feet MSL until intercepting the NAVAID course. Once established on the NAVAID course, use radii for 140 KIAS for subsequent turns unless a speed restriction other than 90 KIAS is noted.

f. Determine the aircraft turn altitude at the fix or radio facility assuming a climb gradient of 500 ft/NM below 10000 feet MSL and 350 ft/NM above 10000 feet MSL for all fixed-wing aircraft, 400 ft/NM for helicopters. If a published climb gradient is higher than those assumed, the higher climb gradient should be used to determine the altitude at the fix or radio facility. The distance used for the calculation will be the distance along the path of flight beginning at the end of the ICA to each subsequent fix or radio facility. Once the altitude is determined, use Table 13-3-2 to determine the turn and boundary radii. If a speed restriction exists at or beyond the evaluation fix or radio facility, that speed will be used to determine the radii, otherwise, use 250 KIAS if the altitude is below 10000 MSL, and 310 KIAS if the altitude is above 10000 MSL.

Table 13-3-2, Turn Radii

	Radii (turn radius / outer boundary radius) (NM)	
Airspeed (KIAS)	**Below 10000 feet MSL**	**At and above 10000 feet MSL**
90	0.8 / 0.9	1.2 / 1.4
120	1.2 / 1.4	1.6 / 2.0
140	1.4 / 1.7	1.9 / 2.5
150	1.6 / 1.9	2.0 / 2.7
175	2.0 / 2.4	2.5 / 3.3
180	2.0 / 2.5	2.6 / 3.4
210	2.6 / 3.2	3.1 / 4.3
240	3.1 / 3.9	3.8 / 5.2
250	3.4 / 4.2	4.0 / 5.5
270	3.8 / 4.7	4.5 / 6.2
300	4.5 / 5.6	5.3 / 7.3
310	4.8 / 6.0	5.6 / 7.7
350	5.8 / 7.3	6.7 / 9.3

Note: The Table depicts common airspeeds used to determine turn radius (See Pilot's Handbook of Aeronautical Knowledge, Chapter 5 for radius of a turn calculations) based on radius of turn caculations accounting for omni winds. Speeds include 60-knot omni winds below 10000 feet MSL; 90-knot omni winds at 10000 feet and above; bank angle 23 degrees.

g. The computed start point of the turn is the distance of turn anticipation (DTA) for the radio facility or fix (see Formula 13-3-3).

Formula 13-3-3. Distance Turn Anticipation

$$DTA = R \times \tan\left(\frac{\beta}{2}\right)$$

Where:

R = turn radius from Table 13-3-2

β = magnitude of heading change (degrees)

h. OEA Construction. Inside turn protection is provided for turns with a heading change greater than 10 degrees. For turns at a radio facility, the inside turn expansion begins at a point abeam the DTA point inbound to the facility. For turns at a fix, the inside turn expansion begins prior to the fix at the earlier of: a point abeam the DTA point inbound to the fix; or the point on the primary and secondary OEA boundaries intersecting the secondary system accuracy line from the radio facility located outbound from the turn fix (see Figure 13-3-11).

i. The inside turn protection boundaries splay outward from the location noted in paragraph 13-3-6.b on the primary and secondary OEA boundaries at an angle equivalent to half the turn magnitude until they intersect the respective boundaries on the segment outbound from the turn radio facility or fix.

13-3-6. Outside Turn Protection.

a. Altitude determination.

(1) Turn at altitude. The start point for subsequent legs is the point along the course centerline where the specified turn altitude is reached.

(2) All other turns. Calculate the projected fix altitude by applying the vertical path rise from the start point or altitude along the course centerline to the subsequent fix or point applying paragraph 13-3-5.f. The start point for subsequent legs is the end fix or point of the preceding leg at the assumed altitude of the fix or point.

b. OEA construction. Determine turn and outer boundary radii from Table 13-3-2.

(1) First arc construction.

(a) *Step 1*. For a turn at a NAVAID, the start point of the arc is the end of the outside boundary of the inbound leg OEA. For a turn at a radio fix, the start point of the arc is the intersection of the error boundary of the outbound leg OEA with the extended outer boundary of the inbound leg OEA.

(b) *Step 2*. Project a line from the start point of the arc along the end of the inbound leg OEA boundary.

(c) *Step 3*. Locate the arc center point on the projection line from *Step 2*, at a distance from the start point equal to the outer boundary radius determined from Table 13-3-2.

(d) *Step 4*. Construct the preliminary first arc from the arc start point with center point as established in *Step 3*.

(2) Second arc construction.

(a) *Step 1*. For a turn at a NAVAID, the start point of the arc is the end of the inside boundary of the inbound OEA, and whichever occurs earliest along the route of flight of either: abeam the start point of the first arc with respect to the extended inbound path; or the intersection of the outbound NAVAID error splay with the extended inbound secondary boundary.

(b) *Step 2.* Project a line from the start point of the arc onto the extended inbound leg OEA boundary.

(c) *Step 3.* Locate the arc center point on the projection line from *Step 2*, at a distance from the start point equal to the outer boundary radius determined from Table 13-3-2.

(3) Arc connection.

(a) *Step 1.* Construct the first arc.

(b) *Step 2.* Construct the first arc convergence line at a 30-degree angle to the outbound course line, tangent to the first arc.

(c) If the first arc convergence line does not instersect the second arc:

1. Truncate the first arc at the start of the first arc convergence line.

2. The OEA boundary will be the truncated first arc and the first arc convergence line.

(d) If the first arc convergence line intersects the second arc:

1. Connect the first and second arcs with a line tangent to both.

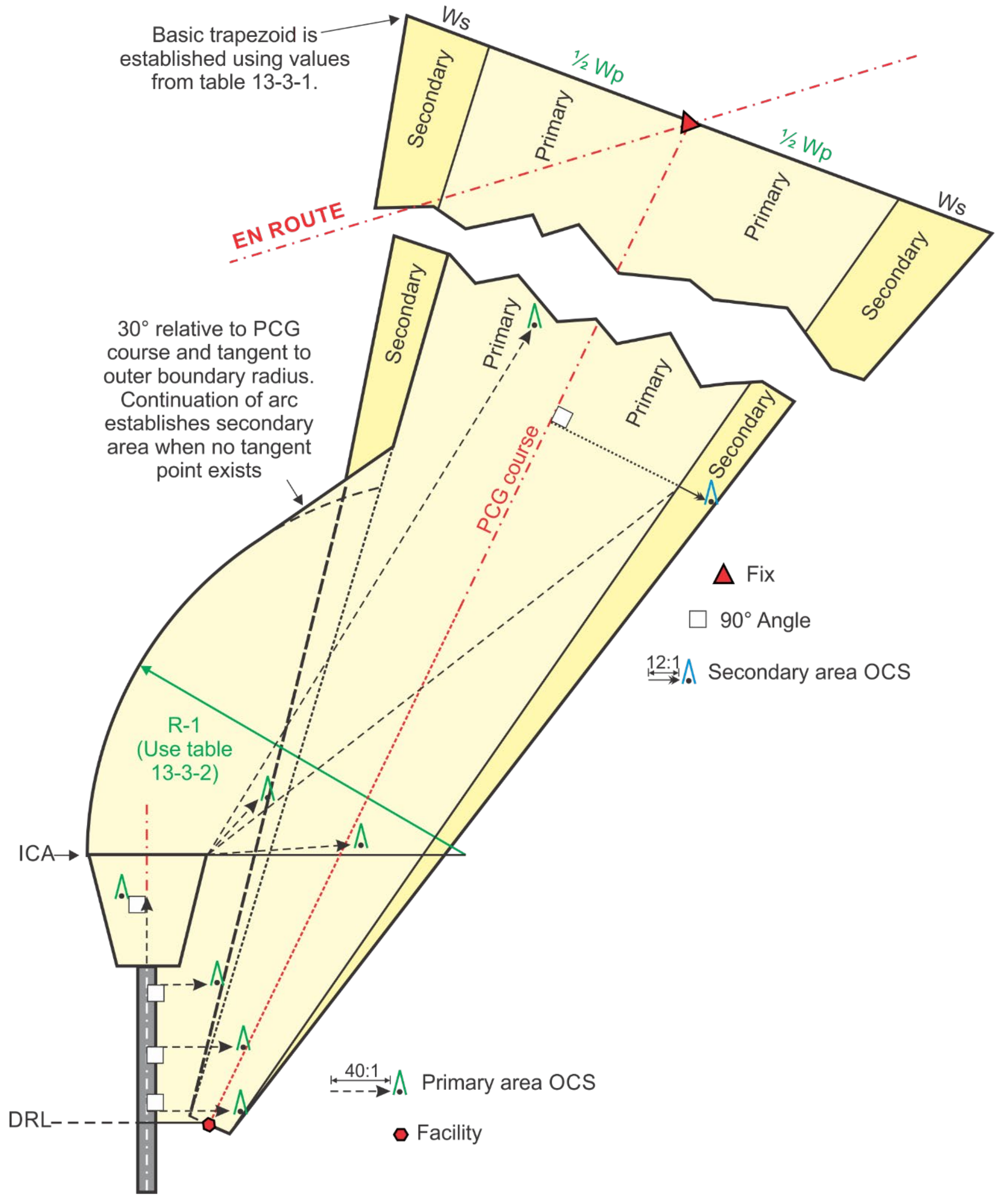
2. Truncate the first and second arcs at the tangent points of the connecting line.

3. Construct the second arc convergences line at a 30-degree angle to the outbound course line, tangent to the second arc.

4. The OEA boundary will be the truncated first arc, the tangent line between the first and second arcs, the truncated second arc, and the second arc convergence line.

13-3-7. Turn to PCG. Extend the ICA boundaries as necessary to intersect the boundaries appropriate to the PCG provided. Where the ICA outer boundary will not intersect the PCG boundary, construct an outer boundary radius from the outer edge of the ICA to intersect the PCG boundary. For the radius length, use Table 13-3-2 or the width of the end of ICA, whichever is longer (see Figure 13-3-7). Specify a course, not aligned with the runway centerline, to intersect a PCG course. The amount of turn is not restricted.

Figure 13-3-7. ICA Joining PCG Area



13-3-8. Multiple Turns. Use Table 13-3-1 to establish dimensions of basic trapezoids.

a. Climb to altitude and turn direct to facility; turn less than 90 degrees (see Figure 13-3-8). Construct a line from departure reference point (DRP) to edge of obstacle area at the facility denoting the second turn point. Extend splay of ICA to line A-B (perpendicular to runway centerline extended) where altitude is reached for the turn. Measure out runway centerline extended using the minimum climb gradient authorized.

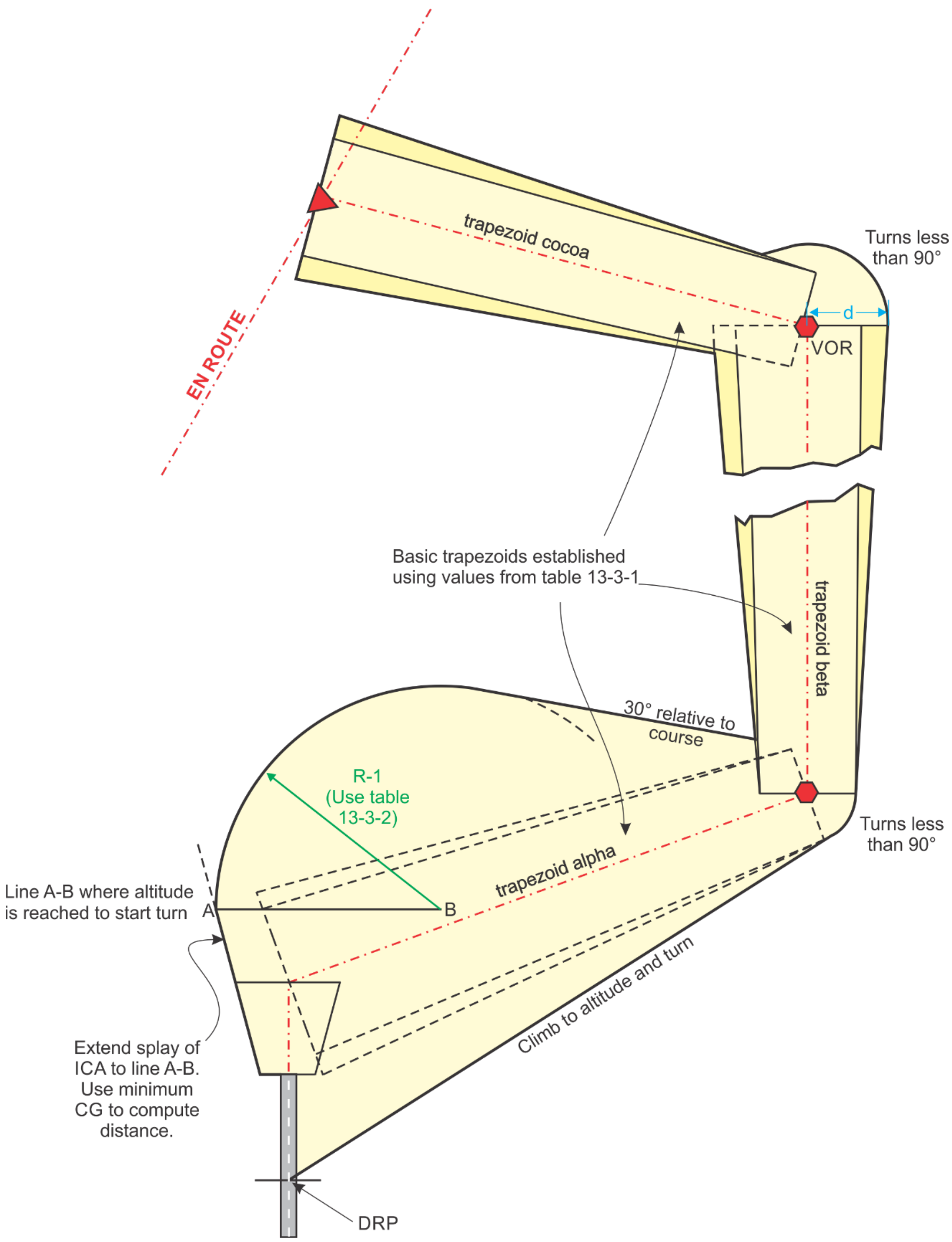
(1) Align the centerline of trapezoid alpha, through point C (end of ICA on runway centerline extended).

(2) Construct an arc from point A using radius R1 (see Table 13-3-2) centered on point B. Construct a tangent from the arc to the boundary of the secondary area of the next segment (trapezoid beta) 30 degrees relative to trapezoid alpha centerline.

(3) Construct trapezoid beta. Extend the outer boundary area, radius "d," to join trapezoid cocoa. Inside boundaries join at the primary and secondary intersections.

(4) Construct trapezoid cocoa and its associated segment, if necessary, to join en route structure.

Figure 13-3-8. Climb to an Altitude and Turn Direct to Facility with Multiple Turn



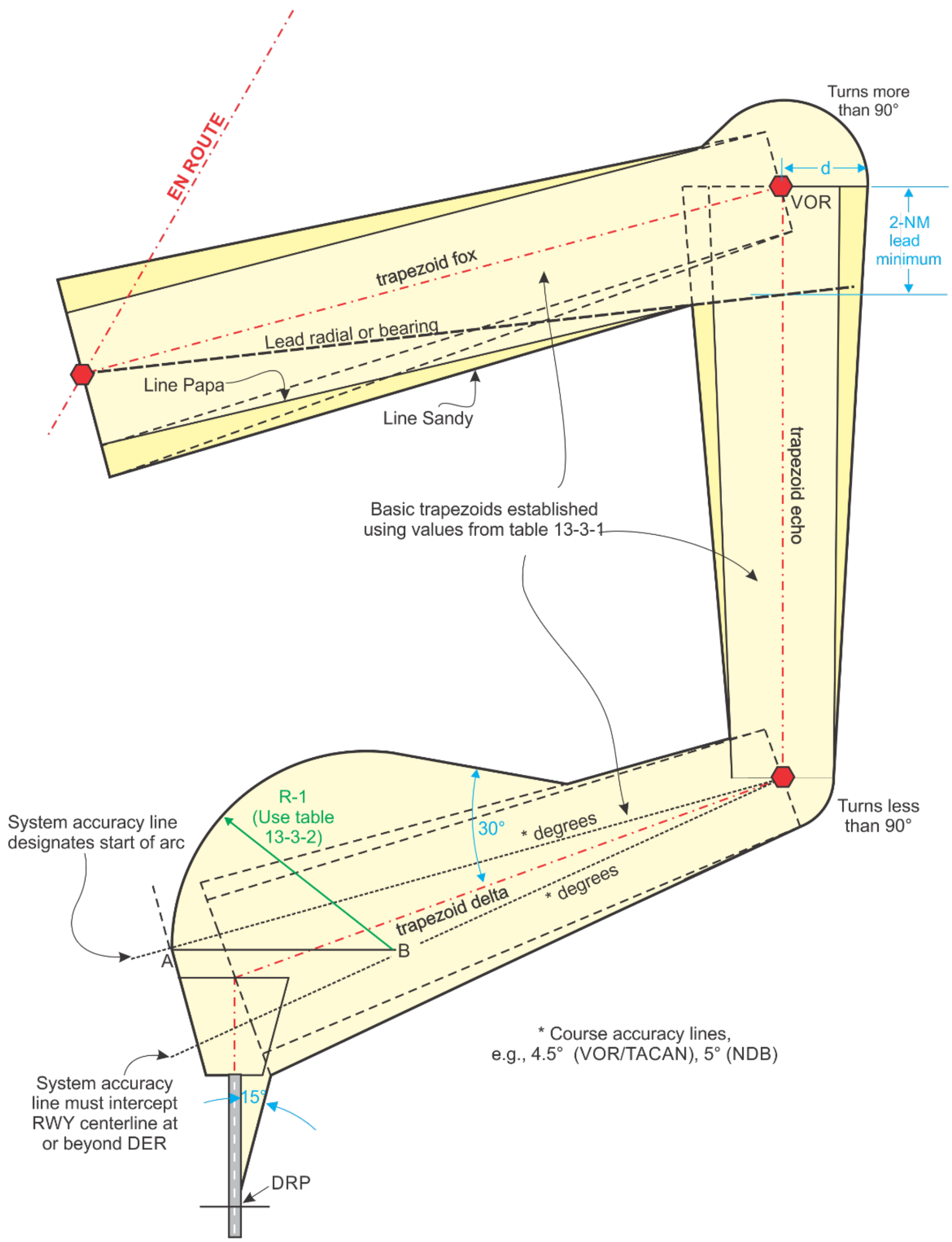
b. Climb to intercept a course (see Figure 13-3-9). Construct a 15-degree splay relative to runway centerline from the DRP to the secondary boundary of trapezoid delta (inside of turn) area. System accuracy line of delta must intercept runway centerline at or beyond DER.

(1) Extend the splay of ICA to line A-B. System accuracy line of trapezoid delta (outside of turn) intercepts the ICA splay at point A.

(2) Construct an arc from point A using radius R1 (see Table 13-3-2) centered on point B. Construct a tangent from the arc to the boundary of next segment (trapezoid echo) 30 degrees relative to trapezoid delta centerline.

(3) Construct trapezoids echo and fox as necessary. Provide a 2-NM lead area when turns are more than 90 degrees, prior to the “VOR” turning into trapezoid fox. Specify a 2-NM lead when possible with a radial, bearing, or DME. When unable to identify the lead point, construct and provide a 2-NM lead area for evaluation of obstacles. Outside protection arc must be as large as the end of the trapezoid, such as "d" at the VOR that ends trapezoid echo. In the segment containing trapezoid fox, note primary “line papa” and secondary “line sandy” originate from the 2-NM lead of trapezoid echo.

Figure 13-3-9. Climb Runway Heading to Intercept a Course With Multiple Turns



c. Multiple turns more than 90 degrees. Refer to Figure 13-3-10 and Figure 13-3-11.

d. In Figure 13-3-10, the initial course intercepts positive course of trapezoid gulf after takeoff from DER. The obstacle area radius is constructed from point A with a tangent 30 degrees relative to the course in trapezoid gulf. The area formed around the intersection of E with trapezoid hotel takes precedence over the 2-NM lead requirement. Primary and secondary areas can be established on the inside of the turn in trapezoid hotel because the 2-NM lead does not cut off any of the primary area.

(1) Construct a 2-NM lead even though no radial, bearing, nor DME is available to provide a lead area for the pilot's early turn. Publish a radial, bearing, or a DME when available. Note within Figure 13-3-11 how the intersections at E and F form the boundaries of obstacle clearance areas. Point E is established abeam the 2-mile lead. The dark lines around point E form a primary area boundary. A secondary area cannot be established on the inside area of trapezoid juniper because the 2-mile lead forms the area that takes precedence over the normal primary and secondary areas at "e."

e. The 2-mile lead is not required when lead point is within primary area of en route course (see Figure 13-3-12).

Figure 13-3-10. Climb to Intercept Course

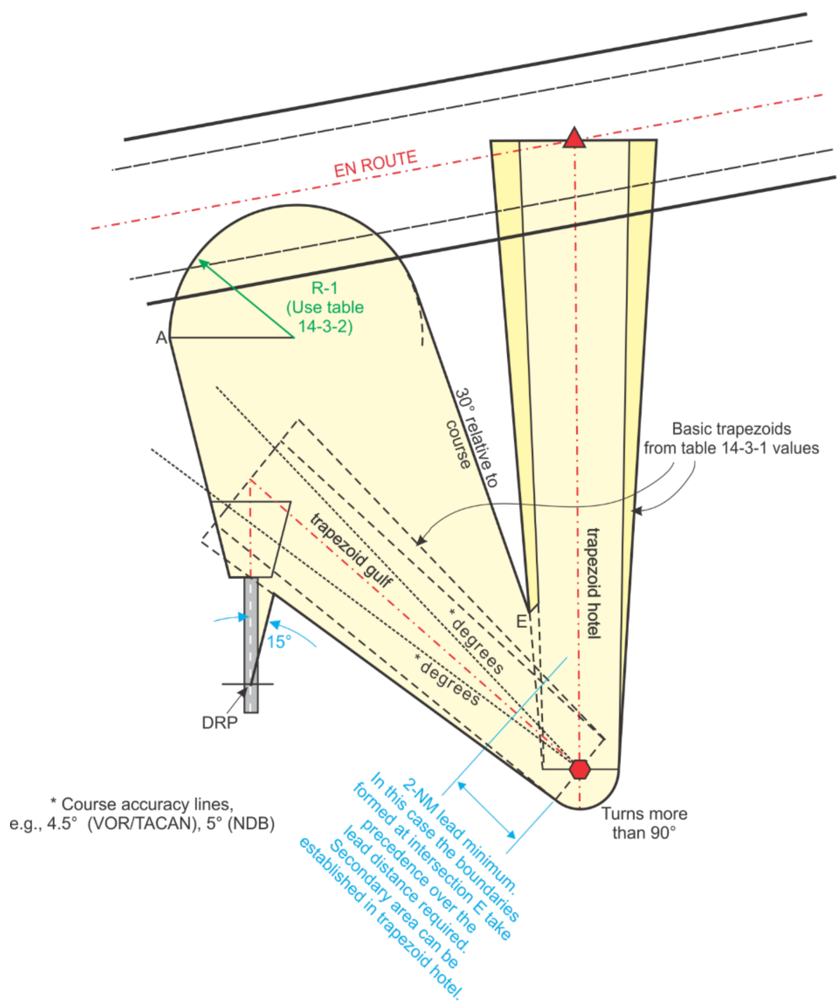


Figure 13-3-11. Multiple Turns

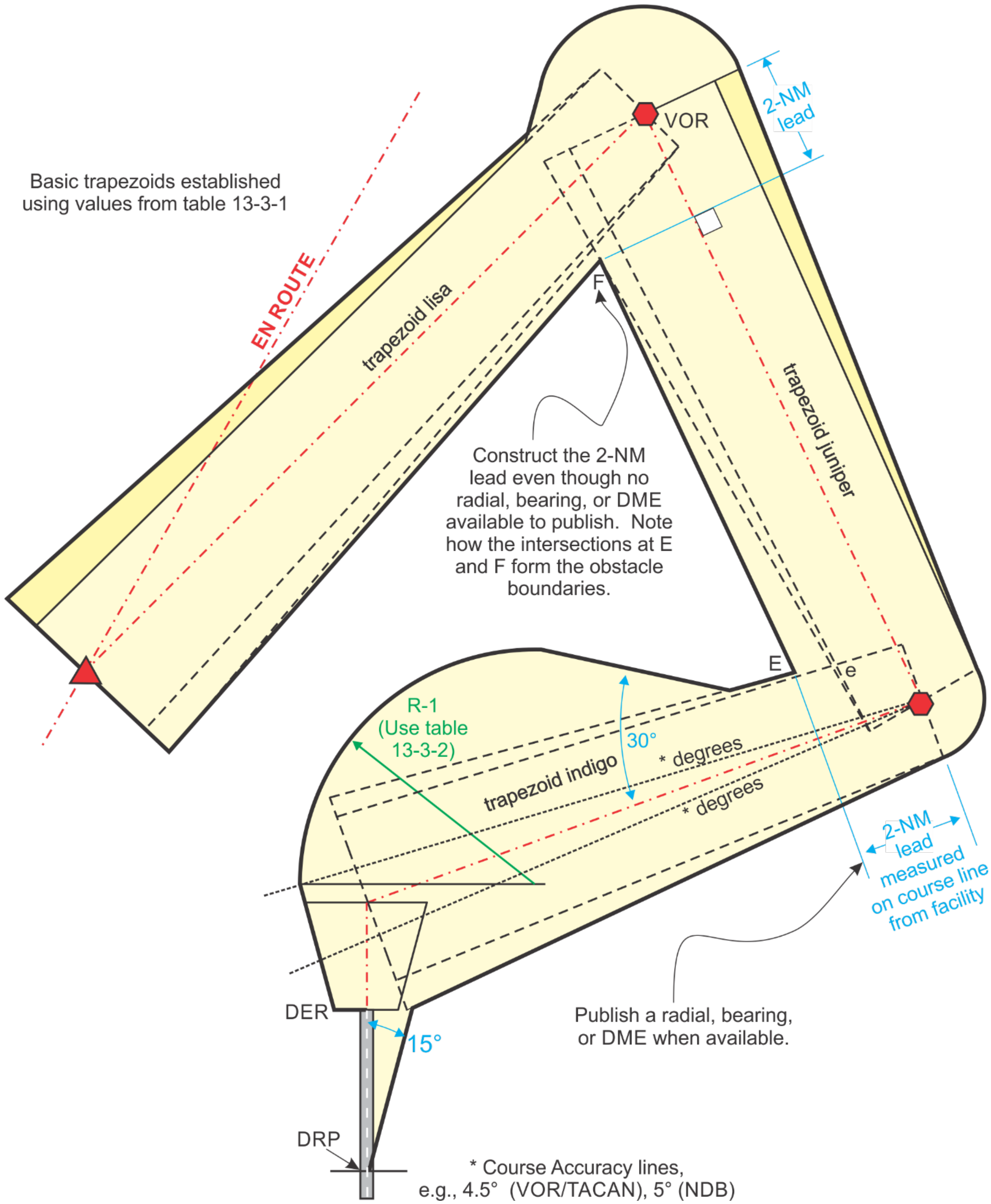
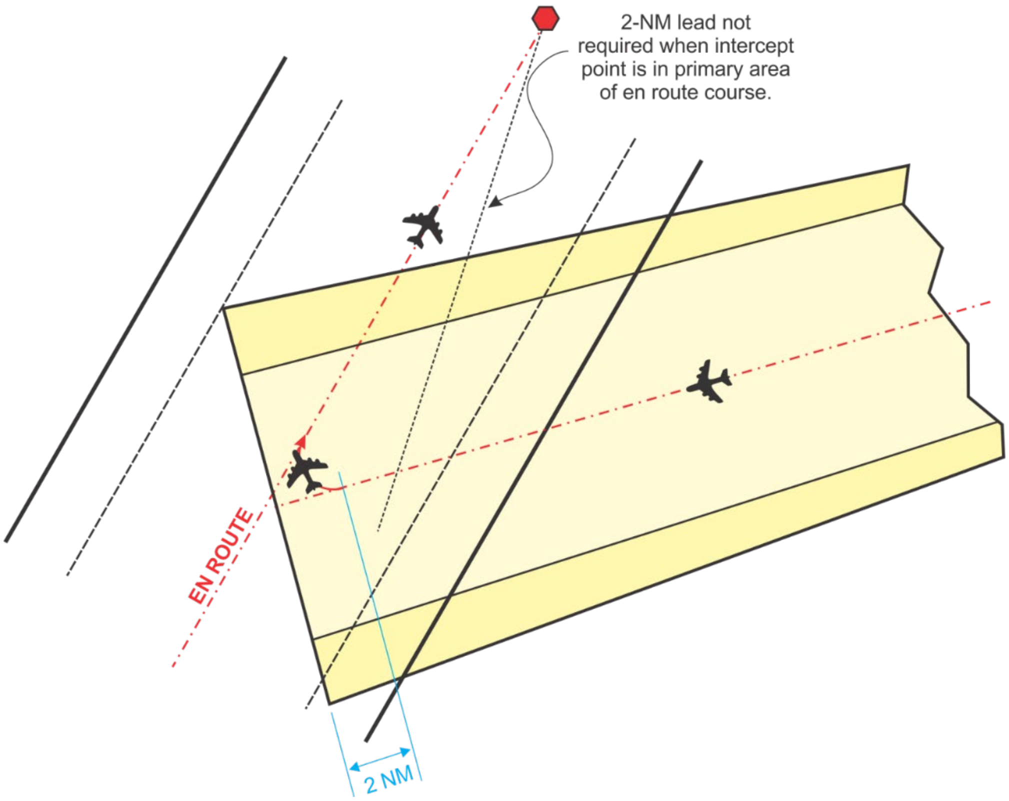


Figure 13-3-12. Turn onto En Route Course



13-3-9. Evaluation of Multiple Turn Areas (see Figure 13-3-13 and Figure 13-3-14).

a. Measure 40:1 straight-line distance from lines D-C-B of the ICA directly to the obstacles outside of the ICA associated with trapezoid alpha in Figure 13-3-13 and trapezoid gulf in Figure 13-3-14. Measure 40:1 from runway centerline to obstacles abeam the runway between the DRP and the DER. Points B and C are at the end of the ICA, and points A and D are at the corners of the ICA abeam the DER. In Figure 13-3-13, no secondary areas exist in trapezoid alpha's segment, and in Figure 13-3-14, no secondary evaluation is allowed for the far turn from DER because the beginning of PCG cannot be determined. However, on the inside turn area a secondary area evaluation could be allowed for trapezoid gulf's segment.

b. Measure 40:1 to point E for obstacles in trapezoids beta, Figure 13-3-13, and hotel, Figure 13-3-14, segments, respectively. Measure 12:1 into secondary area from edge of primary area perpendicular to the segment's course. Convert the secondary area obstacles to primary equivalent at edges of primary area. Measure 40:1 to the conversion points to assess appropriate obstacle clearance.

c. Measure 40:1 to E, then 40:1 down the edge of the primary area of trapezoid beta from E to F to obstacles in trapezoid cocoa's segment. From F measure 40:1 to obstacles in primary area of trapezoid cocoa, Figure 13-3-13. Measure along edge of primary area to a point abeam the obstacles in secondary area. Measure 12:1 from edge of primary area to the obstacle in secondary area perpendicular to applicable course line. Perform secondary area obstacle evaluation.

d. Climbing in a holding pattern. When a climb in a holding pattern is used, no obstacle may penetrate the holding pattern obstacle clearance surface. This surface begins at the end of the segment, F-G (see Figure 13-3-14) leading to the holding fix. Its elevation is that of the departure OEA at the holding fix. It rises 40:1 from the nearest point of the F-G line to the obstacle in the primary area. It also rises 40:1 to the edge of the primary area of the holding pattern abeam an obstacle in the secondary area of the holding pattern. In the secondary area, the surface rises 12:1 to the obstacle measuring the shortest distance between the obstacle and the edge of the primary area (see Figure 13-3-14). The holding pattern altitude must have a level surface evaluation of 1000 feet.

Figure 13-3-13. Climb to an Altitude and Turn Direct to a Facility With Multiple Turns

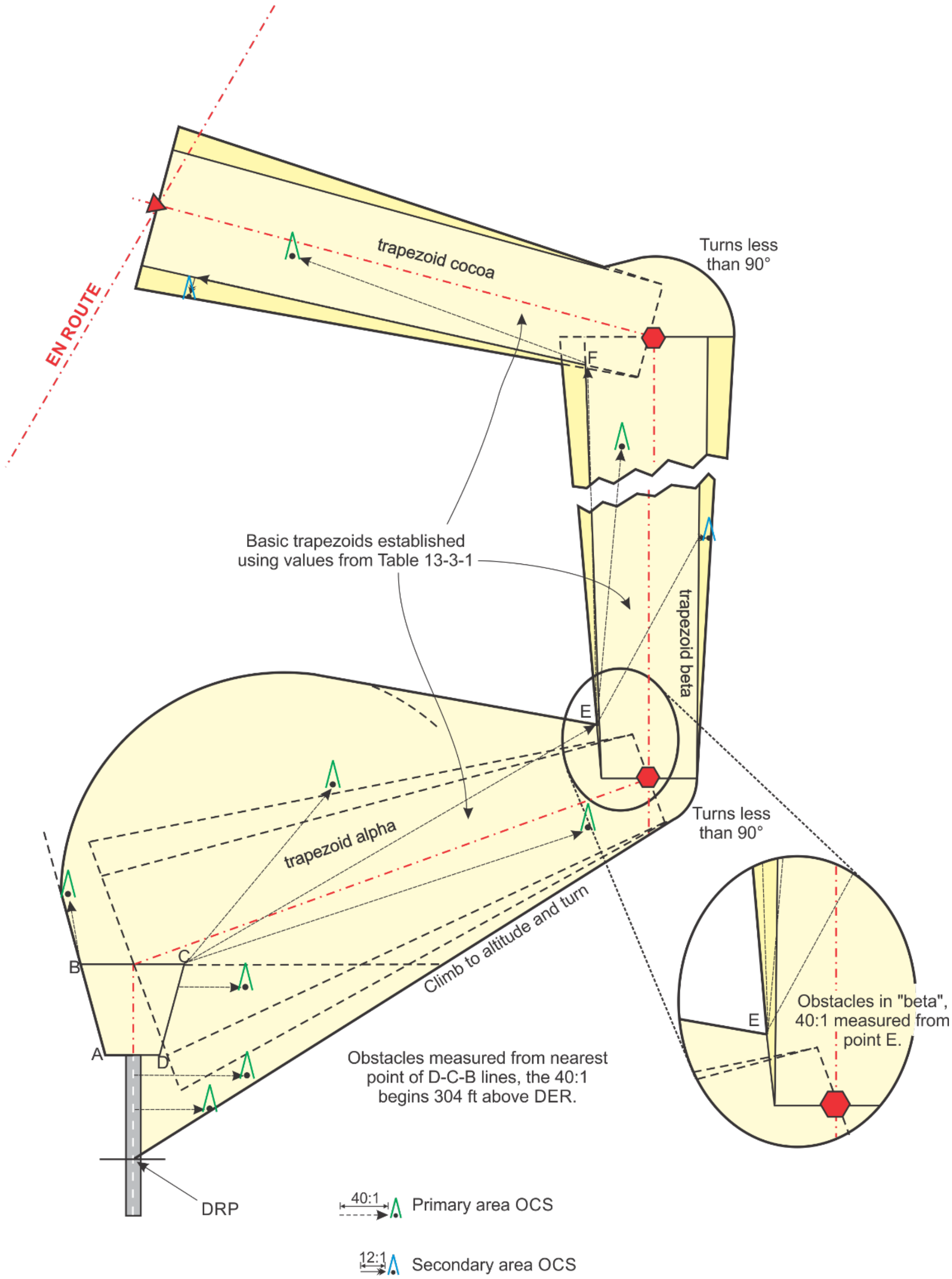
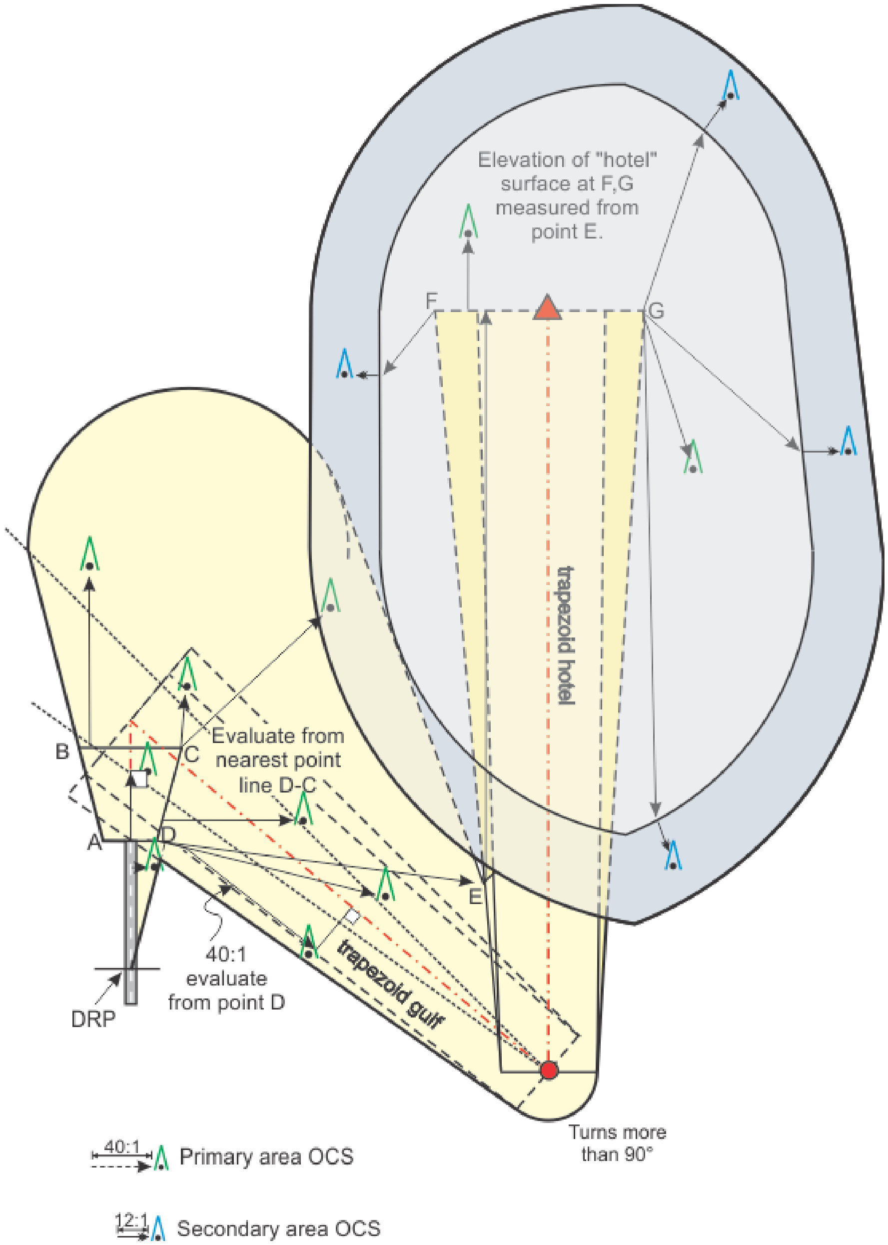


Figure 13-3-14. Climb in a Holding Pattern, Turns More Than 90 Degrees Evaluation



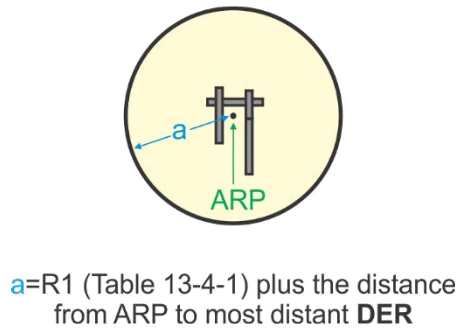
Section 13-4. Visual Climb Over Airport (VCOA)

13-4-1. General. VCOA is an alternative method for pilots to depart the airport where aircraft performance does not meet the specified climb gradient. VCOA is not authorized for departures from heliports.

13-4-2. Basic Area.

a. Construct a visual climb area (VCA) over the airport using ARP as the center of a circle (see Figure 13-4-1). Use R1 in Table 13-4-1 plus the distance the ARP to the most distant runway end as the radius for the circle.

Figure 13-4-1. VCA



b. Select 250 KIAS as the standard airspeed and apply the appropriate MSL altitude to determine the R1 value. Use other airspeeds in Table 13-4-1, if specified on the procedure, using the appropriate radius for the selected airspeed. Altitude must equal or exceed field elevation. The VCA must encompass the area of the ICA from the departure runway(s). Expand the VCA radius if necessary to include the ICA (see Figure 13-4-2).

Figure 13-4-2. VCA Expanded

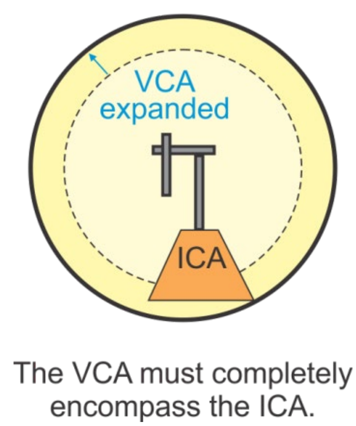


Table 13-4-1. Radius Values

Altitudes MSL	Below 2000 feet	Below 5000 feet	Below 10000 feet	10000 feet And above
Speed KIAS				
90	2.0	2.0	2.0	2.0
120	2.0	2.0	2.0	2.0
180	2.0	2.0	2.5	3.4
210	2.1	2.5	3.2	4.3
250	2.8	3.4	4.2	5.5
310	4.2	4.9	6.0	7.7
350	5.2	6.0	7.3	9.3

Note: Table 13-4-1 speeds include 30-knot tail winds below 2000 feet MSL, 45-knot tail winds below 5000 feet MSL, and 60-knot tail winds below 10000 feet MSL, 90 knot winds at 10000 feet and above; bank angle: 23 degrees.

13-4-3. VCOA Assessment.

a. Diverse VCOA.

(1) Identify the highest obstacle within the VCA. This is the preliminary height of the VCA level surface.

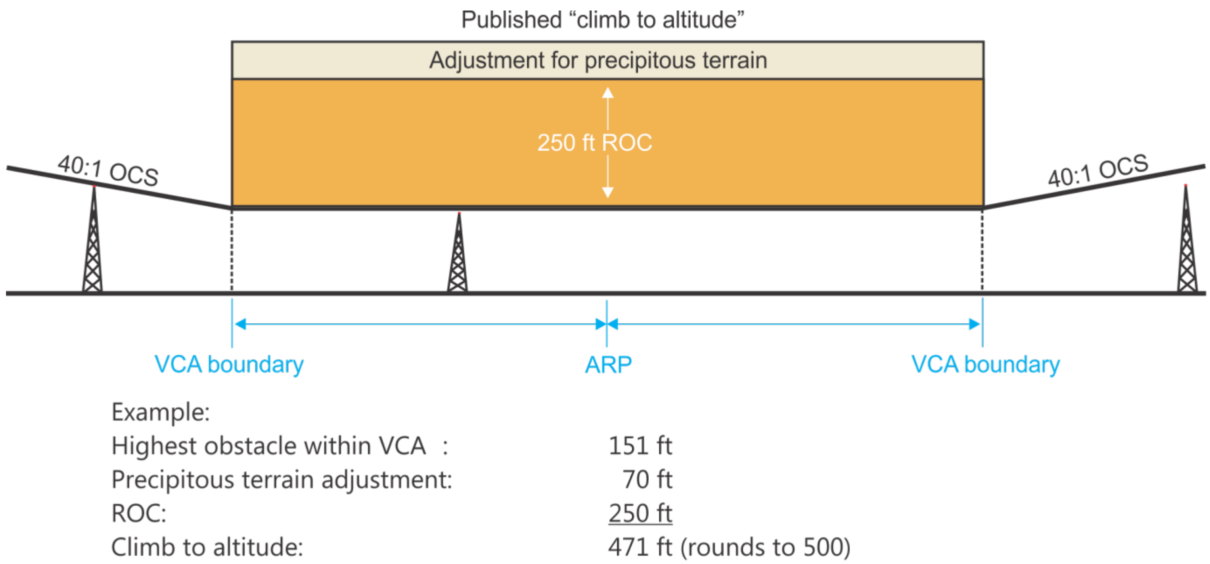
(2) Assess a 40:1 OCS outward from the VCA boundary using the preliminary height of the VCA level surface as the starting OCS height. The 40:1 surface must be evaluated to a minimum distance of 19 NM; expand the assessment to a distance of 40 NM if any part of the assessment area within 19 NM includes designated mountainous terrain.

(3) If the 40:1 OCS is penetrated, increase the VCA level surface by the amount of the greatest penetration.

(4) Add 250 feet of ROC to the final elevation of the VCA level surface. Adjustments for precipitous terrain located within the VCA must be applied as specified in paragraph 3-2-2. Express the resultant altitude in a 100-foot increment; round upward if necessary. This altitude is published as the “climb to altitude” for the VCOA procedure (see Figure 13-4-3).

Note: Rounding upward would not be required if the sum of the obstacle’s height, ROC, and required adjustment was in a 100-foot increment (such as 500 feet). Rounding would be required for any other value (for example, 501 feet rounds to 600 feet).

Figure 13-4-3. Diverse VCOA Assessment



b. Departure routes. Where VCOA diverse departure is not feasible, construct a VCOA departure route based on NDB, VOR, or TACAN guidance.

(1) Construct the VCA by applying paragraph 13-4-2.

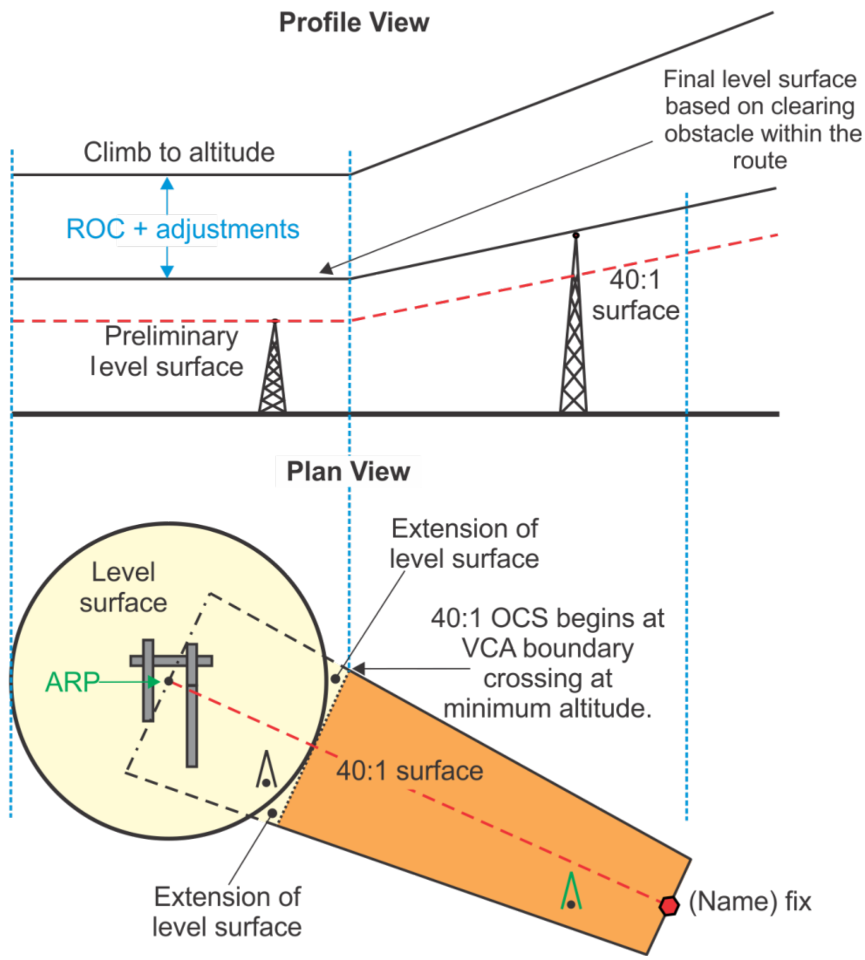
(2) Determine the preliminary level surface height by applying paragraph 13-4-3.a(1).

(3) Locate, within the VCA, the beginning point of the route. Construct the route using criteria for the navigation system desired.

(4) The 40:1 surface rise begins along a line perpendicular to the route course and tangent to the VCA boundary (see Figure 13-4-4). If the 40:1 OCS is penetrated, increase the VCA level surface by the amount of the greatest penetration.

(5) Determine the climb to altitude by applying paragraph 13-4-3.a(4).

Figure 13-4-4. Route Out of VCA



13-4-4. Ceiling and Visibility.

a. Publish visibility as 3 SM. Publish visibility as 5 SM when the climb to altitude is 10000 feet MSL or greater.

b. Publish a ceiling which is at least 100 feet above the "climb to altitude" expressed as a height above the airport elevation. The ceiling must be published in a 100-foot increment; round upward when necessary. The minimum ceiling that may be specified is 1000 feet.

13-4-5. Published Annotations. The procedure must include instructions to climb in visual conditions to cross a location/fix at or above the climb to altitude determined during the evaluation of the procedure.

a. For a VCOA diverse departure, include the term, "before proceeding on course" following the climb to altitude.

Example: "Climb in visual conditions to cross Castle Airport at or above 2200 before proceeding on course."

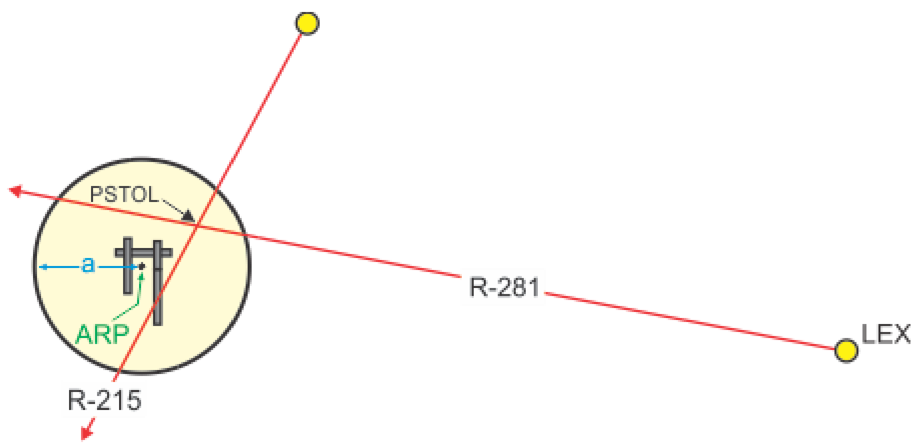
b. For a VCOA route departure, specify the intended direction of flight to cross the first fix of the route, followed by the climb to altitude, and then specify the route.

Example: "Climb in visual conditions to cross PSTOL eastbound at or above 5000, then via LEX R-281 to LEX"

c. Detail the makeup of any fix specified in the VCOA instructions that is not published on an en route or graphical ODP chart.

Example: "Climb in visual conditions to cross PEETE (AGC 040/2 DME) northbound at or above 2000…"

Figure 13-4-5. VCOA Departure Route



Section 13-5. Diverse Vector Area (DVA) Assessment

13-5-1. General. DVA is utilized by ATC radar facilities pursuant to Order JO 7210.3 to allow the radar vectoring of aircraft below the MVA, or for en route facilities, the MIA. A DVA consists of designated airspace associated with a runway where the utilization of applicable departure criteria have been applied to identify and avoid obstacles that penetrate the departure OCS. Avoidance of obstacles is achieved through the application of a sloping OCS within the boundaries of the DVA. Since a sloping OCS is applicable to climb segments, a DVA is valid only when aircraft are permitted to climb uninterrupted from the departure runway to the MVA/MIA (or higher). A DVA is not applicable once an aircraft's climb is arrested. A DVA is not authorized for a departure from a heliport.

a. Assess a single DVA at the request of an ATC facility for any candidate runway. Candidate runways are those runways where a diverse departure assessment has identified obstacles that penetrate the 40:1 OCS that require a climb gradient greater than 200 ft/NM to an altitude more than 200 feet above the DER elevation. Do not establish a DVA when obstacles do not penetrate the departure 40:1 OCS, or when the only penetrations are those that require a climb gradient termination altitude of 200 feet or less above the DER elevation (low, close-in obstacles).

b. A DVA is only applicable to the ATC facility (or facilities) that requested it. A maximum of two ATC facilities may use a DVA. When two facilities are authorized use of a DVA, ensure the OEA and all restrictions (such as range of headings, area, climb gradients, etc.) are identical.

c. No obstacles (except low, close-in) may penetrate OCS of the DVA unless isolated in accordance with paragraph 13-5-3.a (see paragraph 13-5-4).

DoD Only: DoD radar facilities may require the establishment of a DVA even in the absence of any 40:1 OCS penetrations.

13-5-2. Initial Departure Assessment. Assess the runway from which ATC desires to vector departing aircraft below the MVA/MIA using paragraph 13-2-1 to determine the location of 40:1 OCS penetrations which are not considered as low, close-in obstacles. The length of the ICA is based on a climb to 400 feet above the DER rounded to the nearest foot. When requested, provide the requesting ATC facility a graphical depiction of the departure penetrations to assist facility managers in visualizing the departure obstacle environment (not applicable to the USN).

13-5-3. Select a DVA Method. Establish a DVA that either: (a) isolates penetrating obstacles; (b) uses a range of authorized headings to define a sector; (c) climbs to an initial MVA/MIA within a range of headings, (d) defines an area which avoids penetrating obstacles; or (e) uses a combination of these methods.

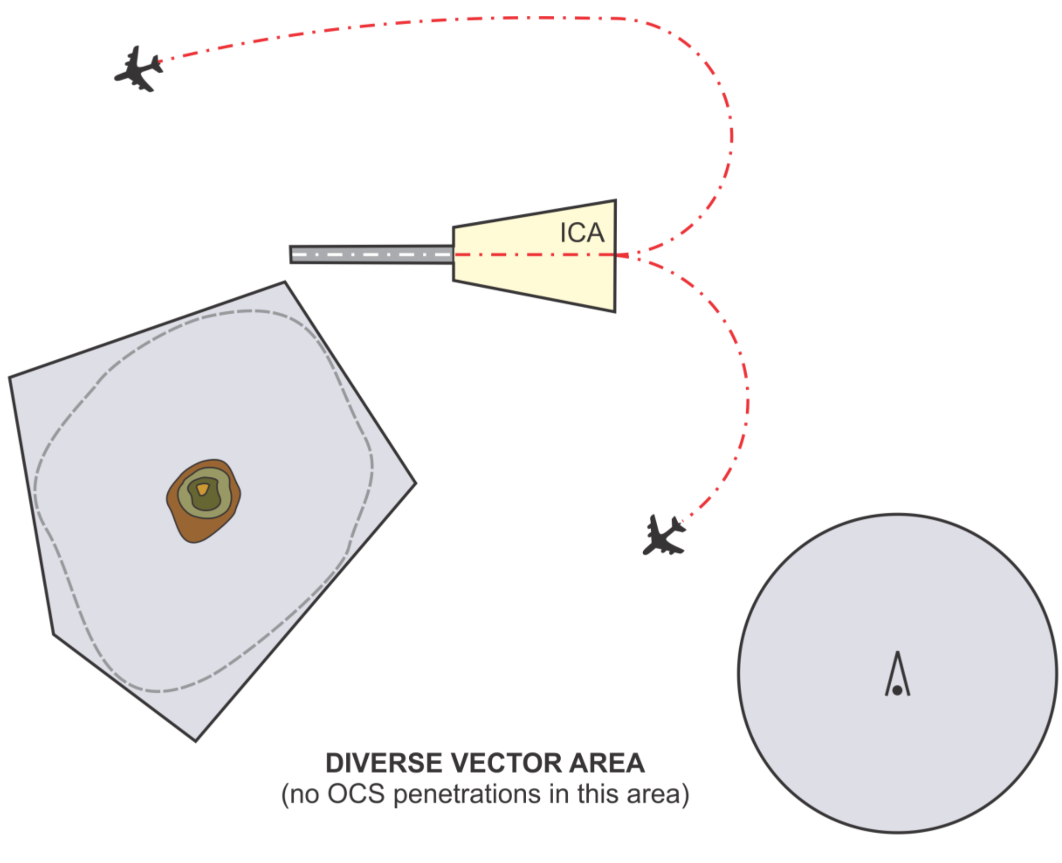
a. Isolate penetrating obstacles. This method is generally suitable for isolating single obstacles, or a group of obstacles in proximity to each other. Boundaries surrounding obstacles that penetrate a departure runway's OCS are established that define an area where vectors below the MVA/MIA are prohibited. Vectors below the MVA which avoid the isolation areas are permitted within the diverse departure evaluation area (25/46 NM from DRP as applicable), minus 5 NM to account for worst case radar separation requirements.

(1) Construct isolation area boundaries around all penetrating obstacles using the MVA sector construction specified in paragraph 11-3-2.b, except a DVA for an ARTCC must use an isolation boundary that provides 5 NM of separation from an obstacle. Consider the ease in constructing and documenting isolation area boundaries when determining the shape of an isolation area which surrounds multiple obstacles or terrain points (zone feature). For example, to simplify construction, documentation, and radar video mapping of an isolation area, it may be preferable to construct the area using only a circle or by using only a minimal series of points and lines. Figure 13-5-1 depicts an example with two isolation areas; one is a circle around a single obstacle and the other is defined by points and lines to define the prohibited area around a terrain contour of irregular shape.

(2) Isolation areas must not overlie any part of the departure runway between the DRP and the DER, nor any part of the ICA associated with the departure runway.

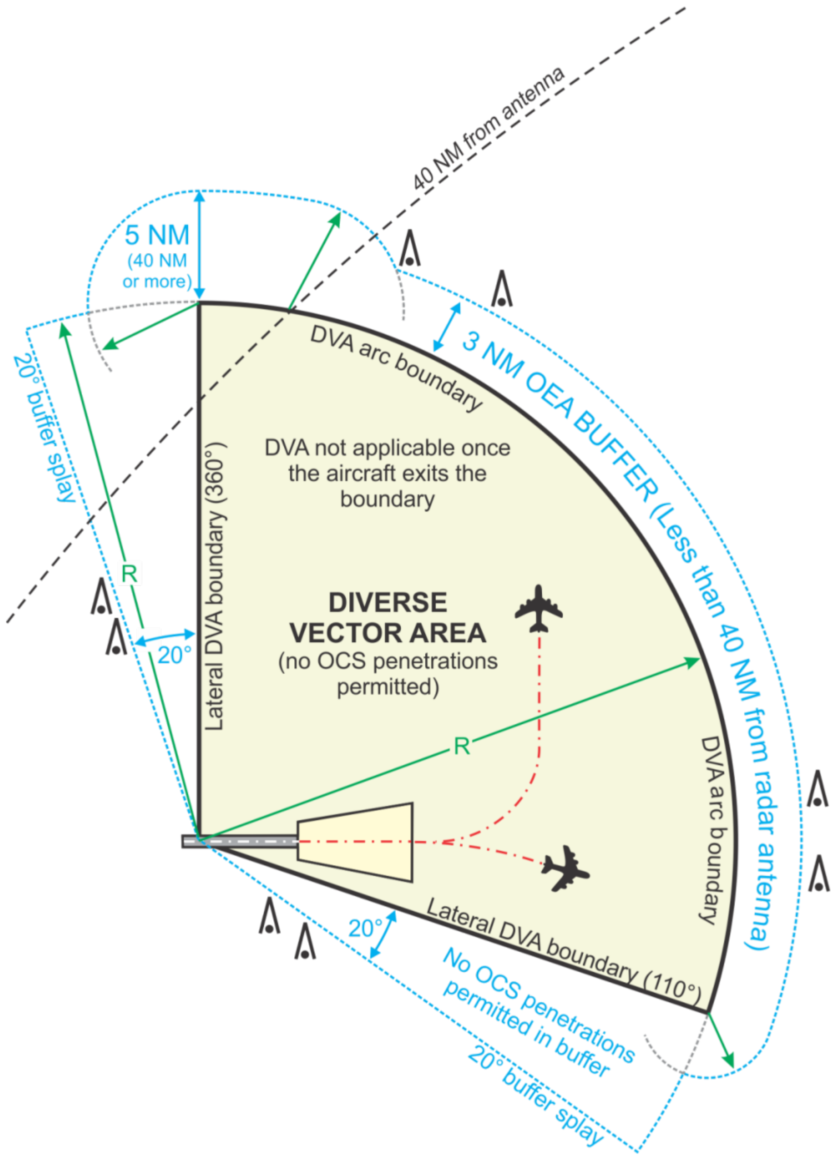
(3) Isolation areas must be located so that sufficient room to vector departing aircraft is provided which would allow ATC to issue vectors as necessary to avoid the areas. This determination must be made in collaboration with the air traffic facility.

Figure 13-5-1. Isolation Areas



b. Define a range of authorized headings. An ATC facility may desire the establishment of a DVA sector which is comprised of a range of authorized headings from the departure runway. For example, the DVA may permit the assignment of headings 360 clockwise through 110 within the DVA evaluation area. The assignment of radar vectors that exceed the authorized range of headings is not permitted until the aircraft reaches the MVA/MIA (see Figure 13-5-2).

Figure 13-5-2. Range of Headings Sector



(1) Construct lateral sector boundaries from the DRP which correspond to the desired headings using the Departure Sectors criteria of paragraphs 13-2-2 and 13-2-3, except the sector boundaries must diverge by a minimum of 30 degrees.

(2) Connect each lateral boundary with an arc centered on the DRP using radius "R" which is equivalent to the desired distance for the DVA.

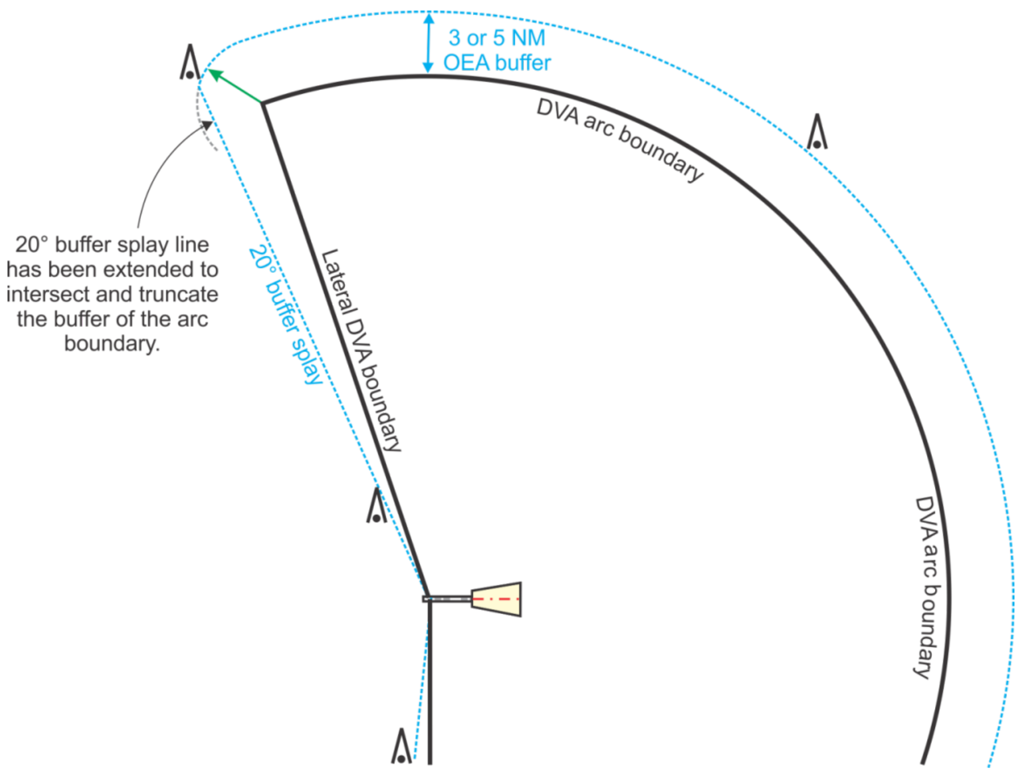
(3) An OEA buffer expands outward from the DVA boundaries. The buffer of the DVA arc boundary must meet the distance requirements of paragraph 11-3-2.a, except a 5-NM buffer always applies to a DVA that will be used by an ARTCC. The lateral buffers begin at DRP and splay outward from the lateral boundaries by 20 degrees.

(4) Connect the 20-degree buffer splay lines with the buffer of the arc boundary as follows:

(a) When the 20-degree splay line is outside the buffer of the arc boundary, join the two buffers with an arc centered on the DRP using radius "R" (see Figure 13-5-2).

(b) When the 20-degree splay line is inside the buffer of the arc boundary, extend the splay line until it intersects and truncates the buffer of the arc (see Figure 13-5-3).

Figure 13-5-3. Truncation of Lateral Boundary Buffer



(5) The DVA boundaries must provide sufficient maneuvering area to permit ATC to vector an aircraft to remain within the DVA until the aircraft can climb to the MVA/MIA. Determination of sufficient maneuvering area must be made in collaboration with the ATC facility.

c. Climb to an Initial MVA/MIA. ATC may request a DVA based on a range of headings to an initial MVA/MIA. For example, ATC may request a DVA in the form of, "009 CW 190 to 3500 ft." For a DVA of this type, it is necessary to obtain and refer to the currently approved MVA/MIA chart which depicts the sector boundaries and minimum altitudes (see Figure 13-5-4 through Figure 13-5-8).

Note: "Initial MVA/MIA" is defined as the altitude at which the DVA terminates and the MVA/MIA is used to provide radar vector service. It will be identified by the requesting ATC facility.

(1) Determine the preliminary 40:1 search boundary's radii (in feet); R_A and R_B.

(a) $R_A = (Initial\ MVA/MIA\ - DER\ Elevation - 951 - 304) \times 40$

(b) $R_B = (Initial\ MVA/MIA - Airport\ Elevation - 951 - 400) \times 40$

Note: 951 represents the least amount of ROC possible (after rounding) within an MVA sector.

Example calculation where MVA is equal to 3500 and DER equal to 618:

$$
\begin{aligned}
R_A &= (3500 - 618 - 951 - 304) \times 40 \\
&= 1627\ \times 40 \\
&= 65080
\end{aligned}
$$

(2) Construct a preliminary search area on the diverse A side of the departure reference line (DRL). Establish point Y and point Z at distance R_A from each corner of the ICAE in the direction of the departure along a line which is parallel to the runway centerline. Swing an arc with radius R_A centered on each corner of the ICAE from points Y and Z away from the runway centerline until it intersects the DRL. If the distance from the DRP to the intersection of the arc and the DRL is less than R_A, then the preliminary search area must be expanded. Expand the area by establishing Points W and X along the DRL at a distance equal to R_A and tangentially connect each arc to each respective point (see Figure 13-5-5). Complete the search area with a line that connects point Y to point Z (see Figure 13-5-4 and Figure 13-5-5).

(3) Construct a preliminary search area on the diverse B side of the DRL using the radius R_B. Swing a 180-degree arc centered on the DRP beginning at the DRL to encompass the start end of the runway (see Figure 13-5-4).

Figure 13-5-4. Preliminary Search Area Boundary

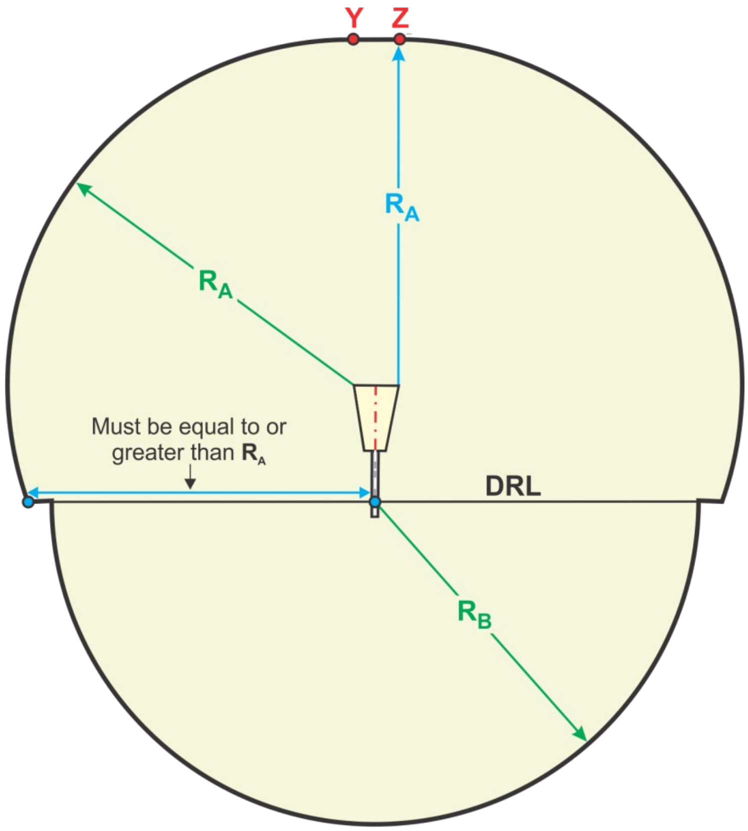
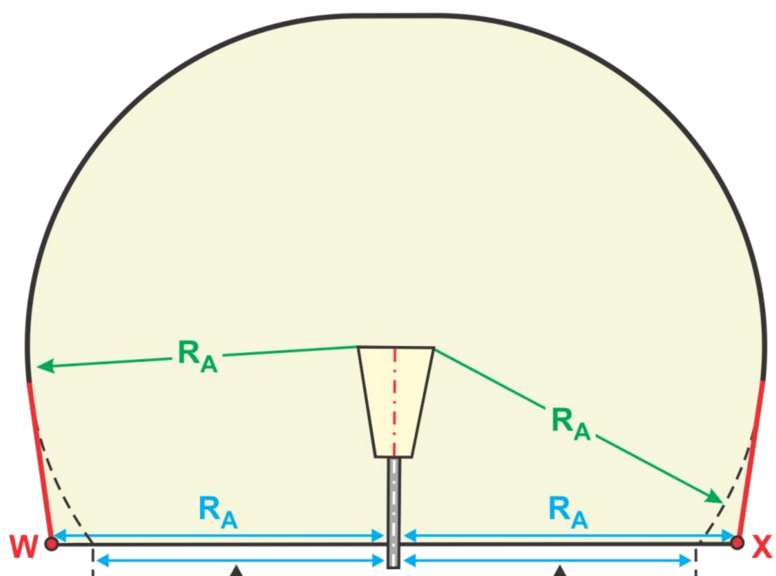


Figure 13-5-5. Construction with Points W and X



When distance from DRP to intersection of DRL and arc is less than R_A, then points W and X must be established along the DRL at a distance equal to R_A. Connect each point tangentially to each respective arc.

(4) Identify all 40:1 OCS penetrations (other than low, close-in) located within the preliminary search area boundaries, or 3/5 NM (appropriate MVA buffer distance per Chapter 11, or 5 NM for an MIA) beyond the next higher MVA/MIA sector boundary, whichever is encountered first (see Figure 13-5-6 and Figure 13-5-7).

(5) Establish lateral boundaries and associated buffers that avoid the 40:1 penetrations using the departure sectors criteria of paragraph 13-2-2. The maximum range of permitted headings (for example, 310 CW to 050) corresponds to the lateral boundaries. All headings are available when no 40:1 penetrations are located within the search area boundaries. The final OEA includes those areas within the boundaries of the search area located between the 20-degree splay lines (see Figure 13-5-8).

Figure 13-5-6. MVA Chart With Applicable Buffer Areas

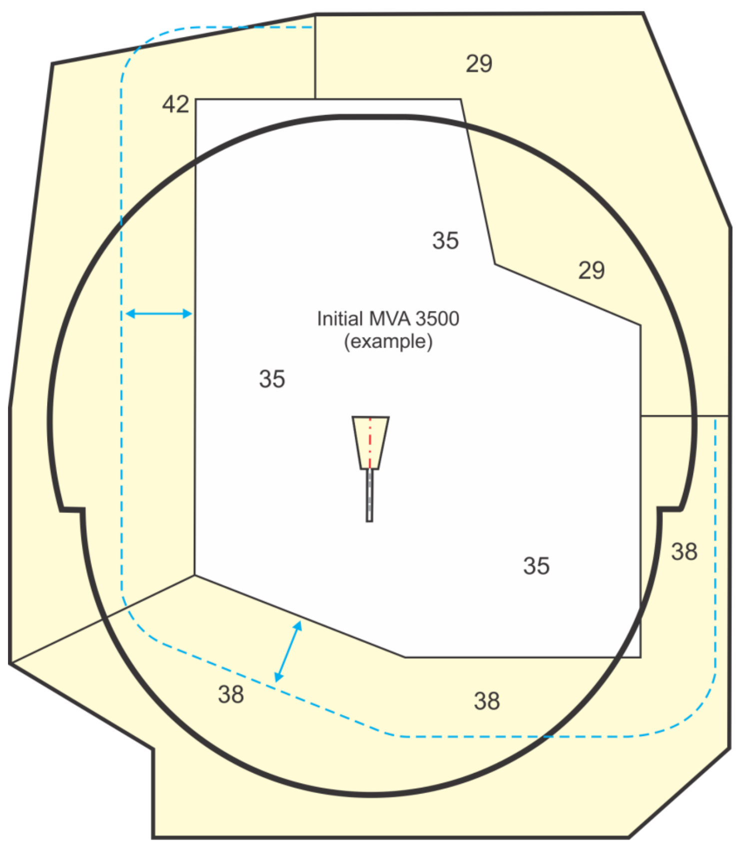


Figure 13-5-7. Obstacle Search Area

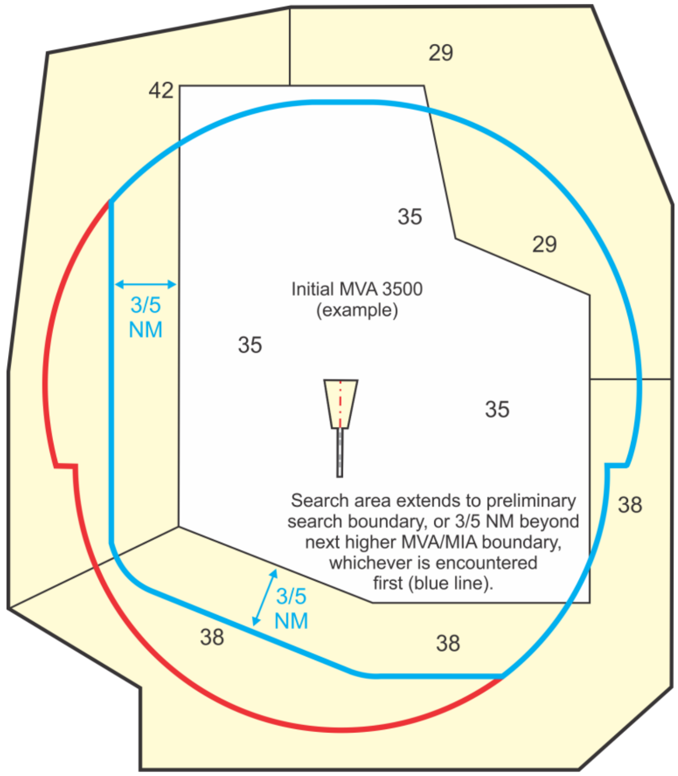
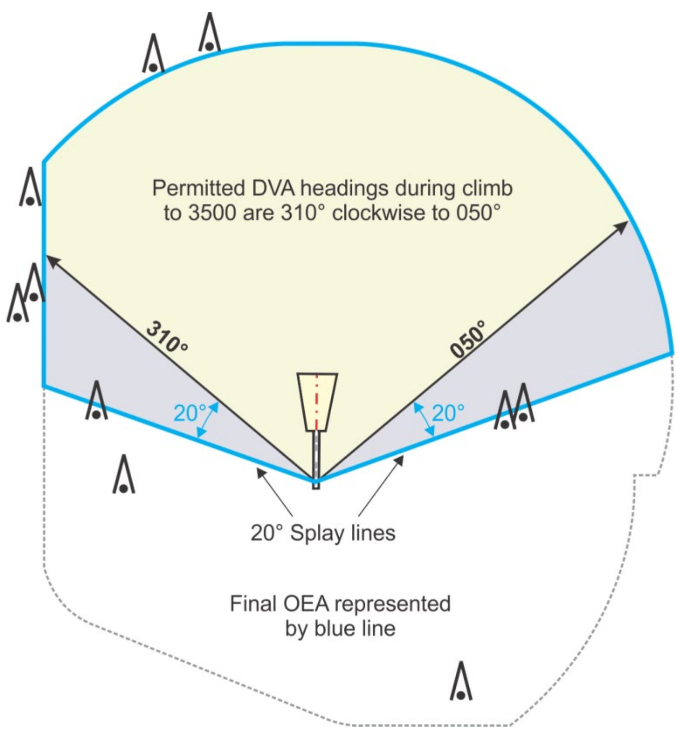


Figure 13-5-8. Permitted DVA Headings Based on Obstacles

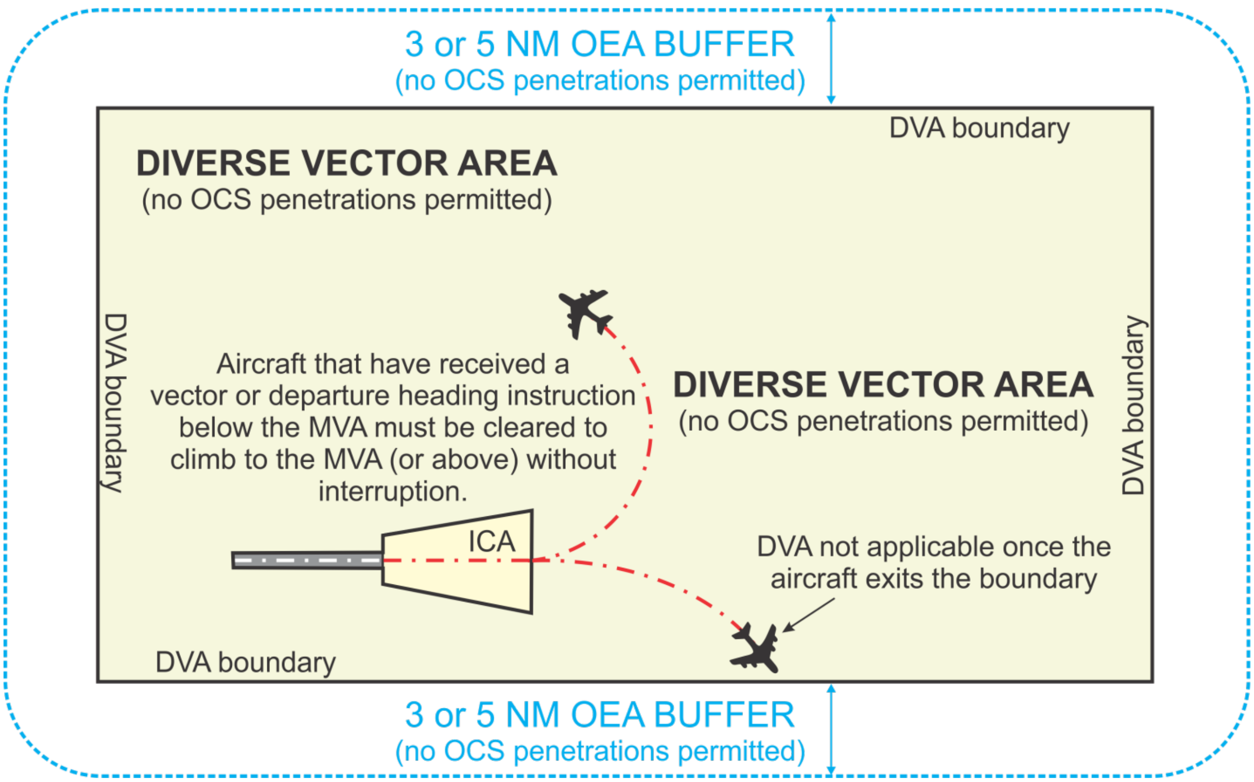


d. Define an area. An area may be defined which excludes all obstacles (low, close-in obstacles are permitted) that penetrate the departure OCS (see Figure 13-5-9).

(1) Construct the area boundary and an OEA buffer using the MVA sector construction specified in Section 11-3. The defined area may take the form of any shape; however, it must be determined in consultation with the ATC facility to ensure it meets their operational needs and to ensure it provides sufficient maneuvering area for ATC to vector an aircraft to remain within the DVA until the aircraft can climb to the MVA/MIA.

(2) The area boundary must fully encompass the entire width of the departure runway from the DRP towards the DER, as well as the entire ICA associated with the departure runway.

Figure 13-5-9. Defined Area



13-5-4. Climb Gradients. A DVA that does not require a climb gradient in excess of 200 ft/NM is preferred; however, operational requirements may necessitate a higher climb gradient. When an obstacle penetrates the 40:1 OCS within the DVA OEA, establish a climb gradient and climb gradient termination altitude in accordance with paragraph 13-1-4.

Note: Do not establish climb gradients for low, close-in obstacles or for obstacle that have been isolated in accordance with paragraph 13-5-3.a.

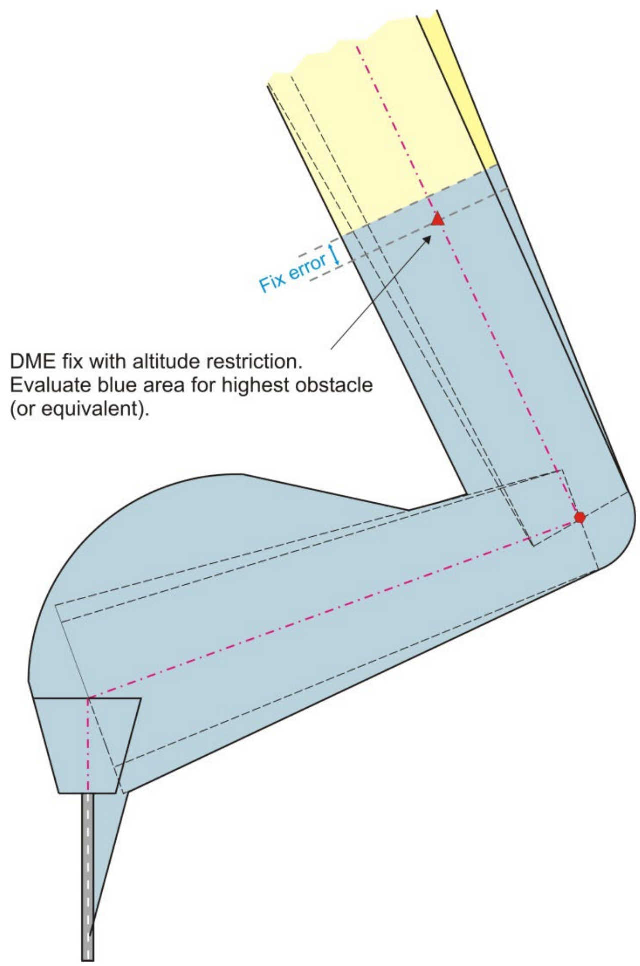
Section 13-6. Obstacle Clearance Requirements for SID Containing ATC Altitude Restrictions

13-6-1. Maximum Altitude Restrictions. A level surface obstacle evaluation must be conducted whenever a maximum, mandatory, or block altitude restriction is charted on a SID. The maximum altitude, the mandatory altitude, and the upper limit of a block altitude, must provide the en route ROC specified in paragraph 14-2-1.

a. Identify the highest obstacle in the primary area, or if applicable, the highest equivalent obstacle in the secondary area, within the OEA located prior to the latest point the fix with the altitude restriction could be received.

(1) When no turn is required at the fix with the altitude restriction, evaluate the OEA prior to a line drawn perpendicular to the latest point the fix could be received (see Figure 13-6-1).

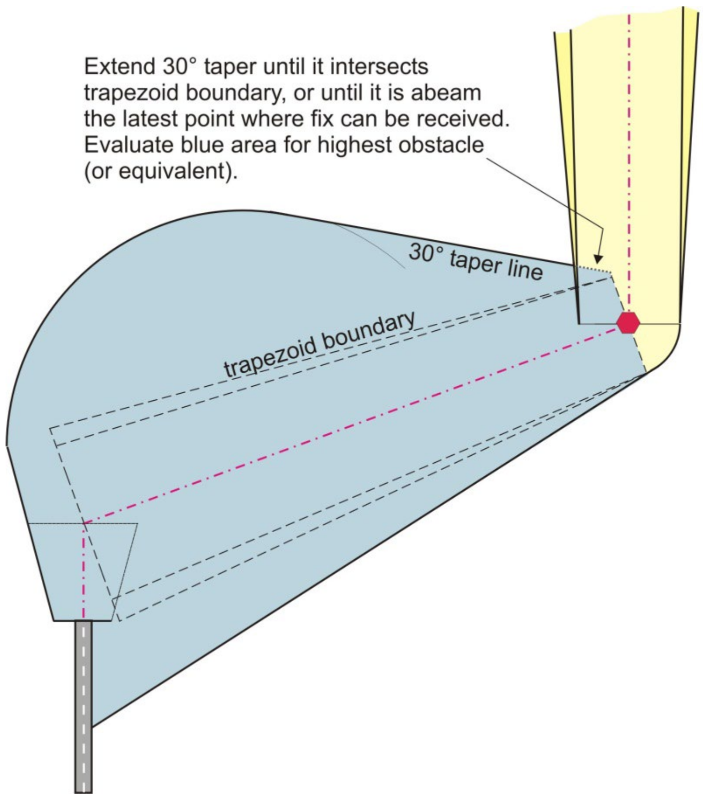
Figure 13-6-1. No Turn Required at Fix



(2) When a turn is required at the fix with the altitude restriction, the evaluation area includes the trapezoid leading to the turn fix as well as any expansion areas. Where an expansion

area has not completed its 30-degree taper from a previous turn, extend the taper line until it intersects the trapezoid boundary or until it is abeam the latest point at which the fix can be received, whichever occurs first, and include that area as part of the OEA (see Figure 13-6-2).

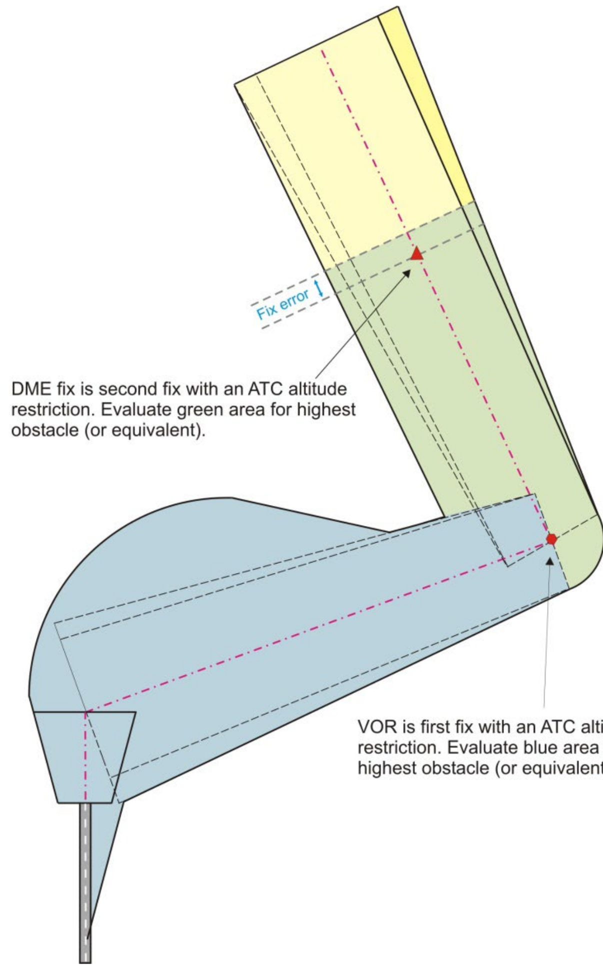
Figure 13-6-2. Turn Required at Fix with Incomplete Taper



b. Determine the level flight OCS elevation by subtracting the appropriate en route ROC from the maximum altitude authorized at the fix. The maximum altitude authorized for a fix is the singular altitude specified for either a maximum altitude restriction or a mandatory altitude restriction, and the upper limit of a block altitude restriction. The obstacle identified through application of paragraph 13-6-1.a must not penetrate the level OCS.

c. Where multiple maximum, mandatory, or block altitude restrictions are necessary, each maximum altitude authorized at a fix must be equal to or higher than the maximum altitude authorized at a proceeding fix. Evaluate additional altitude restrictions in the same manner as the first, by applying a level OCS to the OEA until the latest point at which the fix with the altitude restriction could be received. Those portions of the OEA previously assessed in association with a preceding altitude restriction need not be assessed again (see Figure 13-6-3).

Figure 13-6-3. Multiple Altitude Restrictions



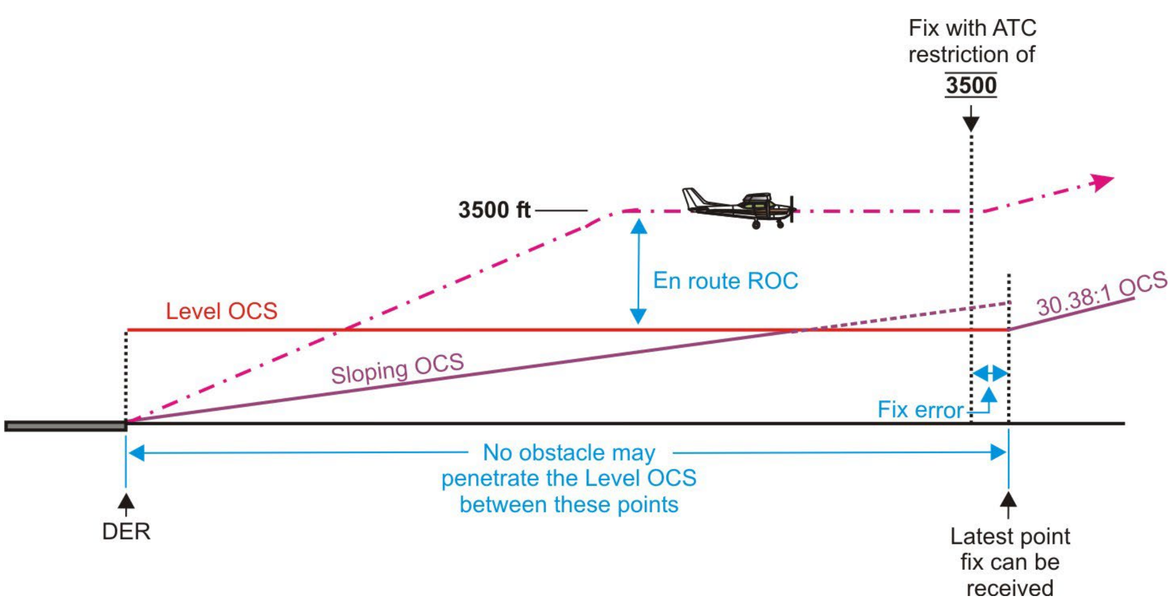
d. Sloping OCS. Compare the height of the level surface and height of the sloping OCS at the plotted position of the fix with the maximum altitude restriction.

(1) Where the height of the level OCS is equal to or greater than the height of the sloping OCS, continue the sloping surface uninterrupted into the next segment of the departure (see Figure 13-6-4).

Figure 13-6-4. Continuation of Sloping OCS

(2) Where the height of the level OCS is less than the height of the sloping OCS, apply a 30.38:1 sloping OCS into the next segment from the primary area boundary of the level OEA. The 30.38:1 OCS originates at the same height as the level OCS. Penetrations may not be mitigated by a climb gradient; if penetrations exist, the maximum altitude authorized at the fix with the altitude restriction must be increased until the penetration is eliminated (see Figure 13-6-5).

Figure 13-6-5. Sloping OCS Applied from Level OCS



13-6-2. Minimum Altitudes. When ATC requests the establishment of a minimum altitude, either stand-alone or as part of a block altitude, ensure the minimum climb gradient for the procedure is sufficient to either meet or exceed the restriction.

Section 13-7. Helicopter Point-in-Space (PinS) Departures

13-7-1. General. PinS departures may be conducted from VFR heliports, unmarked landing areas, and VFR runways not served by an ODP. PinS departures are designed to allow a pilot to navigate to a point where IFR flight may commence. For RNAV PinS departures, refer to Order 8260.58.

a. Only proceed VFR departures are authorized for non-RNAV ground-based PinS departures. IFR obstruction clearance does not begin until reaching the IDF flat surface.

b. An IDF must be established no more than 10 NM from the helipad. PCG and obstruction clearance is not provided from the helipad to the IDF. The dimensions of the flat surface area are dependent on the navigation system being flown (see Table 13-3-1).

c. The DP consists of an IDF flat surface area, which is a level surface area to initiate the DP. Section 1 begins from the IDF flat surface area in the direction of flight at full width utilizing primary and secondary areas. Section 2 begins at the end of Section 1 and continues until the DP is terminated or transition segments begin.

d. When developing routes with multiple segments or more than one navigation system, apply Section 13-3 development standards.

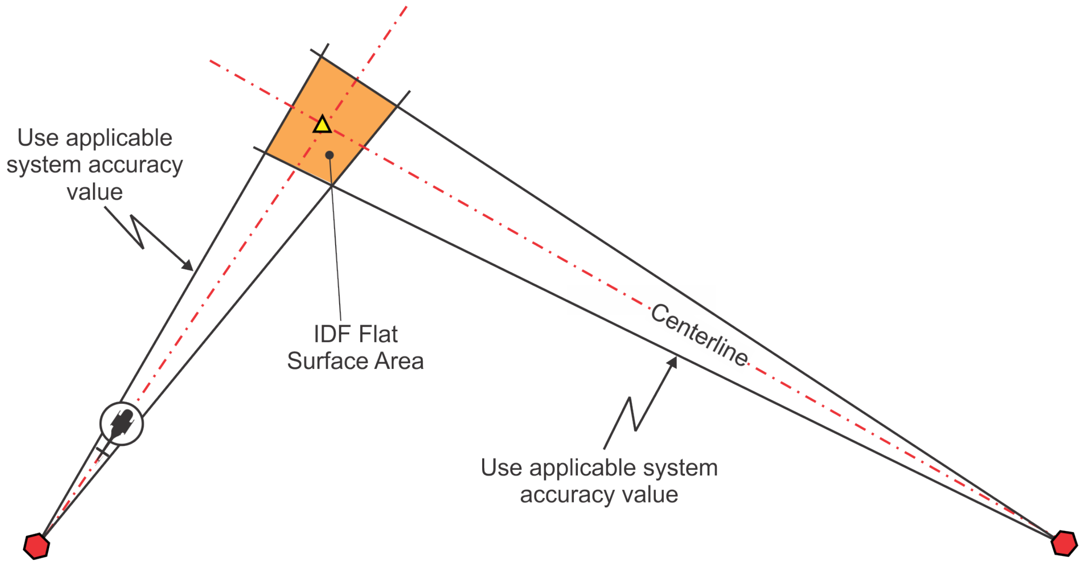
e. The DP must join the en route structure at an altitude that permits en route flight to include airspace and obstacle clearance. It is not mandatory that the DP join an airway, but the DP altitude must allow for continued level flight in all directions. If unable, raise the DP altitude or place restrictions on the DP.

13-7-2. Procedure Design Standards. Utilize the following standards for procedure design.

a. Utilize standard climb airspeed of 80 KIAS and bank angle of 13 degrees until reaching the desired target altitude. After reaching the desired target altitude, evaluate at an airspeed of 140 KIAS and bank angle of 15 degrees.

b. IDF flat surface area dimensions are based on the type of non-RNAV ground based navigation system being flown. Use the appropriate width from Table 13-3-1, to include both primary and secondary areas. The length is based on the governing facility obstruction area values or 1/2 NM for DME.

Figure 13-7-1. IDF Flat Surface



c. Standard ROC of 250 plus adjustments (altimeter, precipitous terrain) is applied in level surface areas.

d. Precipitous terrain evaluation is applied in the IDF flat surface area.

e. Altimeter setting adjustments are applied for altimeter sources more than 5 NM from the IDF fix to the altimeter source.

f. A 20:1 slope for the primary area and a 12:1 slope for the secondary area are applied after the flat surface area.

13-7-3. Obstacle Evaluation Area (OEA). Apply obstacle evaluation as shown in Figure 13-3-13 or Figure 13-3-14. The starting OIS is the IDF flat surface area OIS elevation. Continue the evaluation utilizing a 20:1 slope throughout the procedure.

Appendix A. Administrative Information

1. **Distribution.** This order is distributed electronically only.

2. **Acronyms and Abbreviations.** Many acronyms and abbreviations for old and new aviation terms are used throughout this order. Definitions can be found in the Aeronautical Information Manual and/or within Appendix B of this order. Users of this order can refer to the following alphabetical listing of frequently used acronyms and abbreviations (see Table A-1).

Table A-1. Acronyms and Abbreviations

ACT	Average Cold Temperature
ADF	automatic direction finder
AGL	above ground level
ALSF-1	approach lighting system with sequenced flashing lights (CAT I configuration)
ALSF-2	approach lighting system with sequenced flashing lights (CAT II configuration)
APV	approach with vertical guidance
AR	authorization required
ARA	airborne radar approach
ARC	airport reference code
ARP	airport reference point
ARSR	air route surveillance radar
ASOS	automated surface observing system
ASR	airport surveillance radar
ATC	Air Traffic Control
ATD	along track distance
ATRK	along track
ATS	Air Traffic Service
Baro VNAV	barometric vertical navigation
BC	back course
CAT	category
CDA	continuous descent approach
CF	course to fix
CFR	Code of Federal Regulations
CG	climb gradient
COP	changeover point
CVFP	Charted Visual Flight Procedure
CW	course width
DA	decision altitude
DER	departure end of runway
DF	direct to fix (RNAV)
DG	descent gradient
DH	decision height
DME	distance measuring equipment
DoD	Department of Defense
DP	departure procedure
DR	dead reckoning
DRL	departure reference line
DRP	departure reference point
DTA	distance turn anticipation
DVA	diverse vector area
ESA	emergency safe altitudes
FAC	final approach course
FAS	final approach segment
FATO	final approach and takeoff area
FAWP	final approach waypoint
FEP	final end point
FL	flight level
FMS	flight management system
FPAP	flight path alignment point
FPCP	flight path control point
FROP	final roll-out point
FSS	Flight Service Station
FTE	flight technical error
FHP	fictitious helipoint
FTP	fictitious threshold point
GARP	GNSS azimuth reference point
GBAS	Ground Based Augmentation System
GH	geoid height
GLS	GBAS Landing System
GNSS	Global Navigation Satellite System
GP	glidepath
GPA	glidepath angle
GPI	ground point of intercept
GPS	Global Positioning System
HAA	height above airport

HAE	height above ellipsoid
HAL	height above landing
HAS	height above surface
HCH	helipoint crossing height
HDRP	heliport departure reference point
HF	high frequency
HIRL	high intensity runway lights
HRP	heliport reference point
IAF	initial approach fix
IAP	instrument approach procedure
ICA	initial climb area
ICAB	ICA baseline
ICAE	ICA end-line
ICAO	International Civil Aviation Organization
IDF	initial departure fix
IF	intermediate fix
IAF	initial approach fix
IFP	Instrument flight procedure
IFR	instrument flight rules
ILS	instrument landing system
IMC	instrument meteorological conditions
INS	inertial navigation system
IRU	inertial reference unit
ISA	International Standard Atmosphere
IVH	IFR to VFR heliport
kHz	kilohertz
KIAS	knots indicated airspeed
LAAS	Local Area Augmentation System
LDA	localizer type directional aid
LF	low frequency
LIRL	low intensity runway lights
LNAV	lateral navigation
LOC	localizer
LOM	locator outer marker
LP	localizer performance
LPV	localizer performance with vertical guidance
LHP	landing helipoint
LTP	landing threshold point
MALS	medium intensity approach lighting system
MALSF	medium intensity approach lighting system with sequenced flashing

MALSR	medium intensity approach lighting system with runway alignment indicator lights
MAP	missed approach point
MCA	minimum crossing altitude
MDA	minimum descent altitude
MEA	minimum en route IFR altitude
MHA	minimum holding altitude
MHz	megahertz
MIA	minimum IFR altitudes
MIRL	medium intensity runway lights
MMLS	mobile microwave landing system
MOCA	minimum obstruction clearance altitude
MRA	minimum reception altitude
MSA	minimum safe altitude
MSL	mean sea level
MSS	Mission Support Services
MTA	minimum turn altitude
MVA	minimum vectoring altitude
MVAC	minimum vectoring altitude chart
NAD	North American Datum
NAS	National Airspace System
NAVAID	navigational aid
NDB	nondirectional radio beacon
NM	nautical mile
NoPT	no procedure turn
NOTAM	Notices to Airmen
NOZ	normal operating zone
NPA	Non-precision approach
NTZ	no transgression zone
NWS	National Weather Service
OCS	obstacle clearance surface
ODALS	omnidirectional approach lighting system
ODP	obstacle departure procedure
OEA	obstruction evaluation area
OIS	obstacle identification surface
OM	outer marker
PA	precision approach
PAPI	precision approach path indicator

PAR	precision approach radar
PBN	performance based navigation
PCG	positive course guidance
PFAF	precise final approach fix
PinS	point-in-space
PRM	precision runway monitor
PT	procedure turn
RA	radio altimeter
RAIL	runway alignment indicator lights
RASS	remote altimeter setting source
RCL	runway centerline
RDP	reference datum point
REIL	runway end identifier lights
RF	radius-to-fix
RNAV	area navigation
RNP	required navigation performance
ROC	required obstacle clearance
RPI	runway point of intercept
RRP	runway reference point
RTRL	reduced takeoff runway length
RVR	runway visual range
RWY	runway
SA	Special Authorization
SALS	short approach lighting system
SDF	simplified directional facility
SER	start end of runway
SID	standard instrument departure
SOIA	simultaneous offset instrument approach
SM	statute mile
SSALF	simplified short approach lighting system with sequenced flashers
SSALR	simplified short approach lighting system with runway alignment indicator lights
STAR	standard terminal arrival route
TAA	terminal arrival area
TACAN	tactical air navigational aid
TCH	threshold crossing height
TDZ	touchdown zone
TDZE	touchdown zone elevation
TDZL	touchdown zone lights (system)
TERPS	terminal instrument procedures
TF	track to fix
TLOF	touchdown and lift-off area
TP	tangent point
TPD	tangent point distance
UHF	ultra high frequency
USA	U.S. Army
USAF	U.S. Air Force
USCG	U.S. Coast Guard
USN	U.S. Navy
VASI	visual approach slope indicator
VCA	visual climb area
VCOA	visual climb over airport
VDA	vertical descent angle
VDP	visual descent point
VFR	visual flight rules
VGS	vertical guidance surface
VGSI	visual glide slope indicator
VHF	very high frequency
VMC	visual meteorological conditions
VNAV	vertical navigation
VOR	very high frequency omnidirectional radio range
VOR/DME	very high frequency omnidirectional radio range collocated with distance measuring
VORTAC	very high frequency omnidirectional radio range collocated with tactical air navigational aid
VPA	vertical path angle
VSCA	visual segment climb angle
VSDA	visual segment descent angle
VSDP	visual segment descent point
VSRL	visual segment reference line
WAAS	Wide Area Augmentation System
WCH	wheel crossing height

3. Related Publications.

a. Code of Federal Regulations.

(1) 14 CFR part 1, Definitions and Abbreviations.

(2) 14 CFR part 77, Objects Affecting Navigable Airspace.

(3) 14 CFR part 91, General Operating and Flight Rules.

(4) 14 CFR part 95, IFR Altitudes.

(5) 14 CFR part 97, Standard Instrument Procedures.

(6) 14 CFR part 171, Non-Federal Navigation Facilities.

b. FAA Advisory Circulars.

(1) AC 70/7460-1, Obstruction Marking and Lighting.

(2) AC 150/5300-13, Airport Design.

(3) AC 150/5340-1, Standards for Airport Markings.

c. FAA Directives.

(1) Order 6050.32, Spectrum Management Regulations and Procedures Manual.

(2) Order 6560.10, Runway Visual Range.

(3) Order JO 7210.3, Facility Operations and Administration.

(4) Order JO 7210.37, En Route Minimum Instrument Flight Rule (IFR) Altitude (MIA) Sector Charts.

(5) Order JO 7400.2, Procedures for Handling Airspace Matters.

(6) Order 8200.1, U.S. Standard Flight Inspection Manual.

(7) Order 8260.19, Flight Procedures and Airspace.

(8) Order 8260.43, Flight Procedures Management Program.

(9) Order 8260.46, Departure Procedures (DP) Program.

(10) Order 8260.58, United States Standard for Performance Based Navigation (PBN) Instrument Procedure Design.

(11) Order 9840.1, U.S. National Aviation Handbook for the VOR/DME/TACAN Systems.

4. Forms and Reports. FAA Form 8260-2, Radio Fix and Holding Data Record.

5. Information Update. For your convenience, FAA Form 1320-19, Directives Feedback Information, is included at the end of this order to note any deficiencies found, clarification needed, or suggested improvements regarding the contents of this directive. When forwarding your comments to the originating office for consideration, please provide a complete explanation of why the suggested change is necessary.

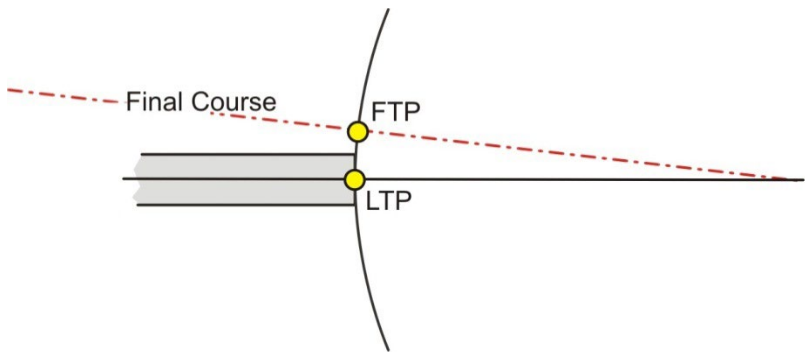
77. Knots indicated airspeed. The speed shown on the aircraft airspeed indicator.

78. Landing area as used in helicopter operations. The portion of the heliport or airport runway used or intended to be used for the landing and takeoff of helicopters.

79. Landing area boundary. The beginning of the landing area of the heliport or runway.

80. Landing threshold point. The LTP is the intersection of the runway centerline and the runway threshold. It is defined by latitude/longitude coordinates, and MSL elevation. LTP elevation applies to the FTP when the final approach course is offset from runway centerline (see Figure B-3).

Figure B-3. Landing Threshold Point and Fictitious Threshold Point



81. Lateral navigation. LNAV is RNAV lateral navigation. This type of navigation is associated with NPA because vertical path deviation information is not provided. LNAV criteria are the basis of the LNAV minima line on RNAV GPS approach procedures.

82. Lateral/Vertical Navigation. An APV evaluated using the Baro VNAV obstacle clearance surfaces conforming to the lateral dimensions of the LNAV OEA.

83. Leg. A subdivision of an RNAV IFP defined by a path and a terminator. Also used in reference to the length of holding patterns.

84. Localizer. The component of an ILS which provides lateral guidance with respect to the runway centerline.

85. Localizer performance. An LP approach is an RNAV NPA procedure evaluated using the lateral obstacle evaluation area dimensions of the precision localizer trapezoid, with adjustments specific to the WAAS. These procedures are published on RNAV GPS approach charts as the LP minima line.

86. Localizer type directional aid. A facility of comparable utility and accuracy to a LOC, but which is not part of a full ILS and may not be aligned with the runway.

87. Minimum descent altitude. The lowest altitude, expressed in feet above mean sea level, to which descent is authorized on final approach where no glide slope is provided, or during a circle-to-land maneuver.

88. Minimum en route IFR altitude. The lowest published altitude between radio fixes which assures acceptable navigational signal coverage, air-to-ground communications, and which meets obstacle clearance requirements. The MEA prescribed for a Federal airway or segment thereof, area navigation low or high route, or other direct route applies to the entire width of the airway, segment, or route between the radio fixes defining the airway, segment, or route.

89. Minimum obstruction clearance altitude. The lowest published altitude between fixes on an ATS route or STAR which meets obstacle clearance requirements for the entire segment.

90. Non-directional beacon airborne automatic direction finder. A combined term which indicates that an NDB provides an electronic signal for use with ADF equipment.

91. Non-VOR/DME RNAV. It is not dependent upon a reference. It utilizes positioning inputs from DME/DME, DME/DME/IRU, or GNSS. A Multi-Sensor System based on any VOR/DME or non-VOR/DME certified approved system or a combination of certified approved systems may also provide positioning inputs.

92. Obstacle. An object, structure, terrain feature, or vegetation, at a fixed geographical location, or which may be expected at a fixed location within a prescribed area, with reference to which vertical clearance must be provided during flight operation. With reference to mobile objects, a moving vehicle 17 feet high is assumed to be on an Interstate Highway, 15 feet high for any other public roadway, 10 feet high on private roads, and 23 feet high on a railroad track, except where limited to certain heights controlled by use or construction. The tallest point of a watercraft (for example, the mast) is assumed according to the types of watercraft known to use an anchorage or to transit a waterway. Includes taxiing aircraft except where operational restrictions prevent taxi operations during takeoff and landings. Any mobile object may be ignored provided positive controls are applied by the airport authority or by air traffic control to exclude their presence during flight operations.

93. Obstacle clearance. The vertical distance between the lowest authorized flight altitude and a prescribed surface within a specified area.

94. Obstacle clearance surface. A level or sloping surface used for obstacle evaluation. The separation between this surface and specified minimum altitude, glidepath angle or minimum required climb path defines the MINIMUM required obstruction clearance at any given point.

95. Obstacle evaluation area. An area with defined limits that is subjected to obstacle evaluation through the appropriate OCS or OIS application standard.

96. Obstacle identification surface. A surface with an OEA of defined limits used for identification of obstacles that may require mitigation to maintain the required level of safety for the applicable segment.

97. Obstacle positions ($OBS_{X,Y,Z}$). $OBS_{X,Y,Z}$ are the along track distance to an obstacle from the LTP, the perpendicular distance from the centerline extended, and the MSL elevation, respectively, of the obstacle clearance surfaces.

121. Service volume. That volume of airspace surrounding a VOR, TACAN, or VORTAC facility within which a signal of usable strength exists and where that signal is not operationally limited by co-channel interference. The advertised service volume is defined as a simple cylinder of airspace for ease in planning areas of operation.

122. Slant-range. The actual distance from the aircraft to the DME facility.

123. Slant-range/geographical distance. The slant-range distance at a given altitude converted to geographical distance across the ground.

124. Start end of runway. The beginning of the takeoff runway available.

125. Standard instrument departure. A preplanned IFR ATC departure procedure printed for pilot/controller use in graphic form to provide obstacle clearance and a transition from the terminal area to the appropriate en route structure. SIDs are primarily designed for system enhancement to expedite traffic flow and to reduce pilot/controller workload. ATC clearance must always be received prior to flying a SID.

126. Standard terminal arrival. A preplanned IFR ATC arrival procedure published for pilot use in graphic and/or textual form. STARs provide transition from the en route structure to an outer fix or an instrument approach fix/arrival waypoint in the terminal area.

127. Start of climb. The SOC is a point located at a calculated flat-surface length distance from the decision altitude for LNAV/VNAV or the missed approach point for LNAV and LP or at the end of section 1 for LPV/GLS procedures.

128. Tangent point. The point on the VOR/DME RNAV route centerline from which a line perpendicular to the route centerline would pass through the reference facility.

129. Tangent point distance. Distance from the reference facility to the TP.

130. Threshold crossing height. The height of the glidepath above the threshold of the runway measured in feet. The LPV glidepath originates at the TCH value above the LTP.

131. Touchdown and lift-off area. A TLOF is a load bearing, generally paved area, normally centered in the FATO, on which the helicopter touches down or lifts off from.

132. Touchdown zone. The first 3000 feet of runway beginning at the threshold. For helicopter procedures it is identical to the landing area.

133. Touchdown zone elevation. The highest runway centerline elevation in the first 3000 feet of the landing surface (touchdown zone).

134. Track to fix leg. A TF leg is a geodesic path between two fixes. The resulting track is wind corrected.

135. Transition level. The altitude below which heights are expressed in feet MSL and are based on an approved station altimeter setting. The transition level in the United States is 18000

MSL. Altitudes at and above the transition level are expressed in FL. For example, 11000 feet, 17900 feet, FL 180, FL 230, etc.

136. True airspeed. The airspeed of an aircraft relative to undisturbed air. KTAS is the KIAS corrected for air density error. KTAS increases with altitude when KIAS remains constant.

137. Turn anticipation. The capability of RNAV airborne equipment to determine the location of the point along a course, prior to a FB fix which has been designated a turn fix, where a turn is initiated to provide a smooth path to intercept the succeeding course.

138. Turn fix. A FB or FO fix denoting a course change.

139. Turn initiation area. The straight portion of a missed approach OEA whose end is identified by a turn at a specified altitude.

140. Turn WP. A WP which identifies a change from one course to another.

141. Unmarked landing area. A designated landing location within the NAS identified by an airport identifier and a set of coordinates. Utilized for helicopter PinS procedures which have no visual reference for the pilot.

142. Vertical descent angle. An advisory angle provided on most nonprecision approach procedures representing the calculated descent angle from the PFAF (or stepdown fix). The VDA is intended to assist the pilot in maintaining a stable vertical path within the final segment.

143. Vertical error budget. The VEB is a set of allowable values that contribute to the total error associated with a VNAV system. Application of equations using the VEB values determines the minimum vertical clearance that must exist between an aircraft on the nominal glidepath and ground obstructions within the OEA of instrument procedure segments. When the VEB is used in final segment construction, its application determines the OCS origin and slope ratio.

144. Visual climb area. Areas around the ARP to develop a VCOA procedure.

145. Visual climb over airport. Option to allow an aircraft to climb over the airport with visual reference to obstacles to attain a suitable altitude from which to proceed with an IFR departure.

146. Visual descent point. The VDP is a defined point on the final approach course of a non-precision straight-in approach procedure from which normal descent from the MDA to the runway touchdown point may be commenced, provided visual reference is established.

147. Vertical guidance surface. The VGS is a narrow inclined plane centered on the runway centerline that is evaluated for obstructions between the DA/VDP and LTP for all straight-in aligned approach procedures.

148. Visual glide slope indicator. The VGSI is an airport lighting aid that provides the pilot with a visual indication of the aircraft position relative to a specified glidepath to a touchdown point on the runway. PAPI and VASI are examples of VGSI systems.

Appendix H. Fix Location Adjustment for High Temperature Compensation

At locations where higher than standard temperatures may cause glideslope intercept at a specified altitude to occur prior to the fix or may cause aircraft on the glideslope prior to the PFAF to cross fixes with indicated altitudes below the fix crossing altitudes the following methodology may be used to compensate for those effects by adjusting the fix location to insure intercept does not occur prior to the fix when temperatures are as high as the three (3) to five (5) year average airport high temperature.

1. **Airport average high temperature.** To determine the 3-5 year average airport high temperature:

a. Source. The National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center (NCDC) is the official government source for historical temperature data.

b. Reporting period. Reporting periods are established in calendar years (January through December) and must have a complete temperature record for the airport for the entire period. Ideally use the five full year period prior to the current year. If temperature data is incomplete, use the longest continuous period with complete data starting not more than six years prior to the current year. The minimum reporting period is not less than three full calendar years.

c. Calculate the average airport high temperature as follows:

(1) *Step 1.* For each year in the reporting period, find the month with the highest average temperature. When two or more months have the same average temperature, chose the month with the highest single day temperature.

(2) *Step 2.* Find the highest reported temperature in each of the warmest months.

(3) *Step 3.* When Fahrenheit values are used, convert the results from *Step 2* to Celsius. Average the Celsius temperature values and round the result to the next warmer whole degree Celsius. This result is the average airport high temperature.

2. **Determine the adjusted Fix location.** To determine the location of the temperature-compensated fix location:

a. *Step 1.* Calculate the airport ISA using Formula H-1.

Formula H-1. Airport ISA

$$\mathbf{ISA_{airport} = 15 - 0.00198 \times elev_{apt}}$$

Where:
$elev_{apt}$ = Airport elevation (feet)

b. *Step 2*. Calculate ISA at the evaluation altitude using Formula H-2.

Formula H-2. ISA at Evaluation Altitude

$$\mathbf{ISA_{altitude} = 15 - 0.00198 \times altitude_{eval}}$$

Where:
$altitude_{eval}$ = Altitude at which glideslope intercept must be ensured (feet)

c. *Step 3*. Calculate the high temperature at the evaluation altitude using Formula H-3 with the 3-5 year average high temperature.

Formula H-3. ISA at Evaluation Altitude

$$\mathbf{temp_{altitude} = temp_{high} - ISA_{airport} + ISA_{altitude}}$$

Where:
$temp_{high}$ = Average airport high temperature from paragraph H-1 (degrees Celsius)

d. *Step 4*. Determine the distance to the evaluation altitude using Formula H-4.

Note: This is the same as Formula 2-6-2, repeated here to aid with calculations.

Formula H-4. Distance to Evaluation Altitude

$$\mathbf{D_{altitude} = \frac{\ln\left(\frac{r + altitude_{eval}}{r + LTP_{elev} + TCH}\right) \times r}{\tan(\theta)}}$$

Where:
LTP_{elev} = LTP elevation (feet)
θ = GPA (degrees)

e. *Step 5*. Determine the glideslope elevation at the distance determined in *Step 4* using Formula H-5.

Formula H-5. Glideslope Elevation at Evaluation Altitude

$$\mathbf{elev_{glideslope} = \frac{(r + LTP_{elev} + TCH) \times \cos(\theta)}{\cos\left(\frac{D_{altitude} \times 180}{r \times \pi} + \theta\right)} - \mathit{r}}$$

f. *Step 6*. Determine the difference between the glideslope elevation and the evaluation altitude using Formula H-6.

Formula H-6. Elevation Difference

$$\mathbf{\Delta_{elev} = elev_{glideslope} - altitude_{eval}}$$

g. *Step 7*. Determine the vertical error associated with higher than standard temperature at the evaluation altitude using Formula H-7.

Formula H-7. Vertical Temperature Error

$$\mathbf{tempErr} = \mathbf{altitude_{eval}} - \left(\mathbf{elev_{apt}} + \left(\mathbf{altitude_{eval}} - \mathbf{elev_{apt}}\right) \times \frac{\mathbf{273 + ISA_{altitude}}}{\mathbf{273 + temp_{altitude}}}\right)$$

h. If Δ_{elev} is greater than or equal to tempErr, the fix distance does not require an adjustment, as the glideslope will be above the desired intercept altitude during periods of high temperature. If Δ_{elev} is less than tempErr, continue to *Step 8*.

i. *Step 8*. Determine the amount of vertical compensation necessary using Formula H-8, and the distance to the adjusted fix location using Formula H-9.

Formula H-8. Vertical Compensation

$$z = \mathbf{altitude_{eval}} + (\mathbf{tempErr} - \Delta_{\mathbf{elev}})$$

Formula H-9. Compensated Fix Distance

$$\mathbf{D_{fix(compensated)}} = \frac{\ln\left(\frac{\mathbf{r + z}}{\mathbf{r + LTP_{elev} + TCH}}\right) \times \mathbf{r}}{\tan(\boldsymbol{\theta})}$$

3. Example.

a. Calculate a temperature compensated fix location assuming the following:

- Airport elevation = 2000 MSL
- LTP_{elev} = 2000 MSL
- GPA = 3 degrees
- TCH = 50 feet
- Average airport high temperature (5 year) = 43° C
- Evaluation altitude = 5000 MSL

$$\mathbf{ISA_{airport}} = \mathbf{15 - 0.00198 \times 2000 \approx 11.04° C} \quad \text{(Formula H-1)}$$

$$\mathbf{ISA_{altitude}} = \mathbf{15 - 0.00198 \times 5000 \approx 5.1° C} \quad \text{(Formula H-2)}$$

$$\mathbf{temp_{altitude}} = \mathbf{43 - 11.04 + 5.1 \approx 37.06° C} \quad \text{(Formula H-3)}$$

$$\mathbf{D_{altitude}} = \frac{\ln\left(\frac{r+5000}{r+2000+50}\right)\times r}{\tan(3)} \approx \mathbf{56279.9\ ft} \quad \text{(Formula H-4)}$$

$$\mathbf{elev_{glideslope}} = \frac{(r+2000+50)\times\cos(3)}{\cos\left(\frac{56279.9\times180}{r\times\pi}+3\right)} - r \approx \mathbf{5076.0\ ft} \quad \text{(Formula H-5)}$$

$$\Delta_{\mathbf{elev}} = \mathbf{5076.0 - 5000 \approx 76.0\ ft} \quad \text{(Formula H-6)}$$

$$\mathbf{tempErr} = \mathbf{5000} - \left(\mathbf{2000} + (\mathbf{5000} - \mathbf{2000}) \times \frac{\mathbf{273+5.1}}{\mathbf{273+37.06}}\right) \approx \mathbf{309.2\ ft} \quad \text{(Formula H-7)}$$

b. Since Δ_{elev} (76.0 ft.) is less than tempErr (309.2 ft), fix location compensation is necessary.

$$\boldsymbol{z} = \mathbf{5000} + (\mathbf{309.2} - \mathbf{76.0}) \approx \mathbf{5233.2}\ \boldsymbol{ft} \quad \text{(Formula H-8)}$$

$$\mathbf{D_{fix(compensated)}} = \frac{\mathbf{ln}\left(\frac{\mathbf{r+5233.2}}{\mathbf{r+2000+50}}\right) \times \mathbf{r}}{\mathbf{tan(3)}} \approx \mathbf{60728.4}\ \boldsymbol{ft} \quad \text{(Formula H-9)}$$

c. The LTP to fix distance should be at least 60724.4 feet to ensure the glideslope can be captured at 5000 MSL on days where the airport temperature is as warm as the highest average temperature.