CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

ORDER
8260.3E CHG 1

National Policy

Effective Date:
03/08/2022

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

1. Purpose. This change incorporates general design criteria for helicopter instrument approaches and departures, transferring that criteria from Order 8260.42B (Change 2), U.S. Standard for Helicopter Area Navigation. Furthermore, it adds evaluation criteria for climb-in-hold at missed approach point type missed approaches.

2. Who this change affects. All personnel who are responsible for IFP development and/or evaluation.

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

a. Chapter 1.

(1) Added instrument flight procedures (IFPs) at instrument flight rules (IFR) heliports to eligibility, including statement to defer application pending development of applicable IFR heliport design standards.

(2) Added reference to heliports for minimum approval standards.

(3) Added procedure naming standards for point-in-space (PinS) procedures.

(4) Added identification information for Air Traffic Service (ATS) routes.

b. Chapter 2.

(1) Added helicopter sloping obstacle clearance surface (OCS) evaluation information for climbing on departure or missed approach.

(2) Added information to consider aircraft on a standard terminal arrival (STAR) decelerating to restricted airspeeds below Class B airspace when determining segment lengths.

(3) Added COPTER as an authorized approach category for helicopter-only approaches.

(4) Added minimum safe altitude (MSA) positional information for PinS procedures.

(5) Added PinS evaluation information for establishment of visual descent points (VDPs) and evaluation of visual guidance surfaces (VGSs).

(6) Added evaluation criteria for climb-in-hold at the missed approach point (MAP) missed approach areas.

c. Chapter 3.

(1) Added PinS approaches to evaluation standards for determination of minimum altitudes/heights.

(2) Revised evaluation of remote altimeter setting source (RASS) adjustments related to PinS procedures.

(3) Modified visual area evaluation criteria to include evaluation for helicopter approaches to runways and heliports.

(4) Added helicopter minimums to standard civil takeoff minimums table.

d. Chapter 12.

(1) Specified types of procedures allowed for helicopter approaches.

(2) Added criteria guidance for PinS proceed visual and proceed VFR approaches.

e. Chapter 13, added criteria for helicopter departures.

f. Appendix A.

(1) Added acronyms for the following to Table A-1: final approach and takeoff area (FATO), fictitious helipoint (FHP), GNSS azimuth reference point (GARP), heliport departure reference point (HDRP), initial departure fix (IDF), IFR to VFR heliport (IVH), landing helipoint (LHP), minimum vectoring altitude (MVA), obstacle departure procedure (ODP), touchdown and lift-off area (TLOF), visual segment climb angle (VSCA), visual segment descent angle (VSDA), visual segment descent point (VSDP), and visual segment reference line (VSRL).

(2) Changed the acronym definitions for the following in Table A-1: height above landing area elevation (HAL) becomes height above landing; and heliport crossing height (HCH) becomes helipoint crossing height.

g. Appendix B.

(1) Added information for heliports to departure reference point information.

(2) Added definitions for: fictitious helipoint, heliport departure reference point, heliport elevation, heliport reference point, initial departure fix, proceed VFR, proceed visual, and unmarked landing area.

(3) Revised definitions for: common route, en route transition, helipoint, helipoint crossing height, runway transition, and touchdown and lift-off area.

h. Appendix E. Removed requirement to chart Global Positioning System (GPS) notes on simultaneous independent approaches due to redundancy with procedure type, and charting requirements contained in Order 8260.19, Flight Procedures and Airspace.

i. Appendix G. Added new appendix, transferred content from Order 8260.42B (Change 2) U.S. Standard for Helicopter Area Navigation (RNAV).

PAGE CHANGE CONTROL CHART

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4. Distribution. This change is distributed electronically only.

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Acting Executive Director, Flight Standards Service

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(NDB), localizer (LOC), and airport surveillance radar (ASR) approaches are examples of NPA procedures.

d. Departure procedures (DP). Procedures designed to provide obstacle clearance during instrument departures.

e. Standard terminal arrival (STAR). A procedure that provides obstacle clearance and routing from the en route structure to a fix in the terminal area.

f. En route Air Traffic Service (ATS) routes. Routes including VOR and L/MF-based airways, which provide obstacle clearance.

1-1-7. Word Meanings. Word meanings as used in this order:

a. Must. This means that application of the criteria is mandatory.

b. Should. This means that application of the criteria is recommended.

c. May. This means that application of the criteria is optional.

1-1-8. Formulas. Refer to Appendix D, Mathematics Convention, for definitions and abbreviations of formula inputs that are commonly used throughout this document.

1-1-9. Geospatial Standards. IFPs may be evaluated geodetically (see Appendix F). Design criteria is stipulated in this order; however, actual construction of obstacle evaluation areas (OEAs) and connection of segments may vary due to constraints within automated software. For precise construction parameters, refer to the software documentation for the appropriate automated software.

Section 1-2. Eligibility, Approval, and Retention

1-2-1. Eligibility.

a. Military airports. IFPs at military airports must be established as required by the directives of the appropriate military service.

b. Civil airports. IFPs at civil airports are established as required by Order 8260.43, Flight Procedures Management Program.

c. Joint-use airports (civil and military). IFPs at joint-use airports are established as specified in paragraph 1-2-1.a when the military is responsible for IFP development, and as specified in paragraph 1-2-1.b when the FAA is responsible for IFP development.

d. Instrument flight rules (IFR) heliports. IFPs at IFR heliports (not applicable to point-in-space (PinS) procedures) are deferred pending development of applicable IFR heliport design standards.

1-2-2. Requests for Procedures. Refer to Order 8260.43 and Order 8260.19, Flight Procedures and Airspace.

1-2-3. Approval. The following minimum standards must be met to approve a request for an IFP:

a. An airport or heliport airspace analysis conducted under Order JO 7400.2, Procedures for Handling Airspace Matters, or appropriate military directives, as applicable must find the airport or heliport acceptable for IFR operations. Acceptability for IFR operations is not required at landing areas for PinS procedures.

b. The airport or heliport (not applicable to PinS Proceed VFR procedures) infrastructure must be adequate to accommodate the aircraft expected to use the procedure (see AC 150/5340-1, Standards for Airport Markings, and AC 150/5300-13, Airport Design, paragraph 317 and Table 3-4, or AC 150/5390-2, Heliport Design, as appropriate).

c. Limit the addition of category (CAT) E minimums for new IFPs to locations where a military requirement exists.

d. Navigation facilities. All instrument and visual navigation facilities used must successfully pass flight inspection.

e. Obstacle marking and lighting. Obstacles that penetrate 14 CFR part 77 imaginary surfaces are obstructions and; therefore, should be marked and lighted per AC 70/7460-1, Obstruction Marking and Lighting. Those penetrating the 14 CFR part 77 approach and transitional surfaces should be removed or made conspicuous under AC 70/7460-1 (or military equivalent). Do not deny instrument approach procedures due to inability to mark and light or remove obstacles that violate 14 CFR part 77 surfaces (see exception in paragraph 3-3-2.c).

f. Weather information. Terminal weather observation and reporting facilities must be available for the airport to serve as an alternate airport. Destination minimums may be approved when a general area weather report is available prior to commencing the approach and approved altimeter settings are available to the pilot prior to and during the approach consistent with communications capability.

g. Communications.

(1) Instrument approach procedure. Air-to-ground communications must be available at the initial approach fix (IAF) minimum altitude and where an aircraft executing the missed approach is expected to reach the missed approach altitude. At lower altitudes, communications are required where essential for the safe and efficient use of airspace.

(2) STAR. Communications with ATC must be available over the entire route at the minimum altitude for each segment.

1-2-4. Cancellation of Procedures. Refer to Order 8260.43.

Section 1-3. Responsibility and Jurisdiction

1-3-1. Responsibility.

a. Military airports. The military services establish and approve IFPs at airports under their respective jurisdictions. IFPs established in accordance with this order are considered equivalent to 14 CFR part 97 procedures and are normally authorized for civil use. The FAA must be informed when IFPs are canceled (see Order 8260.43). The FAA may accept responsibility for the development and/or publication of military IFPs when requested to do so by the appropriate military service through an interagency agreement.

b. Civil airports. The FAA establishes and approves IFPs for civil airports.

c. Military procedures at civil airports. Where existing FAA IFPs at civil airports do not meet user needs, the military may request the FAA to develop IFPs to meet military requirements. Modification of an existing FAA IFP or development of a new IFP may meet these requirements. The FAA must formulate, coordinate with the military and industry, and publish and maintain such procedures. The military must inform the FAA when such IFPs are no longer required.

1-3-2. Jurisdiction. The military or FAA office having jurisdiction over an airport may initiate action under these criteria to establish or revise IFPs when a reasonable need is identified, or where:

a. New navigation facilities or airport infrastructure are installed.

b. Changes to existing facilities/airport infrastructure necessitate a change to an approved IFP.

c. Additional IFPs are necessary.

d. New obstacles or operational uses require a revision to the existing IFP.

Section 1-6. Identification of IFPs

1-6-1. General. IFPs must be uniquely identified to permit differentiation on charts/publications, airborne equipment displays, and during ATC communications. This section specifies IFP identification (procedure naming) only and is not intended for other uses.

1-6-2. Straight-in Approach Procedures. Identification includes the following elements (as applicable) in the following sequence:

a. Navigation system. The first element is the navigation system (and area navigation (RNAV) sensor in some cases) used to provide lateral navigation guidance within the final approach segment.

(1) Non-RNAV. Identify the applicable ground-based system and use the applicable abbreviation, such as, ASR, PAR, NDB, VOR, TACAN, LOC, LDA, or ILS. For localizer back course (BC) procedures, identify as "LOC BC."

Examples: ASR RWY 17, ILS RWY 17, LOC RWY 27, LOC BC RWY 31

(2) RNAV.

(a) Procedures with LNAV, LP, LNAV/VNAV, or LPV minimums use "RNAV (GPS)."

(b) Required Navigation Performance (RNP) procedures with Authorization Required (AR) use "RNAV (RNP)."

(c) Ground Based Augmentation System (GBAS) Landing System (GLS) procedures, use "GLS."

Examples: RNAV (GPS) RWY 17, RNAV (RNP) RWY 17, GLS RWY 17

b. Exception. High altitude approaches, prefix the navigation system with "HI-." This prefix does not eliminate the requirement to use an alphabetical suffix when more than one procedure uses the same navigational guidance to the same runway (see paragraph 1-6-2.d).

Examples: HI-TACAN RWY 31, HI-ILS X RWY 13

c. Precision runway monitor (PRM) modifier. This element is applicable to ILS, GLS, RNAV (GPS), and LDA procedures authorized for closely spaced parallel approach operations including Simultaneous Offset Instrument Approach (SOIA) operations. Include "PRM" following the navigation system (and RNAV sensor if applicable) when requested by ATC to support closely spaced parallel operations.

Examples: ILS PRM RWY 35L, RNAV (GPS) PRM RWY 35L, LDA PRM RWY 28R, GLS PRM RWY 17

d. Alphabetical suffix. When more than one procedure to the same runway uses the same type of navigation system for lateral guidance within the final approach segment, differentiate each procedure by adding a non-repeating alphabetical suffix using the letters “S” through “Z.” Suffixes are normally assigned in reverse order starting with “Z,” but may be assigned as needed to meet operational needs (for example, all RNAV (RNP) approaches at an airport assigned “Z” suffix, all RNAV (GPS) approaches assigned “Y” suffix, etc.).

Examples: ILS Z RWY 17, ILS Y RWY 17, COPTER ILS X RWY 17

(1) “V” suffix. “V” is reserved for ILS, RNAV, and GLS procedures designated to support simultaneous converging approach operations.

(2) Category I ILS, Special Authorization (SA) Category I ILS, Category II ILS, SA Category II ILS, and/or Category III ILS approaches to the same runway with the same ground tracks, altitudes (landing minimums excluded), and missed approach instructions are not considered duplicates of each other and do not require separate alphabetical identification suffixes. For example, no suffix is required for either the “ILS RWY 16R” or “ILS RWY 16R (SA CAT I)”, but if the CAT I ILS has a suffix, then assign the same suffix to the SA ILS, for example, “ILS Y RWY 16R” and “ILS Y RWY 16R (SA CAT I).”

(3) PRM. Assign the same identification suffix to the PRM approach as is assigned to the non-PRM approach it is based on. For example, title the PRM, “RNAV (GPS) PRM Y RWY 28L” when based on the “RNAV (GPS) Y RWY 28L.” Do not assign a suffix if the non-PRM approach is published without one. For example, title the PRM, “ILS PRM RWY 17” when based on the “ILS RWY 17.”

(4) RNAV (GPS) and RNAV (RNP). Alphabetical suffixes are required for each procedure with “RNAV” in the title when there are two or more such procedures to the same runway.

Examples: RNAV (GPS) Z RWY 28L, RNAV (GPS) Y RWY 28L, RNAV (RNP) X RWY 28L
High altitude procedures and other procedures using the same final approach guidance to the same runway require a suffix unless all tracks and altitudes are identical. For example, title the high ILS as, “HI-ILS Z RWY 32” and the low ILS as, “ILS Y RWY 32.”

e. Runway numbers, which the final approach course (FAC) is aligned and to which straight-in minimums are authorized. Describe as “RWY” followed by the runway designator(s).

Examples: ILS RWY 17, RNAV (GPS) RWY 18L, HI-TACAN Y RWY 13. Where approaches meet straight-in alignment criteria to more than one runway: VOR RWY 14L/R, VOR RWY 5/7.

f. PinS procedures apply the type of navigation followed by the published final approach course.

Examples: ILS OR LOC 353, RNAV (GPS) 025, COPTER RNAV (GPS) 247, VOR 221, COPTER VOR 243

g. Helicopter procedures to IFR heliports apply PinS naming.

1-6-3. Circling Approach Procedures. When the approach does not meet criteria authorizing straight-in landing minimums, identification includes the following elements:

a. The navigation system (and sensor when applicable) as specified in paragraph 1-6-2.a.

b. A non-repeating alphabetical suffix assigned sequentially.

(1) The first approach established uses the suffix “A” even though there may be no intention to establish additional procedures. Only suffixes “A” through “H” may be used.

(2) Do not duplicate the alphabetical suffix where there are multiple circling procedures at the same airport, even when the procedures use different navigation systems; if additional procedures are established, they must be identified alphabetically in sequence. A revised approach procedure will use its original identification.

Examples: NDB-A, VOR-B, LDA-C

(3) The alphabetical suffix must not be duplicated at airports with identical city names within the same state, regardless of the airport name/navigation system guidance.

Example:

State	City	Airport	Procedure name
GA	Atlanta	KFTY	VOR-A
GA	Atlanta	KCCO	NDB-B
GA	Atlanta	KPDK	LDA-C

1-6-4. Combined Charting of Approach Procedures. A VOR approach may be combined with a TACAN approach if they share common tracks, fixes, fix altitudes, and missed approach instructions. An ILS approach may be combined with a LOC approach if they share common tracks, fixes and fix altitudes (excluding the precise final approach fix (PFAF), missed approach point (MAP) and any final segment step down fixes), and missed approach instructions. Identify as specified in paragraph 1-6-2, except the runway number element (single suffix for circling) is included only with the last approach listed, and identifications are connected by the word “or.”

Examples: ILS or LOC RWY 36L, VOR or TACAN RWY 31, ILS Z or LOC Z RWY 18, ILS Z or LOC RWY 36, ILS Z or LOC Y RWY 28, VOR or TACAN-A

1-6-5. Non-part 97 Approach Procedure Naming. Non-part 97 straight-in approach procedures will be designated with the suffixes “M,” “N,” “P,” or “Q.” Circling-only approach procedures will be designated with the suffixes “J” or “K.”

a. The first approach established uses the suffix “M” (or “J” if circling-only) even though there may be no intention to establish additional procedures.

b. Do not duplicate the alphabetical suffix where there are multiple non-part 97 approach procedures at the same airport, even when the procedures use different navigation systems; if additional procedures are established, they must be identified alphabetically in sequence. A revised approach procedure will use its original identification.

c. The alphabetical suffix must not be duplicated at airports with identical city names within the same state, regardless of the airport name/navigation system guidance.

Examples: ILS M or LOC M RWY 36L, VOR N RWY 31, NDB-J

1-6-6. Departure Procedure Identification. For named departures, see Order 8260.46, Departure Procedures (DP) Program.

1-6-7. En Route Procedure Identification. ATS routes are identified with names or letter designators associated with specific route types.

a. Low/Medium Frequency (L/MF) routes are identified by color names: Amber, Blue, Green, or Red.

b. VOR routes are identified by the letter "V."

c. Jet routes (Flight Level (FL) 180 through FL 450) are identified by the letter "J."

d. RNAV routes are identified by their usage.

(1) Low altitude (below FL 180) RNAV routes are identified by the letter "T."

(2) High altitude (FL 180 through FL 450) RNAV routes are identified by the letter "Q."

(3) Helicopter RNAV routes are identified by a letter supplemented with a suffix: "TK."

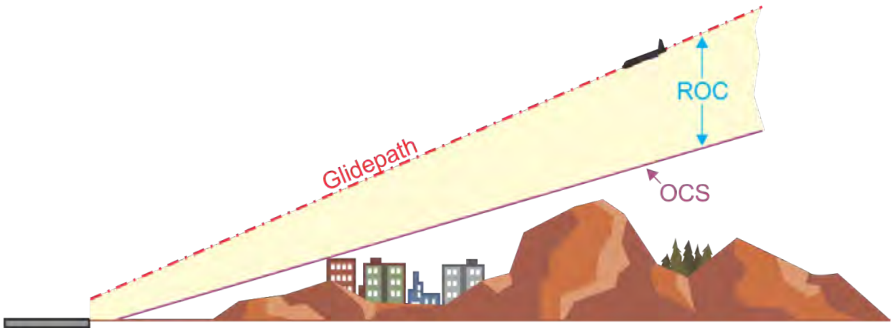
e. Non-part 95 routes are identified by their usage.

(1) Low altitude (below FL 180) RNAV routes are identified by the letter "Z."

(2) Helicopter RNAV routes are identified by a letter supplemented with a suffix: "ZK."

1-6-8. Standard Terminal Arrival Identification. See Order 8260.19.

Figure 2-1-3. PA/APV Glidepath Descent



(1) If the OCS is penetrated, the OCS slope may be adjusted upward, thereby increasing the glidepath angle. The glidepath angle would increase because it is dependent on the required slope.

(2) Descent on an ILS/LPV glidepath and descent on other types of glidepaths such as barometric vertical navigation (baro-VNAV) provide ROC through application of a descending sloping surface based on standards using differing formulas, but the concept is the same.

b. Climbing on departure or missed approach. The concept of providing obstacle clearance in the climb segment of an IFP is based on the aircraft maintaining a minimum climb gradient. The climb gradient must be sufficient to increase obstacle clearance along the flight path so that the minimum ROC for the subsequent segment is achieved prior to leaving the climb segment. The minimum climb gradient that will provide adequate ROC in the climb segment is 200 ft/nautical mile (NM) (400 ft/NM for helicopters), unless a higher gradient is specified.

(1) The obstacle evaluation method for a climb segment is the application of a rising OCS below the minimum climbing flight path. Whether the climb is for departure or missed approach is immaterial. The vertical distance between the climbing flight path and the OCS is ROC. ROC for a departure segment is defined as ROC = 0.24 × CG. This concept is often called the "24 percent rule." Altitude gained is dependent on climb gradient (CG) expressed in ft/NM.

(a) For other than helicopters, the minimum ROC supplied by the 200 ft/NM CG is 48 ft/NM ($0.24 \times 200 = 48$). Since 48 of the 200 feet gained in 1 NM is ROC, the OCS height at that point must be 152 feet ($200 - 48 = 152$), or 76% of the CG ($152/200 = 0.76$). The slope of a surface that rises 152 feet over 1 NM is 40:1[1] (see Figure 2-1-4).

(b) Helicopters utilize ROC = 0.24 × CG to achieve 96 ft/NM of ROC with a 400 ft/NM CG. Since 96 of the 400 feet gained in 1 NM is ROC, the OCS height at that point is 304 feet ($400 - 96 = 304$), or 76% of the CG ($304/400 = 0.76$). The slope of a surface that rises 304 feet over 1 NM is 20:1[2] (see Figure 2-1-4).

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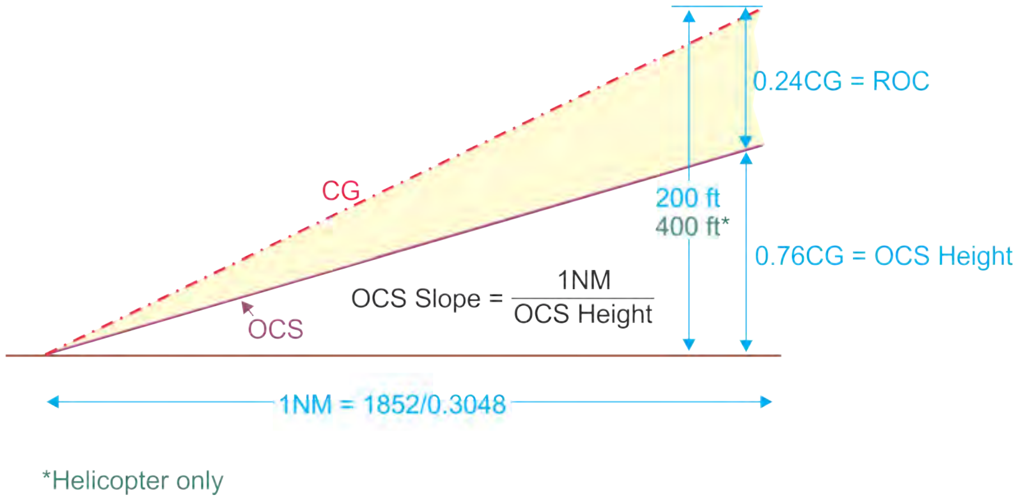
[1] $\frac{1852}{152}/0.3048 \approx 39.97$, rounded to 40

[2] $\frac{1852}{304}/0.3048 \approx 19.99$, rounded to 20

Figure 2-1-4. Climb Segment



(2) Where an obstruction penetrates the sloping OCS, a climb gradient greater than 200 ft/NM (400 ft/NM for helicopters) is required to provide adequate ROC. Departure climb gradients greater than standard will have ROC greater than 48 ft/NM (96 ft/NM for helicopters) since ROC is equal to 24% of the climb gradient. The ROC expressed in ft/NM can be calculated using Formula 2-1-1. However, instead of calculating the ROC value, the required climb gradient is normally calculated directly using Formula 2-1-2. Refer to Chapter 10 for ILS missed approach climb gradients.

Formula 2-1-1. Departure Sloping Segment ROC

$$ROC = \frac{(0.24 \times h)}{(0.76 \times D)}$$

Where:
h = Height of obstacle above the altitude from which the climb is initiated
D = Distance in NM from the initiation of the climb to the obstacle

Formula 2-1-2. Departure Climb Gradient

$$CG = \frac{h}{(0.76 \times D)}$$

Where:
h = Height of obstacle above the altitude from which the climb is initiated
D = Distance in NM from the initiation of the climb to the obstacle

c. In the case of an instrument departure, the sloping OCS is applied during the climb until en route ROC is attained. The OCS begins at the departure end of runway, at the elevation of the runway end. ROC is zero at the runway end, and increases along the departure route until the appropriate ROC value is attained to allow en route flight to commence.

d. In the case of a missed approach procedure, the climbing flight path starts at the height of the minimum descent altitude (MDA) or decision altitude (DA) minus height loss. The OCS starts approximately at the MAP/DA at an altitude of MDA/DA minus the final segment ROC and adjustments (see paragraph 3-2-2). Therefore, the final segment ROC is assured at the beginning of the OCS and increases as the missed approach route progresses. The OCS is applied until at least the minimum en route or holding value of ROC is attained (as appropriate).

e. Extraordinary circumstances, such as a mechanical or electrical malfunction, may prevent an aircraft from achieving the minimum climb gradient assumed by TERPS. In these cases, adequate obstacle clearance may not be provided by published IFPs. Operational procedures contained outside TERPS guidelines are required to cope with these abnormal scenarios.

2-1-5. Units of Measurement. Units of measurement must be expressed as set forth below:

a. Bearings, courses, and radials. Bearings and courses must be expressed in degrees magnetic. Radials must also be expressed in degrees magnetic, and must further be identified as radials by prefixing the letter "R" to the magnetic bearing from the facility. For example, R-027 or R-010.

b. Altitudes. The unit of measure for altitude in this publication is feet. Published heights below the transition level (18000 feet) must be expressed in feet above mean sea level (MSL); for example, 17900 feet. Published heights at and above the transition level (18000 feet) must be expressed as flight levels; for example, FL 180, FL 190, etc.

c. Distances. Develop all distances in NM and hundredths, except where feet are required (1 NM = 1852/0.3048 feet). When applied to visibilities, distances must be expressed in statute miles (SM) (5280 feet/SM) and the appropriate fractions thereof (see Section 3-3). Runway visual range (RVR) must be expressed in feet.

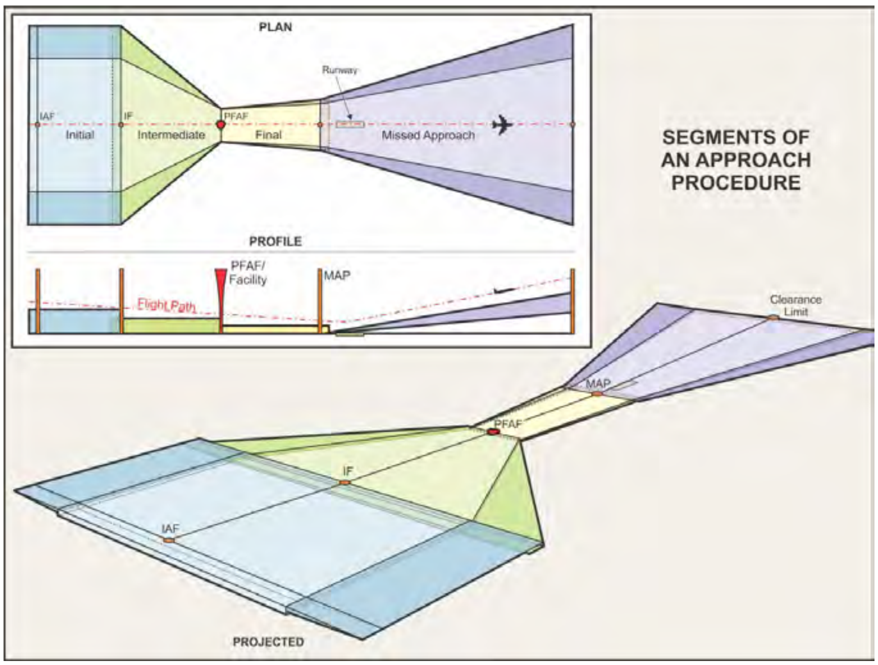
d. Speeds. Aircraft speeds must be expressed in knots indicated airspeed (KIAS).

2-1-6. Positive Course Guidance (PCG). PCG is achieved where pilots receive a continuous display of navigation data, which enable the aircraft to be flown along a specific course line or track. For courses based on a ground-based navigation facility, PCG is possible only within the standard or expanded service volume of the facility. PCG must be provided for feeder routes, initial (except as provided for in paragraph 2-4-4), intermediate, and final approach segments.

2-1-7. Approach Categories. Aircraft performance differences have an effect on the airspace and visibility needed to perform certain maneuvers. Because of these differences, aircraft manufacturer/operational directives assign an alphabetical category to each aircraft (see 14 CFR part 97). The categories used and referenced throughout this order are CAT A, B, C, D, and E. For helicopter-only approaches, COPTER is an authorized category. The authorized CAT must be used to determine OEAs for circling and missed approaches and used to establish landing minimums.

2-1-8. Procedure Construction. An instrument approach procedure (IAP) may have as many as four separate segments. They are the initial, intermediate, final, and missed approach segments. In addition, an area for circling the airport under visual conditions is considered when circling is authorized. An approach segment begins and ends at the plotted position of the fix; however, under some circumstances certain segments may begin at specified points where no fixes are available. The fixes are named to coincide with the associated segment. For example, the intermediate segment begins at the intermediate fix (IF) and ends at the PFAF. The order in which this chapter discusses the segments is the same order in which the pilot would fly them in a completed procedure; that is from an initial, through an intermediate, to a final approach. In constructing the procedure, the FAC should be identified first because it is the least flexible and most critical of all the segments. Then establish the other segments to produce an orderly maneuvering pattern responsive to the local traffic flow and to conserve controlled airspace to the maximum extent possible (see Figure 2-1-5).

Figure 2-1-5. Segments of an Approach Procedure



2-1-9. Continuous Descent Approach (CDA). CDA is a procedure that optimizes the aircraft approach from the beginning of its descent to touch-down. With CDA, noise and emission levels are substantially reduced and significant fuel cost savings can be realized by participating aircraft. CDA procedures do not require special instrument approach design criteria; they can be flown using existing instrument approach procedures where “at or above” altitudes are established based on the minimum ROC required for the segment. This allows pilots to descend at the optimum profile for their aircraft while maintaining a safe altitude. Mandatory and/or maximum altitude restrictions severely restrict the use of CDA and should only be implemented where absolutely necessary.

2-1-10. Aircraft Speed. Do not establish speed restrictions that require an aircraft to exceed the restrictions in 14 CFR part 91.117 (a) and (c).

Section 2-2. Standard Terminal Arrival Procedures

2-2-1. Standard Terminal Arrival. A STAR is a preplanned route designed to facilitate the transition from the en route environment to the terminal environment for landing at one or more airports.

2-2-2. Origination and Termination.

a. A STAR must originate from a fix (see Appendix B). The distance between the origination fix and any airport served by the STAR should not exceed 200 NM.

b. A STAR must terminate at a fix. The fix may be:

(1) A point-in-space.

(2) A fix that is also charted on an IAP.

(a) When charted on an instrument approach procedure, the termination fix must be a feeder fix, IAF, or IF. The termination fix must be the first fix that is common to both the STAR and the IAP (the STAR and the IAP must not share more than one common fix, and that fix must be the last fix on the STAR).

(b) When charted as an IAF or IF on an IAP and the approach procedure contains a course reversal, the approach segment following the STAR termination fix must be designated as "no procedure turn" (NoPT).

c. Specify a heading or course to fly after the termination fix when requested by ATC.

2-2-3. Routes and Transitions. A STAR serving a single airport consists of a common route, with optional en route and/or runway transitions. A STAR without a common route (such as a STAR with only a common point) may also be established if it contains at least two en route transitions or at least two runway transitions. STARs serving multiple airports may consist of separate common routes to each airport; however, all common routes must begin at a fix that serves all airports.

a. En route transitions. En route transitions are established prior to the first fix of a common route. An en route transition must terminate at a fix common to all en route transitions on the same STAR.

b. Runway transitions. Runway transitions may only be established for a single airport served by the STAR. They are established between the last fix of a common route and a fix that serves a runway (or multiple runways at the same airport).

c. Positive course guidance. Positive course guidance is required for all segments of a conventional (non-RNAV) STAR from origination to the termination fix.

2-2-4. Alignment.

a. The angle of intersection between the initial routing of a ground-based STAR and the ATS route where it begins (if applicable) must not exceed 120 degrees. For RNAV STARs, apply Order 8260.58, United States Standard for Performance Based Navigation (PBN) Instrument Procedure Design.

b. When a STAR terminates at a fix located on an approach procedure, the maximum angle of intersection is 90 degrees.

c. The approach procedure segment following a STAR termination fix must meet the minimum length standards required for the magnitude of turn necessary to transition from the STAR.

2-2-5. Area. For routes based on a ground-based navigational aid (NAVAID), apply Chapter 14. For RNAV routes, apply Order 8260.58.

2-2-6. Obstacle Clearance. Apply criteria in Chapter 14.

2-2-7. Altitudes.

a. Minimum en route altitudes (MEAs) and published altitudes must:

(1) Provide at least the minimum ROC. ROC must be provided from each fix with an altitude restriction to the previous altitude restriction except maximum altitude restrictions.

(2) Meet communication and navigational facility requirements.

(3) Be established in 100-foot increments; when necessary round to the next higher 100-foot increment (for example, when obstacle elevation plus ROC equals 3001, round up to 3100).

b. Altitude restrictions above FL 200 should only be published to support an operational requirement.

c. When altitude restrictions are necessary, establish in the following order of preference (see exceptions in paragraphs 2-2-7.e and 2-2-7.f):

(1) Minimum altitudes. Example: AT/ABOVE 9000

(2) Block altitudes. Example: AT/ABOVE 9000 AT/BELOW 12000

(3) Mandatory altitudes. Example: AT 6000. **Exception:** A mandatory altitude is the first preference for the last fix on a STAR if the fix is not shared with an approach procedure.

(4) Maximum altitudes. Example: AT/BELOW 12000

d. En route transitions.

(1) Establish an MEA between fixes on the transition.

(2) Establish a minimum obstruction clearance altitude (MOCA) between fixes on a transition.

(3) Do not apply minimum crossing altitude (MCA) criteria. An MEA or a MOCA must not be higher than the previous MEA or MOCA (as applicable); increase previous MEAs/MOCAs as necessary to comply.

(4) Do not raise an MEA to support ATC operational requirements. An altitude restriction must be used if ATC has an operational requirement for an altitude higher than the MEA.

e. Common route and runway transitions. Establish a mandatory, minimum or block altitude restriction at a fix that represents the lowest altitude authorized by the STAR or STAR runway transition.

(1) Establish additional altitudes as required for obstacle clearance or to support an ATC operational requirement.

(2) When a maximum altitude restriction is established, also establish a minimum altitude at the same fix (a block altitude) or at a subsequent fix to ensure obstacle clearance. The subsequent minimum altitude (or minimum altitude of a block) must also provide obstacle clearance to the previous fix(es) with a maximum altitude. For example, publishing a maximum altitude at CHRLY (as shown in Figure 2-2-1) requires the addition of a minimum altitude at CHRLY or the minimum altitude at DELTA must provide obstacle clearance back to the previous minimum altitude (in this example, the minimum altitude of a block) at BRAVO.

(3) Do not establish MEAs or MOCAs for common routes or runway transitions.

f. STAR termination altitude.

(1) An altitude restriction must be established at the termination fix of the STAR if the same fix is charted on an approach procedure. If the approach procedure fix has an altitude restriction associated with it, then the STAR termination altitude restriction must be identical to it. For example, if the approach procedure’s fix is a mandatory altitude, then the STAR must end with an identical mandatory altitude. If the approach procedure’s fix is a minimum altitude, then the STAR must end with an identical minimum altitude.

(2) If the STAR authorizes radar vectors after the termination fix, an altitude is required at the termination fix and that altitude must be at or above the minimum vectoring altitude (MVA) and/or minimum IFR altitude (MIA) (as applicable). If the STAR authorizes radar vectors after the termination fix and does not join an approach, then the altitude authorized at the termination fix should be a mandatory altitude. Flight Standards approval is required if no altitude is established due to an operational need (see paragraph 1-4-2).

(3) If the STAR termination fix will be authorized for either joining an approach or for radar vectors, the altitude must be above the MVA/MIA and comply with paragraph 2-2-7.f(1).

(4) A STAR termination altitude may be no lower than any instrument approach procedure fix altitude to be flown after the STAR termination. If the approach procedure has no altitude charted at that approach procedure fix, the STAR termination altitude may be no lower than any approach procedure minimum segment altitude following that fix.

2-2-8. Descent Gradient (DG). Calculate DGs between fixes with an altitude restriction by using the guidance in this paragraph and the calculation methods in Section 2-9. When deceleration is required, also use paragraphs 2-2-9 and 2-2-10. The DG past the termination fix of the STAR is not calculated as part of the STAR design; the overall airspace design should optimize the location and altitude for the STAR termination fix and that becomes an input to the STAR design.

a. The maximum DG (see Figure 2-2-1) is based on altitude, deceleration, and airspeed constraints, as follows:

(1) The maximum permissible DG 10000 feet MSL and above is 330 ft/NM (approximately 3.11 degrees).

(2) The maximum permissible DG below 10000 feet MSL is 318 ft/NM (approximately 3.0 degrees).

(3) When a STAR contains a descent between fixes that passes through 10000 feet MSL, the maximum permissible DG is between 318 ft/NM and 330 ft/NM and is in proportion to the amount of the altitude change that is below/above 10000 feet MSL. Use Formula 2-2-1 to determine the maximum DG (DG_{max}) between fixes that contain a descent that passes through 10000 feet MSL.

Formula 2-2-1. Maximum DG Passing Through 10000 Feet MSL (ft/NM)

$$DGmax = \frac{(Alt_1 - 10000) \times 12}{(Alt_1 - Alt_2)} + 318$$

Where:
Alt_1 = Altitude at the fix prior to crossing 10000 feet MSL
Alt_2 = Altitude at the fix after crossing 10000 feet MSL

Example 1: From BRAVO to CHRLY in Figure 2-2-1, the altitude of 11000 minimum at BRAVO and 9000 maximum at CHRLY, will have 1/2 of the gradient at 330 ft/NM and 1/2 at 318 ft/NM, Maximum DG $= (11000 - 10000) \times 12 / (11000 - 9000) + 318 = 324$.

Example 2: In the previous example if there were no altitude restrictions at BRAVO, the gradient applies from ALPHA to CHRLY. Maximum DG $= (19000 - 10000) \times 12 / (19000 - 9000) + 318 = 328.8$.

Example 3: From GOLFF to HOTEL in Figure 2-2-2, the mandatory altitude of 15000 at GOLFF and a mandatory altitude of 4000 at HOTEL, will have 5/11 of the gradient at 330 ft/NM and 6/11 at 318 ft/NM, Maximum DG = (15000 – 10000) × 12 / (15000 – 4000) + 318 = 323.45.

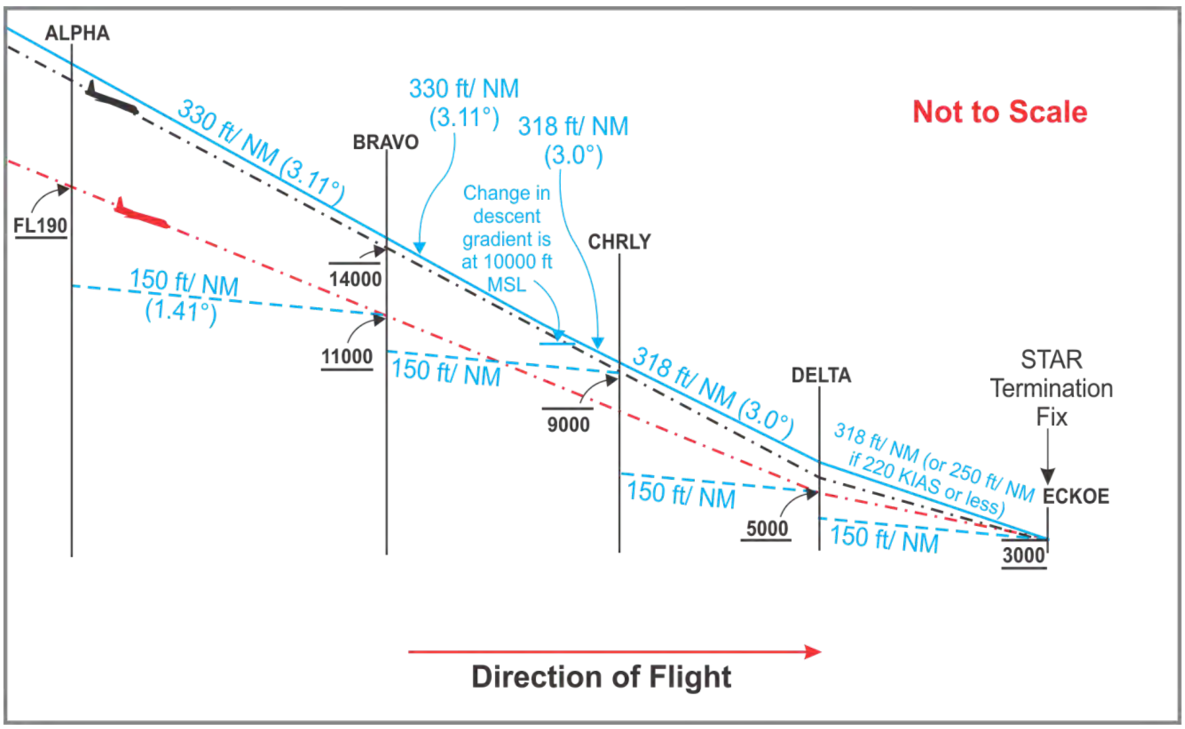
Note: Descent below 10000 feet MSL requires a deceleration calculation unless an airspeed restriction of 250 KIAS or less exists prior to the point where the descent below 10000 feet MSL occurs.

(4) Gradient after deceleration to 220 KIAS. After a speed restriction of 220 KIAS or less is used, for subsequent fixes along the route of the STAR the maximum permissible descent gradient is 250 ft/NM (approximately 2.36 degrees).

(5) Evaluation of a fix with no altitude restriction. The evaluation is done from the previous fix that has an altitude restriction to the subsequent fix that has an altitude restriction using the overall distance between the fixes with the restrictions.

(6) If more than one of paragraphs 2-2-8.a(1) through 2-2-8.a(5) applies, use the lower of the resulting values for the maximum DG.

Figure 2-2-1. Altitude Restrictions and Maximum Descent Gradient

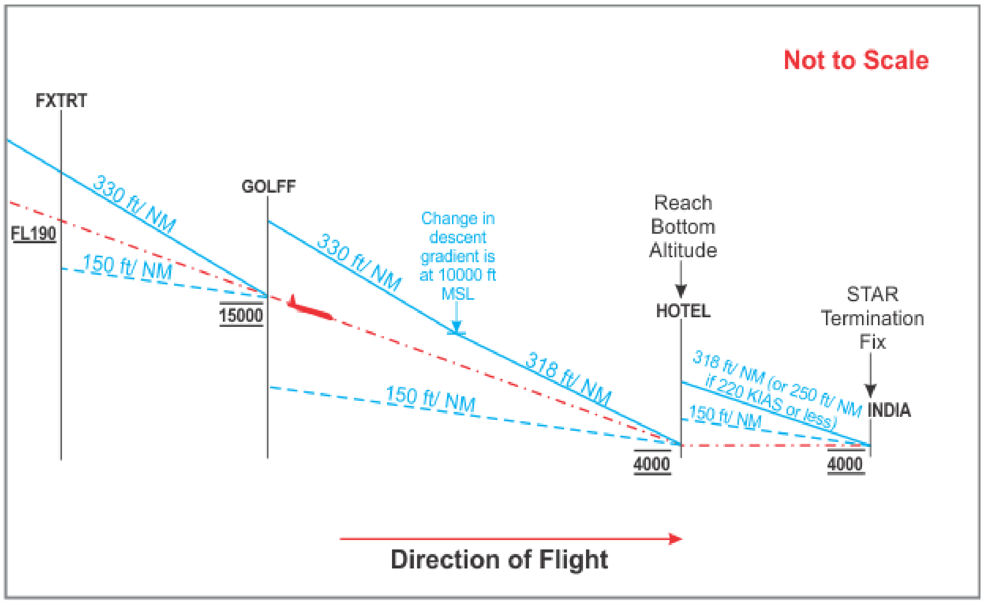


b. When a gradient exceeds the maximum DG allowed in paragraph 2-2-8.a, the STAR requires approval (see paragraph 1-4-2).

c. The descent gradient between any two consecutive fixes with an altitude restriction should be at least 150 ft/NM (approximately 1.41 degrees). Descent gradients of less than 150 ft/NM (or no descent as depicted between HOTEL and INDIA in Figure 2-2-2) should not be used except to support an operational requirement.

d. Figure 2-2-1 and Figure 2-2-2 illustrate examples of STAR design. Figure 2-2-1 shows different flight paths to illustrate the recommended design of allowing some flexibility in the descent, preferably through the use of minimum altitudes. Figure 2-2-1 shows the recommended design of all altitude constraints being on or above the 150 ft/NM line; an ATC and/or airspace requirement is shown in Figure 2-2-2 with no descent between HOTEL and INDIA. The solid blue line, depicting the maximum descent gradient, depicts the upper design limit for fixes prior to an altitude constraint. As shown in Figure 2-2-2, the use of mandatory altitude constraints reduces the range of altitudes allowed at previous fixes and may result in an inefficient descent for aircraft on the STAR.

Figure 2-2-2. Altitude Restrictions With Mandatory Altitudes



2-2-9. Speed Restrictions. Minimize the use of speed restrictions as much as practicable. Optimum values are 280 KIAS at 10000 feet MSL or above and 240 KIAS below 10000 feet MSL.

a. Speed restrictions above FL 200 should only be published to support an operational requirement. When published, the restriction must allow for Mach transition (see Order 8260.19, Chapter 4).

b. Do not establish more than one speed restriction per fix (for example, one speed applicable to jets and one applicable to props).

c. If a STAR terminates at a fix charted on an approach procedure, and the fix has a charted speed restriction, then establish a speed restriction on the STAR with the same numerical airspeed value. The STAR's speed restriction must be a mandatory ("at") speed restriction and the approach procedure must be a maximum ("at or below") speed restriction. For example, if the approach procedure's speed restriction is a maximum airspeed of 210 KIAS, then the STAR's speed restriction at the same fix must indicate a mandatory airspeed of 210 KIAS.

d. If a STAR terminates at a fix charted on an instrument approach procedure, and the fix does not have a speed restriction, then verify if the approach procedure contains a speed 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. Sufficient distance and a reduced descent gradient are required prior to any fix with a speed restriction. STARs not meeting the requirements of this paragraph may be authorized with Flight Standards approval (see paragraph 1-4-2). When an altitude restriction exists at a fix that could place an aircraft below Class B airspace, consideration should be given for deceleration for the aircraft to comply with the 200 KIAS airspeed restriction.

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$(K = 310\text{-}280 \;/\; 10)$.

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($K = 280\text{-}250 / 10$). 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($K = 250\text{-}230 / 10$).

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).

Section 2-3. Feeder Routes/Emergency Areas

2-3-1. Feeder Routes. Establish non-radar feeder routes where the IAF is not part of the en route structure and where preferred over other options [for example, radar vectors, terminal arrival area (TAA)]. Limit the number of feeder routes where radar vectoring is provided on a 24-hour basis, but where practical provide at least one route per location to account for radar/communications failure. Feeder routes originate at a navigation facility or named fix on an airway and terminate at another feeder fix or at an IAF. The feeder route must not extend beyond the operational service volume of the facility which provides navigational guidance.

a. Alignment.

(1) The angle of intersection between a ground-based feeder route course and the en route structure must not exceed 120 degrees. For RNAV routes, apply Order 8260.58.

(2) The angle of intersection between a ground-based feeder route course and the next segment (feeder/initial) course must not exceed 120 degrees except when connecting to a course reversal segment. For RNAV routes, apply Order 8260.58.

(3) Do not establish a feeder route that terminate at a course reversal fix if both the angle of intersection between the route and the segment that follows the course reversal fix is 120 degrees or less (90 degrees or less for RNAV), and if the required descent is within initial segment limitations (see paragraph 2-4-3). Under these conditions, the route must be developed as an initial segment based on straight course criteria.

b. Area. For routes based on ground-based NAVAIDs, apply Chapter 14. When connecting to a course reversal segment, the area terminates at a line perpendicular to the feeder course through the course reversal fix. For RNAV routes, apply Order 8260.58.

c. Obstacle clearance. Apply criteria in Sections 14-2 or 14-5 as appropriate. The published minimum feeder route altitude must provide at least the minimum ROC value and must not be less than the altitude established at the IAF. Establish minimum altitudes in 100-foot increments; when necessary round to the next higher 100-foot increment (for example, when obstacle elevation plus ROC equals 3001, round up to 3100).

d. Descent gradient. The optimum descent gradient in the feeder route is 250 ft/NM. Where a higher descent gradient is necessary, the maximum gradient is 500 ft/NM. The optimum descent gradient for feeder routes associated with high altitude procedures is 800 ft/NM. Where a higher descent gradient is necessary, the maximum gradient is 1000 ft/NM.

2-3-2. Minimum Safe Altitude (MSA). Establish an MSA for all approach procedures, graphic obstacle departure procedures (ODPs), and standard instrument departures (SIDs) within a 25-NM radius of a specified point for use during emergency situations (see Figure 2-3-1).

a. Altitude selection. Specify altitudes in 100-foot increments; when necessary round to the next higher 100-foot increment (for example, when obstacle elevation plus ROC equals 1501, round up to 1600).

b. Area.

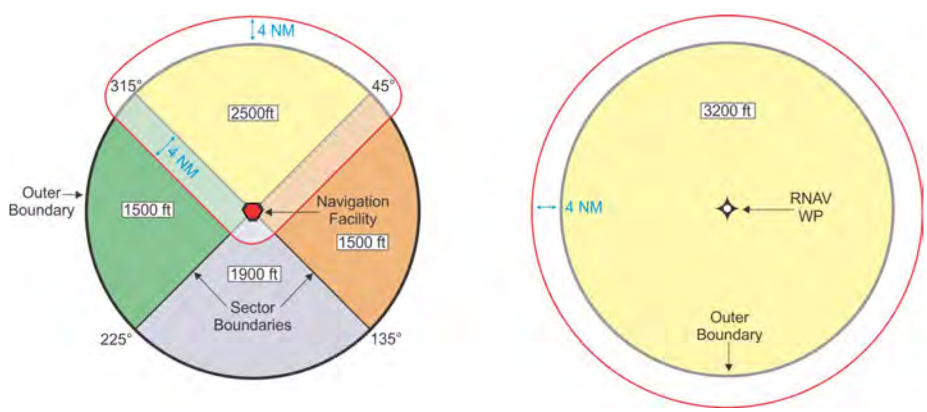
(1) Non-RNAV procedures. Center the MSA on the omni-directional facility upon which the procedure is based. When the distance from the facility to the airport exceeds 25 NM, extend the radius to include the airport or heliport landing surfaces up to a maximum distance of 30 NM. When the procedure does not use an omnidirectional facility (for example, an ILS or vector SID), use the primary omnidirectional facility in the area. If a graphic OPD or SID utilizes more than one omni-directional facility, use the facility nearest the airport or heliport. If no omni-directional NAVAID is located within 30 NM of the airport landing surfaces, then center the MSA on the airport reference point (ARP) or heliport reference point (HRP). Establish a common area (no sectors) around the facility or ARP/HRP. If necessary to offer relief from obstacles, sector divisions may be established for an MSA based on a facility. Sectors must not be less than 90 degrees in spread.

(2) RNAV procedures. For RNAV straight-in approach procedures, establish a common safe altitude within the specified radius of the runway threshold (preferred) or the MAP waypoint (WP); for RNAV circling and RNAV departure procedures use the airport waypoint (APT WP). For approaches to or departures from a heliport, use the heliport waypoint.

(3) PinS procedures. For PinS approach procedures, establish a common safe altitude within the specified radius of the MAP WP. For PinS departure procedures, use the initial departure fix (IDF).

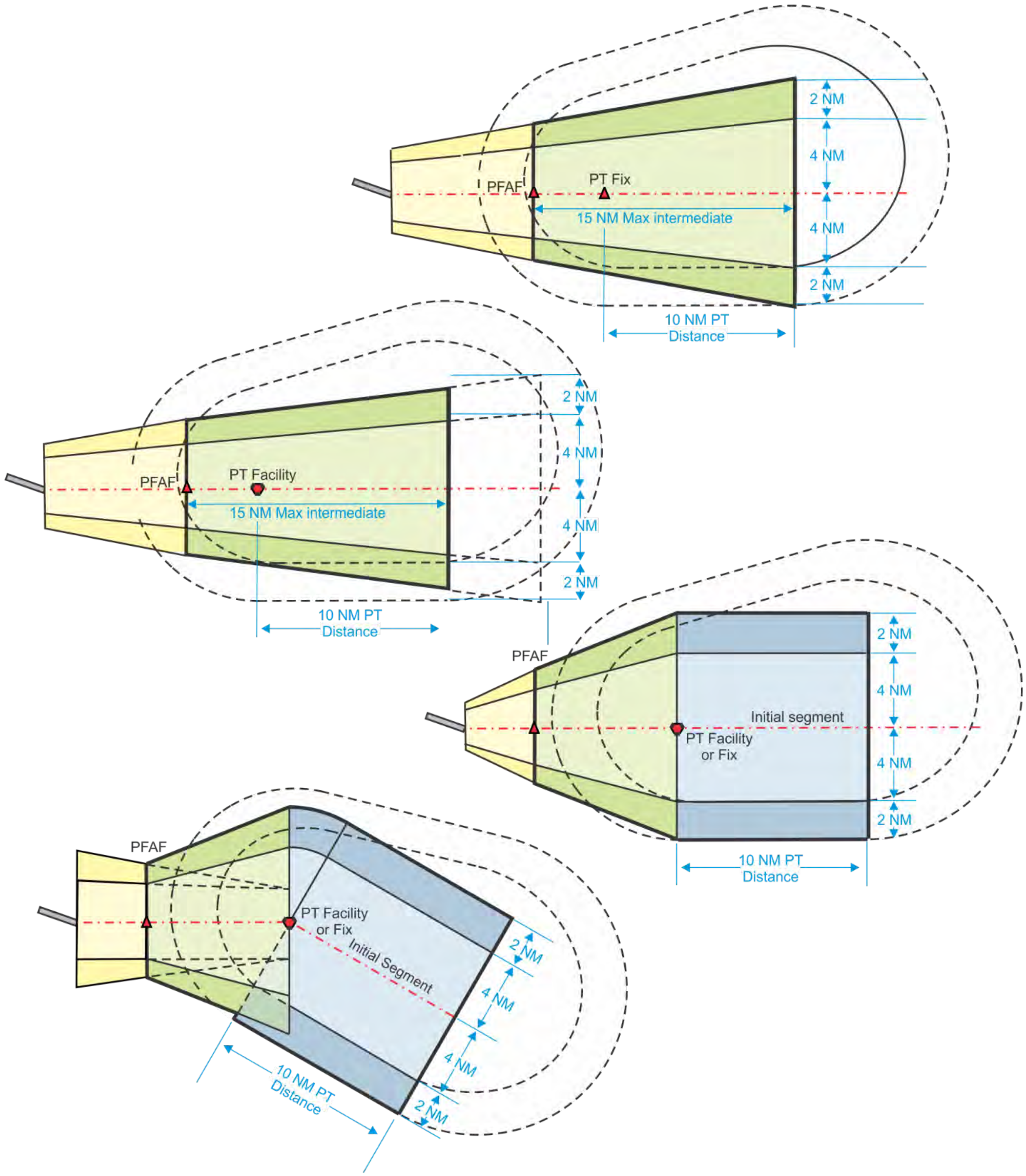
c. Obstacle clearance. Common safe altitudes and sector altitudes must provide 1000 feet of obstacle clearance to include a 4-NM buffer area beyond the 25-NM radius, and a 4-NM buffer area in any adjacent sector. Sector altitudes should be raised and combined with adjacent higher sectors when the altitude difference is 300 feet or less.

Figure 2-3-1. MSA



2-3-3. Emergency Safe Altitude (ESA). ESAs are applicable to military procedures at the option of the approving authority. Establish ESAs within a 100-NM radius of the navigation facility or WP used as the ESA center, with a common altitude for the entire area. Where ESAs are located in designated mountainous areas, provide at least 2000 feet of obstacle clearance. Paragraph 2-3-2.a applies.

Figure 2-5-8. Use of PT Fix for IF



Section 2-6. Final Approach

2-6-1. Final Approach Segment. This is the segment in which alignment and descent for landing are accomplished. Final approach may be made to a runway for a straight-in landing or to an airport for a circling approach. The segment begins at the PFAF and ends at the MAP and/or DA. Criteria for alignment, length, OEA, and OCS evaluation are contained in the chapters/directives specific to the facility/system providing navigation guidance. A visual portion within the final approach segment is also assessed for all approaches (see Section 3-3).

2-6-2. Glidepath Angle (GPA) and Vertical Descent Angle (VDA).

a. Approval is required to establish a GPA or a VDA (of a procedure where the FAC is straight-in aligned) that is more than 0.20 degrees greater than the glidepath angle of a visual glide slope indicator (VGSI) installed on the same runway (see paragraph 1-4-2).

b. Approval is required to establish a VDA (of a procedure where the FAC is straight-in aligned) that is less than the angle of a VGSI installed to the same runway (see paragraph 1-4-2).

c. GPA/VDA must not exceed the values specified in Table 2-6-1.

Table 2-6-1. Maximum VDAs

CAT	Maximum Angle
A (80 knots or less)	6.40
A (81-90 knots)	5.70
B	4.20
C	3.77
D	3.50
E	3.10*

* USAF/USN CAT E maximum is 3.50 degrees.

2-6-3. GPA. Use a standard 3.00 degree GPA where possible. A GPA greater than 3.00 degrees but not more than the maximum (see Table 2-6-1) is authorized without approval when needed to provide obstacle clearance or to meet simultaneous parallel approach standards. Other cases or a GPA less than 3.00 degrees requires approval (see paragraph 1-4-2). U.S. Air Force (USAF) and U.S. Navy (USN) minimum GPA is 2.50 degrees.

2-6-4. VDA. Determine a VDA for all NPA procedures except those published in conjunction with vertically-guided minimums or no-FAF procedures that do not contain a stepdown fix in the final segment. Optimum VDA is 3.00 degrees. Minimum VDA for a procedure with straight-in minimums is 2.75 degrees (2.50 degrees for USAF and USN); no minimum VDA applies to a procedure with only circling minimums or PinS procedures.

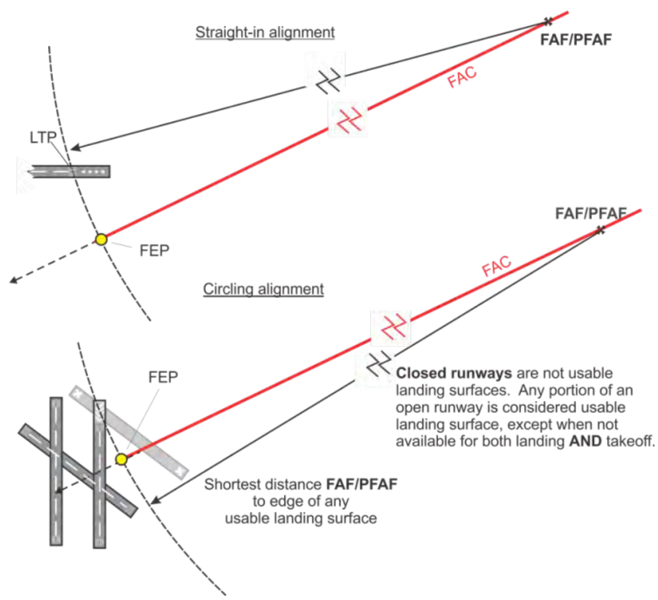
a. Where the FAC is straight-in aligned, design with a VDA equal to or higher than the lowest PA/APV glidepath angle established to the same runway. If no PA/APV procedure is established but a VGSI to the same runway is installed, then design with a VDA that is at least equal to, but not more than 0.20 degrees greater than the VGSI angle (see paragraph 2-6-2.a).

(1) If the final is circling aligned, or if a VGSI is not installed, then design the procedure at the optimum VDA when possible.

(2) If Flight Inspection determines the VDA is unsatisfactory due to obstacles, redesign the procedure using the highest allowable VDA within Table 2-6-1. If the highest VDA is still unsatisfactory to flight inspection, then do not publish a VDA (see Order 8260.19).

b. Calculate VDA based on the distance from the plotted position of the PFAF or stepdown fix to the plotted position of the final end point (FEP) (see Figure 2-6-1). The FEP is a point on the FAC equal to the distance from the PFAF to the landing threshold point (LTP) or from PFAF to the edge of first usable landing surface for circling only aligned procedures.

Figure 2-6-1. Final End Point



c. VDA for procedures meeting straight-in alignment.

(1) Calculate the VDA from the PFAF altitude (or stepdown fix altitude per paragraphs 2-6-4.e(1) or 2-6-4.f) to threshold crossing height (TCH) using Formula 2-6-1. Round results to the nearest 0.01 degrees.

Formula 2-6-1. VDA Calculation for Procedure Meeting Straight-in Alignment

$$VDA = atan\left(\ln\left(\frac{r + alt}{r + THRe + TCH}\right) \times \frac{r}{D_{FIX}}\right)$$

Where:
alt = PFAF altitude in feet (stepdown altitude if applicable)
THRe = Threshold elevation
TCH = Use value that meets minimum and maximum TCH requirements
D_{FIX} = PFAF (stepdown fix if applicable) to FEP distance (feet)

(2) When the maximum VDA calculated in accordance with Formula 2-6-1 is exceeded and altitudes/fix locations cannot be modified, straight-in minimums are not authorized. The procedure may be approved when restricted to circling minimums provided the maximum VDA calculated in accordance with paragraph 2-6-4.d is not exceeded. In this case, when VDA is published, specify the VDA calculated in accordance with Formula 2-6-1 (published angle may exceed the maximum).

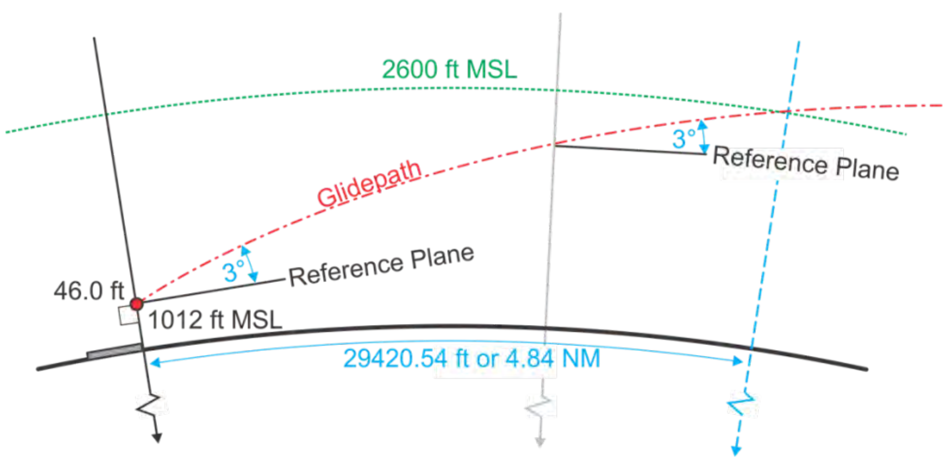
(3) Use Formula 2-6-2 to determine a PFAF or stepdown fix location to achieve a specified design angle. Where a VGSI is installed and within the range of minimum/maximum VDAs, select a fix location which permits a VDA equivalent with the VGSI angle. When it is not feasible to achieve equivalency (for example, VGSI is not within the range of acceptable angles, or VGSI is not installed), select a fix location to achieve an optimum VDA when possible or within standard VDA range (see Figure 2-6-2).

Formula 2-6-2. Determining PFAF or Stepdown Fix Location

$$D_{FIX} = \frac{\ln\left(\frac{r + alt}{r + THRe + TCH}\right) \times r}{\tan(\theta)}$$

Where:
D_{FIX}= PFAF (stepdown fix if applicable) to FEP distance (feet)
alt = PFAF altitude in feet (stepdown altitude if applicable)
THRe = Threshold elevation
TCH = Use Table 10-1-1 value that meets minimum and maximum TCH requirements
θ = VGSI or specified VDA

Figure 2-6-2. Straight-In FAF/PFAF or Stepdown Fix Distance Based on Altitude and Angle



d. VDA for procedures not meeting straight-in alignment or for straight-in aligned procedures not authorized straight-in minimums.

(1) Procedures designed to circling alignment standards are not normally flown using a stabilized descent from the PFAF to landing. Therefore, PFAF location is not predicated on VDA; however, the achieved angle must not exceed the maximum VDA. Establish the PFAF

location in accordance with the alignment and segment length criteria applicable to the final approach NAVAID or system and calculate the circling VDA.

(2) Calculate the VDA from the PFAF (or stepdown fix altitude per paragraphs 2-6-4.e(2) or 2-6-4.f) to the lowest CMDA using Formula 2-6-3. When the maximum VDA is exceeded, relocate the PFAF/stepdown fix and/or raise the CMDA until the angle is compliant.

Formula 2-6-3. VDA Calculation for Procedures Not Authorized Straight-In Minimums

$$VDA = atan\left(\ln\left(\frac{r + alt}{r + CMDA}\right) \times \frac{r}{D_{FIX}}\right)$$

Where:
alt = PFAF altitude in feet (stepdown altitude if applicable)
CMDA = Lowest published circling minimum descent altitude
D_{FIX}= PFAF (stepdown fix if applicable) to FEP distance (feet)

e. Stepdown fixes (with PFAF procedures and/or procedures published w/out PA/APV minimums). Establish stepdown fixes at the lowest altitude possible that also provides obstacle clearance. Determine the altitude of the vertical path at a stepdown fix using Formula 2-6-4. When a minimum fix altitude is above the vertical profile of a VDA calculated in accordance with paragraph 2-6-4.c, adjust the stepdown fix location(s) if feasible. When stepdown fix location(s) cannot be modified, change the FAF/PFAF location or raise the FAF/PFAF altitude until stepdown fix(es) are at or below the vertical path of the VDA (must not exceed the maximum angle).

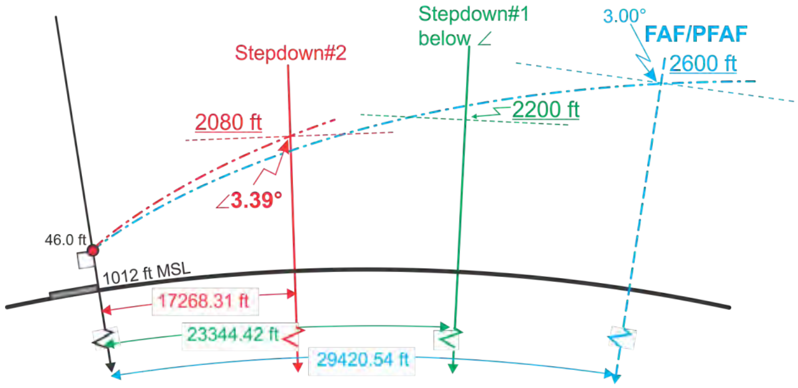
Formula 2-6-4. Vertical Path Elevation at Stepdown Fix

$$Z_{vertpath} = e^{\frac{D_{FIX} \times tan(\theta)}{r}} \times (r + base_{alt}) - r$$

Where:
D_{FIX} = PFAF (stepdown fix if applicable) to FEP distance (feet)
θ = Angle calculated in accordance with paragraph 2-6-4.c or 2-6-4.d
$base_{alt}$ = (THRe + TCH) for paragraph 2-6-4.c calculations; CMDA for paragraph 2-6-4.d calculations

(1) For straight-in aligned procedures only, when no other option is practical, calculate a VDA from each stepdown fix altitude above the vertical path (apply paragraph 2-6-4.c). Publish the greatest VDA and associate it with the applicable stepdown fix (see Figure 2-6-3).

Figure 2-6-3. VDA with Stepdown Fixes



(2) For circling aligned procedures, when no other option is practical, calculate a VDA from each stepdown fix altitude above the vertical path (apply paragraph 2-6-4.d) and ensure each angle is less than or equal to the maximum angle.

(3) Do not raise stepdown fix altitudes higher than needed for obstacle clearance solely to achieve coincidence with the VDA vertical path (USN not applicable).

f. Stepdown fixes (no-PFAF procedures). Apply paragraph 2-6-4.c or 2-6-4.d to calculate the VDA from the stepdown fix. When there are multiple stepdown fixes, also apply paragraph 2-6-4.e, except the vertical path is calculated from the first stepdown fix (farthest from LTP) instead of from the PFAF.

g. Do not establish maximum, mandatory, or block altitudes at any final segment fix (including PFAF) except for where operationally required and approved (see paragraph 1-4-2).

2-6-5. Visual Descent Point (VDP). The VDP defines a point on an NPA procedure from which normal descent from the MDA may be commenced provided the required visual references have been acquired.

a. Establish a VDP for all straight-in NPA procedures (to include those combined with a PA/APV procedure), with the following exceptions/limitations:

(1) Do not publish a VDP when the primary altimeter setting comes from a remote source.

(2) Do not publish a VDP located prior to a stepdown fix.

(3) If the VDP is between the MAP and the runway do not publish a VDP.

(4) Do not publish a VDP when the visual area 20:1 surface is penetrated (see Section 3-3).

(5) The VDP should be ≥ 1 NM from any other final segment fix (for example, MAP, stepdown). When not feasible, the VDP must be at least 0.5 NM from any other final segment

fix. If < 0.5 NM and the other fix cannot be relocated, do not publish a VDP. Do not increase the MDA to achieve the ≥ 0.5 NM distance.

(6) Do not publish a VDP on PinS procedures.

b. Determine VDP distance (in feet) using Formula 2-6-5. When dual or multiple lines of NPA minimums are published, use the lowest MDA from any CAT to calculate the VDP distance.

(1) For runways served by a VGSI (regardless of coincidence with final VDA), using the VGSI TCH, establish the distance from LTP to a point where the lowest published VGSI glidepath angle reaches the appropriate MDA.

(2) For runways not served by a VGSI, using an appropriate TCH from Table 10-1-1, establish the distance from LTP to a point where the greater of a three degree or the final segment VDA reaches the appropriate MDA. Apply this paragraph to establish a VDP for a non-PinS procedure to a helipad, using the helipoint crossing height (HCH) in place of TCH.

Formula 2-6-5. VDP Distance

$$d_{VDP} = \frac{r \times \pi}{180} \times \left(90 - \theta - asin\left(\frac{\cos(\theta) \times (r + THRe + TCH)}{r + MDA}\right)\right)$$

Where:
MDA = Lowest published MDA
THRe = Threshold (or helipad) elevation
TCH = VGSI TCH or TCH from Table 10-1-1 (HCH for helipads)
θ = VGSI or specified VDA

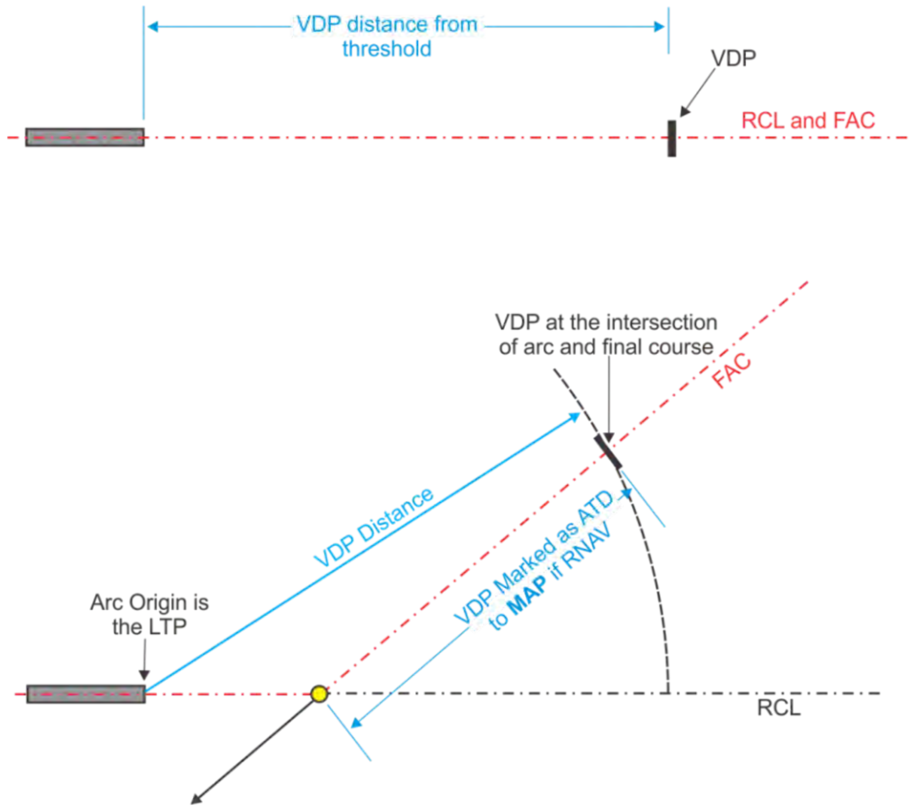
c. Marking VDP location.

(1) For Non-RNAV procedures, mark the VDP location with a DME fix. The DME source must be the same as for other DME fixes in the final segment. If suitable DME is not available, do not publish a VDP. Maximum fix error is ± 0.5 NM.

(2) For RNAV procedures, mark the VDP location with an along track distance (ATD) fix to the MAP. Maximum fix error is ± 0.5 NM.

(3) If the final course is not aligned with the runway centerline (RCL), using the LTP as an arc center, swing an arc of a radius equal to the VDP distance across the final approach course (see Figure 2-6-4). The point of intersection is the VDP. For RNAV procedures, the distance from the point of intersection to the MAP is the ATD for the VDP.

Figure 2-6-4. VDP Location



2-6-6. Vertical Guidance Surface (VGS). The VGS must be evaluated for all PA and APV approach procedures (except helicopter APV PinS procedures).

a. If evaluation results in a penetration of the VGS, eliminate the penetration by increasing the GPA or TCH until it no longer penetrates. Offsetting the FAC to achieve a lower DA (and therefore a shorter VGS) may also be an option to eliminate the penetration. Penetrations caused by airport lighting, airport signage, and their associated equipment may be disregarded when installed in accordance with FAA (or military) standards.

b. Once the VGS is clear, refer to Table 2-6-1 to determine the highest CAT that may be authorized based on the required GPA to clear the penetration.

c. Length.

(1) The VGS begins at the LTP and extends to the DA point (highest DA). See Figure 2-6-5.

(2) For approaches to a heliport, the VGS begins at the center of the touchdown and lift-off area (TLOF) and extends to the DA point (highest DA).

Note: For VGS purposes, the DA point must be calculated using primary altimeter minimums only.

d. Width.

(1) The beginning width is 100 feet each side of the runway edge. It expands towards the DA point. Calculate the beginning half-width ("k") by applying Formula 2-6-6. Calculate the half-width at the DA point using Formula 2-6-7. Apply Formula 2-6-8 to calculate the half-width for any other distance from LTP.

(2) For approaches to a heliport, the beginning width is the width of the safety area, or the diameter of the safety area for a circular final approach and takeoff area (FATO).

Formula 2-6-6. VGS Half-Width at Origin for Approach to a Runway

$$k = \frac{runway\ width}{2} + 100$$

Formula 2-6-7. VGS Half-Width at DA Point

$$E = 0.036 \times d + 392.8$$

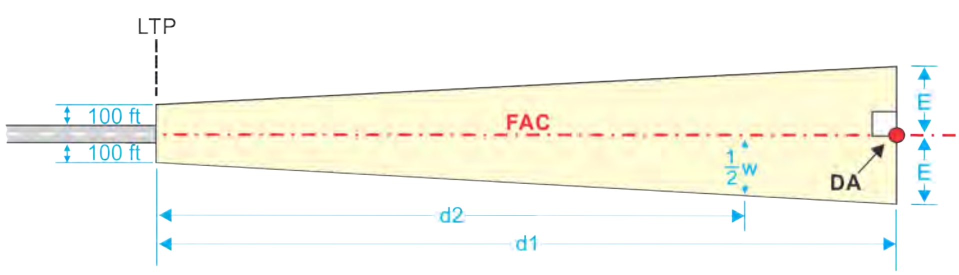
Where:
d = distance (feet) from LTP or center of TLOF to DA point

Formula 2-6-8. VGS Half-Width at Specified Distance

$$\frac{1}{2}w = \left(\frac{E - k}{d1} \times d2\right) + k$$

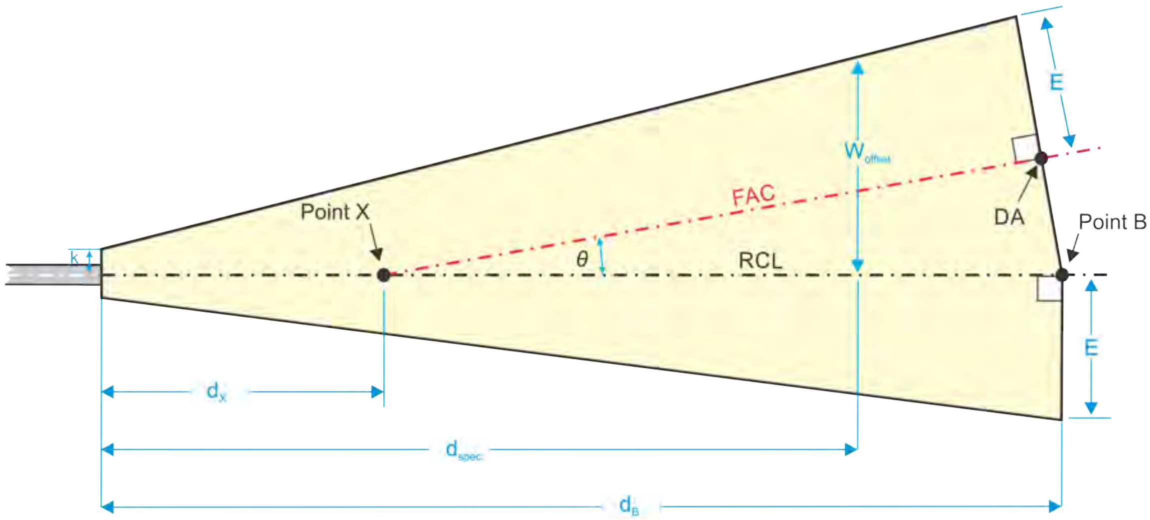
Where:
E = VGS half-width at DA point (feet) (see Formula 2-6-7)
k = VGS half-width at origin (feet) (see Formula 2-6-6 for approach to a runway, or paragraph 2-6-6c(2) for approach to a heliport)
$d1$ = Distance (feet) from LTP (or center of TLOF) to DA point
$d2$ = Specified distance (feet) from LTP (or center of TLOF) as measured along RCL (or final approach course for approach to a heliport)

Figure 2-6-5. VGS Area



e. Offset area. Expand the VGS area when the FAC is offset from the RCL by more than three degrees. The area at the DA point extends perpendicularly from the FAC on the side of the offset for distance "E" (see Formula 2-6-7). On the side closest to the RCL, the area extends perpendicularly to the FAC until intersecting the RCL. It then extends perpendicularly to the RCL for distance "E" (see Figure 2-6-6). Apply Formula 2-6-9 to determine the offset side width from RCL for a specified distance from LTP.

Figure 2-6-6. Offset VGS Area Construction



Formula 2-6-9. VGS Offset Side Width at Specified Distance

$$W_{Offset} = d_{spec} \times \left(\frac{\cos(\theta) \times [\sin(\theta) \times (d_B - d_X) + E] - k}{d_B - \sin(\theta) \times [\sin(\theta) \times (d_B - d_X) + E]}\right) + k$$

Where:
d_{spec} = Specified distance (feet) from LTP as measured along RCL
θ = FAC offset in degrees
d_B = Distance (feet) from LTP to point B
d_X = Distance (feet) from LTP to intersection of RCL and FAC (point X)
E = VGS half-width at DA point (feet) (see Formula 2-6-7)
k = VGS half-width at origin (feet) (see Formula 2-6-6)

f. VGS Slope Origin. The VGS slope origin and starting elevation is based on TCH (see Figure 2-6-7). For helicopter procedures, the starting elevation will be the TLOF elevation.

(1) Where the TCH is greater than 50 feet, the slope origin is the beginning of the VGS area. Starting elevation is V_{Offset} above THRe. Calculate V_{Offset} by applying Formula 2-6-10.

(2) Where the TCH is at least 40 feet but not more than 50 feet, the slope origin is the beginning of the VGS area. Starting elevation is THRe.

(3) Where the TCH is less than 40 feet, the slope origin is X_{Offset} distance from the beginning of the VGS area. Calculate X_{Offset} by applying Formula 2-6-11. The VGS area within X_{Offset} distance is a level surface equal to THRe which must be clear of obstacles (see exceptions in paragraph 2-6-6.a).

Formula 2-6-10. V_{Offset} Height for TCH Greater Than 50 Feet

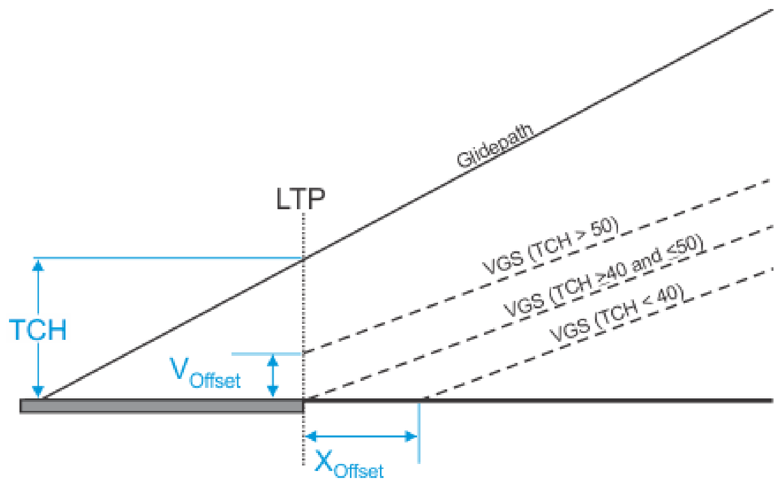
$$V_{Offset} = TCH - 50$$

Formula 2-6-11. X_{Offset} Distance for TCH Less than 40 Feet

$$X_{Offset} = \frac{40 - TCH}{tan(\theta)}$$

Where:
θ = GPA

Figure 2-6-7. VGS Slope Origin



g. VGS slope elevation. The VGS slope is based on 2/3 x GPA. Apply Formula 2-6-12 to determine the VGS elevation.

Formula 2-6-12. VGS Elevation

$$VGS_{Elev} = tan\left(\theta \times \frac{2}{3}\right) \times \left(d - X_{Offset}\right) + THRe + V_{Offset}$$

Where:
θ = GPA
d = Distance (feet) from LTP
X_{Offset} = Formula 2-6-11 result for TCH less than 40 feet, else 0. Not applicable for approaches to heliports.
V_{Offset} = Formula 2-6-10 result for TCH greater than 50, else 0. Not applicable for approaches to heliports.

Example:

$$\mathrm{VGS_{Elev}} = \tan\left(3.1 \times \frac{2}{3}\right) \times (4991.01 - 0) + 1125.4 + 5$$

$$\mathrm{VGS_{Elev}} \approx 1310.5$$

Section 2-7. Circling Approach and Sidestep Maneuvers

2-7-1. Circling Approach Area. Where circling is authorized, evaluate the circling approach OEA for each CAT published on the procedure. The CMDA is based on the results of the circling approach OEA evaluation and the evaluation of the final segment OEA (also see paragraph 3-2-1.g).

a. Obstacle evaluation area.

(1) The OEA for each CAT is based on true airspeed (V_{KTAS}). The minimum altitude used for true airspeed conversion is 1000 feet above airport elevation. Use Formula 2-7-1 to convert indicated airspeed (V_{KIAS}) to true airspeed (V_{KTAS}).

Formula 2-7-1. True Airspeed

$$V_{KTAS} = \frac{V_{KIAS} \times 171233 \times \sqrt{303 - 0.00198 \times (alt + k)}}{\left(288 - 0.00198 \times (alt + k)\right)^{2.628}}$$

Where:
V_{KIAS} = Indicated airspeed (see Table 2-7-1)
alt = Airport elevation (MSL)
k = Height above airport (minimum 1000 feet)

(2) Calculate the circling approach radius (CAR) based on true airspeed, bank angle, and straight segment using Formula 2-7-2. The minimum CAR is 1.30 NM.

Formula 2-7-2. Circling Approach Radius

$$CAR = 2 \times \frac{(V_{KTAS} + 25)^2}{\tan\left(bank_{angle}\right) \times 68625.4} + S$$

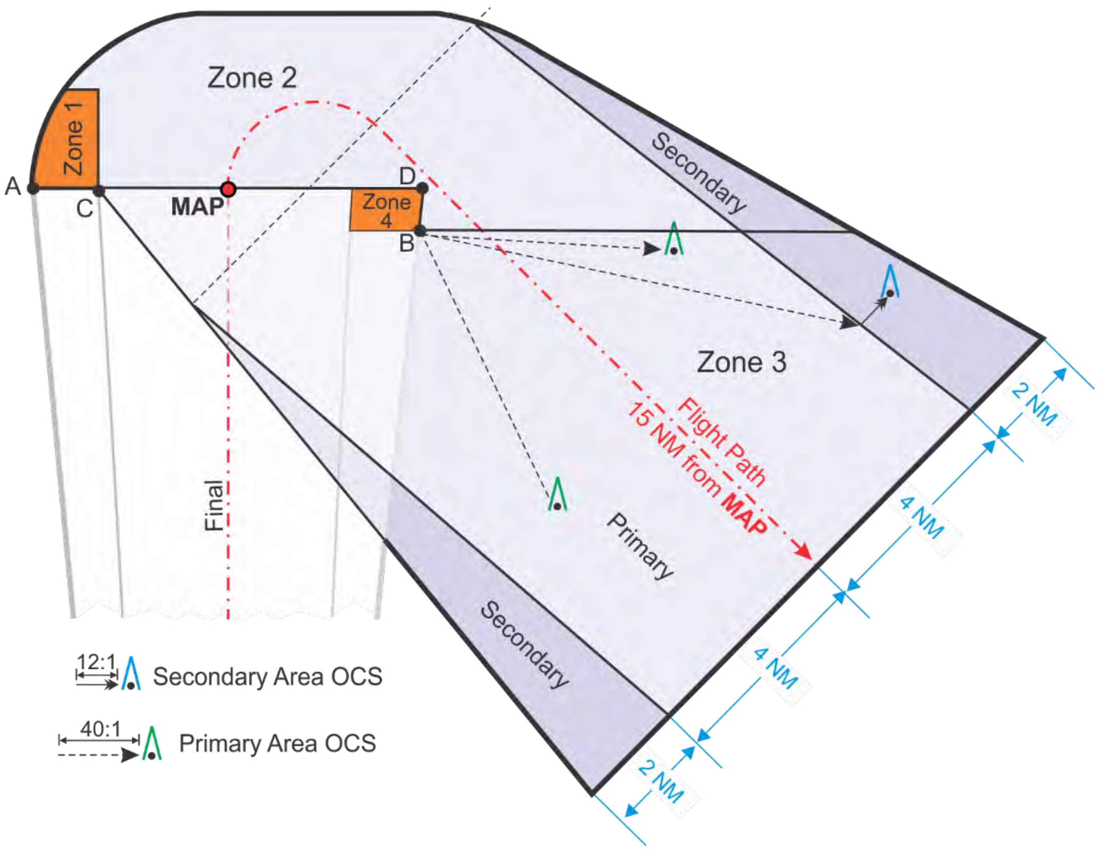
Where:
V_{KTAS} = True airspeed from Formula 2-7-1
$bank_{angle}$ = Bank angle (see Table 2-7-1)
S = Straight segment length in NM (see Table 2-7-1)

Table 2-7-1. Circling Approach Area Parameters

CAT	V_{KIAS}	$Bank_{angle}$	Straight Segment Length (S)
A	90	25	0.4
B	120	25	0.4
C	140	20	0.5
D	165	20	0.6
E	200	22	0.7

(3) Construct the OEA by drawing arcs equal to the CAR for each CAT from the LTP of each runway to which circling will be authorized. However, when only one end of the runway

Figure 2-8-11. Turning Missed Approach Obstacle Clearance, More Than a 90-Degree Turn



c. Secondary area. In the secondary area no obstacles may penetrate a 12:1 slope which extends outward and upward from the 40:1 surface from the inner to the outer boundary lines of the secondary area.

d. Evaluate the missed approach segment from the MAP to the clearance limit. Terminate the 40:1 OCS at an elevation corresponding to the en route ROC below the missed altitude.

(1) If the 40:1 OCS terminates prior to the clearance limit, continue the evaluation using a level obstacle identification surface (OIS) at the height that the 40:1 OCS was terminated.

(2) If the clearance limit is reached before the 40:1 OCS terminates, continue a climb-in-hold evaluation at the clearance limit.

e. The preliminary charted missed approach altitude is the highest of the minimum missed approach obstruction altitude, MHA established in accordance with paragraph 16-2-4, or the lowest airway MEA at the clearance limit. To determine the minimum missed approach obstruction altitude for the missed approach segment, identify the highest obstacle in the primary area; or if applicable, the highest equivalent obstacle in the secondary area. Then add the appropriate ROC (plus adjustments) for holding or en route to the highest obstacle elevation. If the resultant altitude is not in a 100-foot increment, then round upward to the next 100-foot value.

f. Determine if a climb-in-hold evaluation is required (see Section 16-7). If a climb in holding is intended at the clearance limit, a climb-in-hold evaluation is mandatory.

(1) Calculate the elevation of the 40:1 surface at the end of the segment (clearance limit). The 40:1 surface starts at the same elevation as it does for obstacle evaluations. Compute the 40:1 rise from a point on the "A-D-B" line in the shortest distance to the end-of-segment line at the clearance limit.

(2) Compute the ROC surface elevation at the clearance limit by subtracting the appropriate ROC (plus adjustments) from the preliminary charted missed approach altitude.

(3) Compare the ROC surface elevation at the clearance limit with the 40:1 surface elevation.

(a) If the computed 40:1 surface elevation is equal to or greater than the ROC surface elevation, a climb-in-hold evaluation is not required.

(b) If the computed 40:1 surface elevation is less than the ROC surface elevation, a climb-in-hold evaluation is required. Section 16-7 specifies higher speed groups, and; therefore, larger template sizes are usually necessary for the climb-in-hold evaluation. These templates may require an increase in MHA under paragraph 16-2-4. If this evaluation requires an increase in the MHA, evaluate the new altitude using the higher speed group specified in Section 16-7. This sequence of review must be used until the MHA does not increase, then the 40:1 surface is re-evaluated. If obstacles penetrate the 40:1 surface, take action to eliminate the penetration.

g. The charted missed approach altitude is the higher of the preliminary charted missed approach altitude or the MHA established under paragraph 2-8-5.c(3)(b).

2-8-8. Combination Straight and Turning Missed Approach Area. If a straight climb to a specific altitude followed by a turn is necessary to avoid obstacles, a combination straight and turning missed approach area must be constructed. The straight portion of this missed approach area is section 1. The portion in which the turn is made is section 2. Evaluate the missed approach segment to ensure obstacle clearance is provided.

a. Straight portion. Section 1 is a portion of the normal straight missed approach area and is constructed as specified in paragraph 2-8-4. Obstacle clearance is provided as specified in paragraph 2-8-5 except that secondary area reductions do not apply. The length of section 1 is determined as shown in Figure 2-8-12 and relates to the need to climb to a specified altitude prior to the turn. Point A_1 marks the end of section 1.

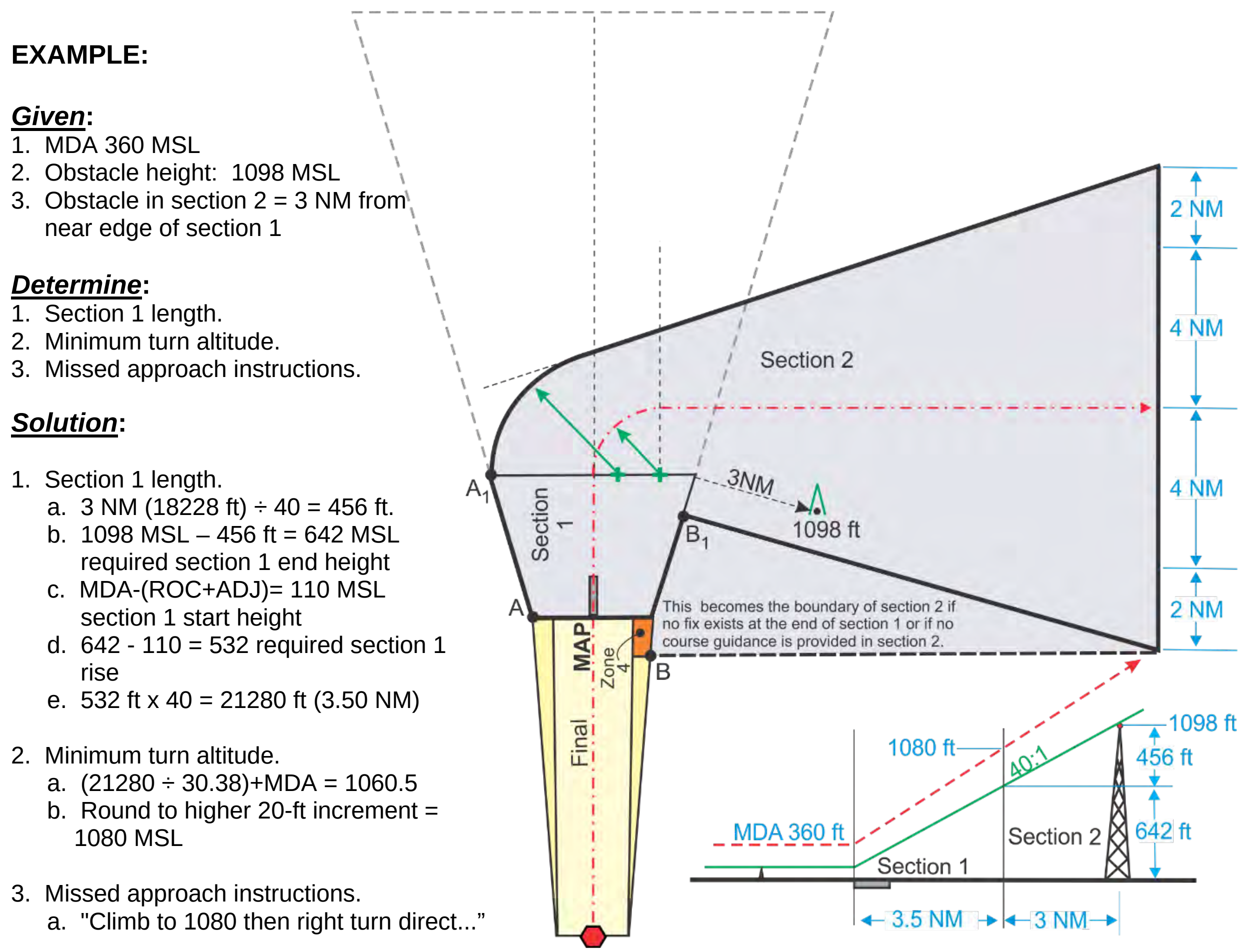
b. Turning portion. Section 2 is constructed as specified in paragraph 2-8-6 except that point "A" is replaced by point "A_1" and unless a fix does not exist at the end of section 1, or if positive course guidance is not provided in section 2, point "B" is replaced by a point 1 NM from the end of section 1 (point "B_1") (see Figure 2-8-12). Obstacle clearance requirements in section 2 are the same as those specified in paragraph 2-8-7 with the following exemptions:

(1) Zone 1 is not considered.

(2) The height of the missed approach surface over point "B₁" or "B" for zone 3 computations is equal to the turn altitude less any RASS and precipitous terrain adjustments for final.

(3) Zone 4 may begin at either point "B₁" or "B," if either are found prior to the MAP. The height of zone 4 is equal to the height of the OCS at the end of section 1.

Figure 2-8-12. Combination Missed Approach Area



c. Evaluate the 40:1 surface from the MAP to the clearance limit (end of the missed approach segment). If obstacles penetrate the surface, take action to eliminate the penetration.

d. The preliminary charted missed approach altitude is the highest of the minimum missed approach obstruction altitude, MHA established in accordance with paragraph 16-2-4, or the lowest airway MEA at the clearance limit. To determine the minimum missed approach obstruction altitude for the missed approach segment, identify the highest obstacle in the primary area; or if applicable, the highest equivalent obstacle in the secondary area. Then add the appropriate ROC (plus adjustments) for holding or en route to the highest obstacle elevation. If the resultant altitude is not in a 100-foot increment, then round upward to the next 100-foot value.

e. Determine if a climb-in-hold evaluation is required (see Section 16-7). If a climb in holding is intended at the clearance limit, a climb-in-hold evaluation is mandatory.

(1) Calculate the elevation of the 40:1 surface at the end of the segment (clearance limit). The 40:1 surface starts at the same elevation as it does for obstacle evaluations. First, compute the 40:1 rise from a point on the line defining the origin of the 40:1 surface at the MAP, in the shortest distance and perpendicular to the end-of-section 1. If there is a RASS adjustment and the missed approach instructions do not include a parenthetical climb to altitude then the elevation at the end of section 1 is adjusted by subtracting the altitude difference between the RASS adjustments when two remote altimeter sources are used; or subtracting the RASS adjustment for a part-time altimeter source. The resulting altitude at the end of section 1 must not be lower than the 40:1 surface height at the MAP. Second, compute the 40:1 rise from a point on the nearest edge of section 1, in the shortest distance to the end-of-segment line at the clearance limit. Add the two values together and this is the 40:1 surface height at the end of the segment (clearance limit).

(2) Compute the ROC surface elevation at the clearance limit by subtracting the appropriate ROC (plus adjustments) from the preliminary charted missed approach altitude.

(3) Compare the ROC surface elevation at the clearance limit with the 40:1 surface elevation.

(a) If the computed 40:1 surface elevation is equal to or greater than the ROC surface elevation, a climb-in-hold evaluation is not required.

(b) If the computed 40:1 surface elevation is less than the ROC surface elevation, a climb-in-hold evaluation is required. Section 16-7, specifies higher speed groups, and therefore larger template sizes, and are usually necessary for the climb-in-hold evaluation. These templates may require an increase in MHA under paragraph 16-2-4. If this evaluation requires an increase in the MHA, evaluate the new altitude using the higher speed group specified in Section 16-7. This sequence of review must be used until the MHA does not increase, then the 40:1 surface is re-evaluated. If obstacles penetrate the 40:1 surface, take action to eliminate the penetration.

f. The charted missed approach altitude is the higher of the preliminary charted missed approach altitude or the MHA established under paragraph 2-8-5.c(3)(b).

2-8-9. Climb-in-Hold at the MAP Missed Approach Area. A climb-in-hold at the MAP is a missed approach that occurs when the aircraft reaches the missed approach point and immediately turns to enter holding while climbing. The missed approach turn direction must be to the holding side of the holding pattern, and the MAP will be the holding fix. The missed approach will include Zone 4 (see Figure 2-8-13) which is evaluated as described in paragraph 2-8-7.a. See Section 16-7 for climb-in-hold obstacle evaluation. This type of missed approach is only allowed for VOR and NDB procedures and is permitted for both straight-in and circling procedures.

a. The following requirements must be met:

(1) The MAP must be the final approach course facility, and it must also be the clearance limit.

(2) The missed approach holding pattern must be aligned with (and overlie) the final approach course.

(3) Obstacles in the holding pattern are measured from the closest distance to the OCS origin as described in Chapter 2, except for those in Zone 4, which are evaluated as described in paragraph 2-8-7.a.

b. The following limitations apply:

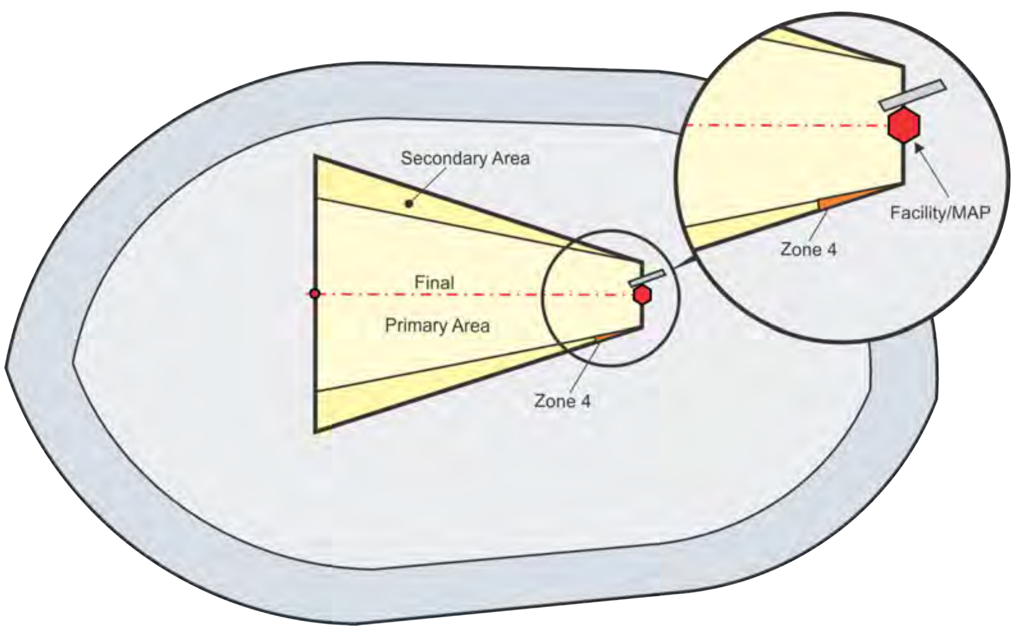
(1) A climb-in-hold at the MAP must not be used in conjunction with a climb-to altitude before turning, or any other instructions that would delay entry into the holding pattern.

(2) A climb-in-hold at the MAP is not authorized if the MDA/CMDA is less than 400 feet above TDZE/airport elevation rounded to the nearest foot increment.

(3) Penetrations of the 40:1 OCS may only be eliminated/mitigated by an increase in MDA/CMDA. Climb gradients greater than 200 ft/NM are not authorized.

(4) The 310-knot pattern must be used for the climb-in-hold evaluation.

Figure 2-8-13. Climb-in Hold at MAP



2-8-10. End of Missed Approach. Aircraft are assumed to be in the initial approach or en route environment upon reaching MOCA or MEA. Thereafter, the initial approach or the en route clearance criteria apply.

Section 2-9. Terminal Area Fixes

2-9-1. General. Terminal area fixes include, but are not limited to the PFAF, the IF, the IAF, the holding fix, and when possible, a fix to mark the MAP. Each fix is a geographical position on a defined course. Terminal area fixes should be based on similar navigation systems. For example, TACAN, VORTAC, and VOR/DME facilities provide radial/DME fixes. NDB facilities provide bearings. VOR facilities provide VOR radials. The use of integrated (VHF/NDB) fixes must be limited to those intersection fixes where no satisfactory alternative exists.

2-9-2. Fixes Formed By Intersection. A geographical position can be determined by the intersection of courses or radials from two stations. One station provides the course the aircraft is flying and the other provides a crossing indication which identifies a point along the course which is being flown. Because all stations have accuracy limitations, the geographical point which is identified is not precise, but may be anywhere within a quadrangle which surrounds the plotted point of intersection. Figure 2-9-1 illustrates the intersection of an arc and a radial from the same DME facility and the intersection of two radials or courses from different navigation facilities. The area encompassed by the sides of the quadrangle formed in these ways is referred to in this publication as the “fix displacement area.”

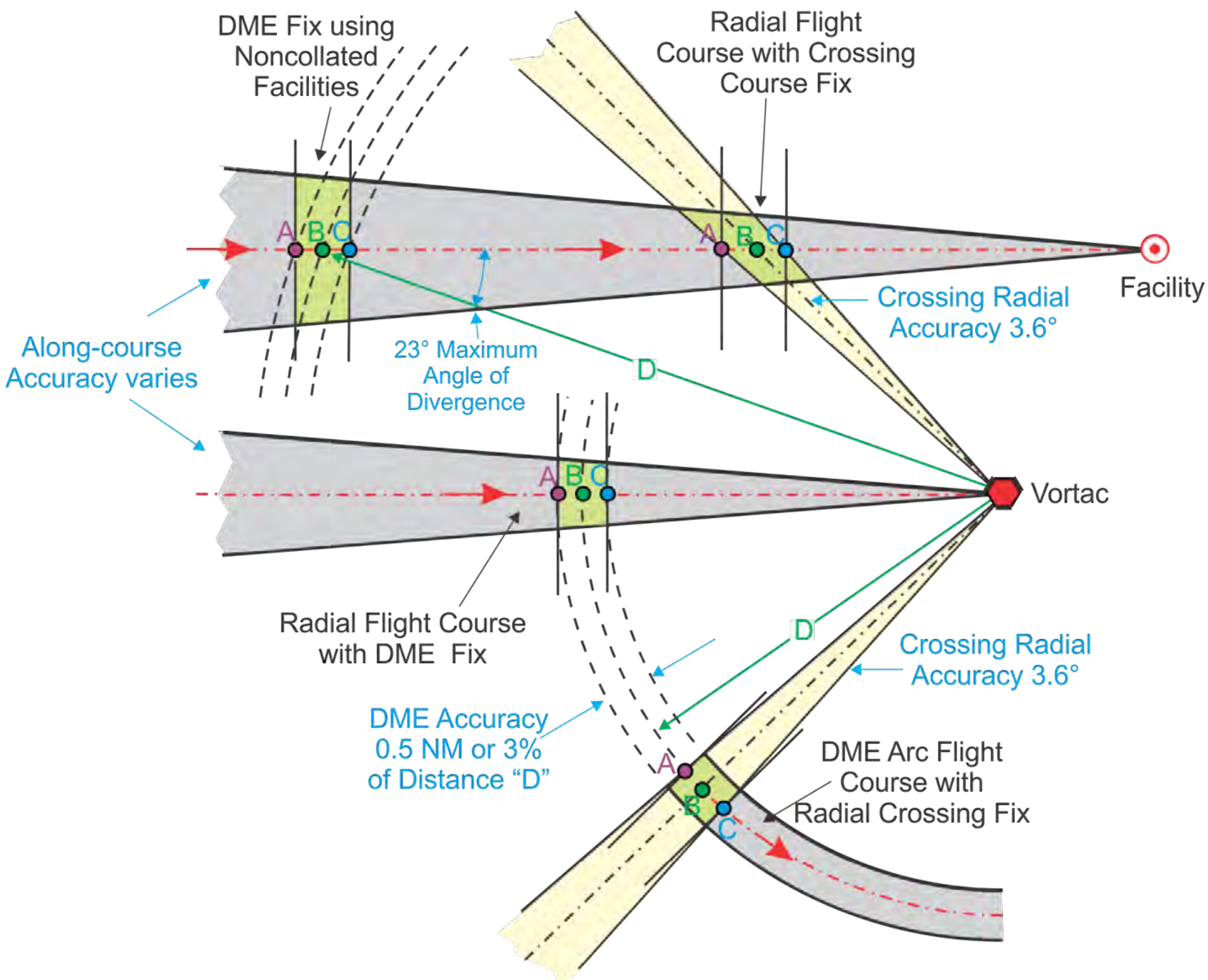
2-9-3. Course/Distance Fixes.

a. DME fixes. A DME fix is formed by a DME reading on a positive navigational course. The information should be derived from a single facility with collocated azimuth and DME antennas. Collocation parameters are defined in Order 6050.32, Spectrum Management Regulations and Procedures Manual. Where operationally required, DME information from a non-collocated facility may be used to identify a fix provided the angular divergence between the signal sources at the fix does not exceed 23 degrees (see Figure 2-9-1).

b. ATD fixes. An ATD fix is an along track position defined as a distance in NM, with reference to the next WP along a specified course.

c. Fixes formed by marker beacons. Marker beacons are installed to support certain NAVAIDs that provide course guidance. A marker beacon is suitable to establish a fix only when it marks an along course distance from the NAVAID it is associated with; for example a localizer and outer marker.

Figure 2-9-1. Fix Displacement



2-9-4. Fixes Formed By Radar. Where ATC can provide the service, ASR may be used for any terminal area fix. PAR may be used to form any fix within the radar coverage of the PAR system. Air Route Surveillance Radar (ARSR) may be used for initial approach and intermediate approach fixes. Coordinate with the appropriate ATC facility before establishing a radar fix to ensure the facility agrees to provide the radar fix service.

2-9-5. Fix Displacement Area. The areas portrayed in Figure 2-9-1 extend along the flight course from point "A" to point "C." The fix error is a plus-or-minus value, and is represented by the lengths from "A" to "B" and "B" to "C." Each of these lengths is applied differently. The fix error may cause the fix to be received early (between "A" and "B"). Because the fix may be received early, protection against obstacles must be provided from a line perpendicular to the flight course at point "A."

2-9-6. Intersection Fix Displacement Factors. The intersection fix displacement area is determined by the system use accuracy of the navigation fixing systems. The system use accuracy in VOR and TACAN type systems is determined by the combination of ground station error, airborne receiving system error, and flight technical error (FTE). En route VOR data have shown that VOR system use accuracy along radial courses of ± 4.5 degrees, 95 percent of occasions, is a realistic, conservative figure. Thus, in normal use of VOR or TACAN intersections, fix displacement factors may conservatively be assessed as follows:

a. Along-course accuracy.

(1) VOR/TACAN radials, plus-or-minus 4.5 degrees.

(2) Localizer course**,** plus-or-minus 1 degree.

(3) NDB courses or bearing, plus-or-minus 5 degrees.

Note: The plus-or-minus 4.5 degrees (95 percent) VOR/TACAN figure is achieved when the ground station course signal error, the FTE, and the VOR airborne equipment error are controlled to certain normal tolerances. Where it can be shown that any of the three error elements is consistently different from these assumptions (for example, if flight inspection shows a consistently better VOR signal accuracy or stability than the one assumed, or if it can be shown that airborne equipment error is consistently smaller than assumed), VOR fix displacement factors smaller than those shown above may be utilized under paragraph 1-4-2.

b. Crossing course accuracy.

(1) VOR/TACAN radials, plus-or-minus 3.6 degrees.

(2) Localizer course**,** plus-or-minus 0.5 degrees.

(3) NDB bearings**,** plus-or-minus 5 degrees.

Note: The plus-or-minus 3.6 degrees (95 percent) VOR/ TACAN figure is achieved when the ground station course signal error and the VOR airborne equipment error are controlled to certain normal tolerances. Since the crossing course is not flown, FTE is not a contributing element. Where it can be shown that either of the error elements is consistently different, VOR displacement factors smaller than those shown above may be utilized under paragraph 1-4-2.

c. Calculate intersection fix displacement along the track to be flown using Formula 2-9-1 and Formula 2-9-2 (see Figure 2-9-2).

Formula 2-9-1. Fix Displacement Calculations

$$E = \frac{1852 \times D \times \sin(B)}{0.3048 \times \sin([A + B])}$$

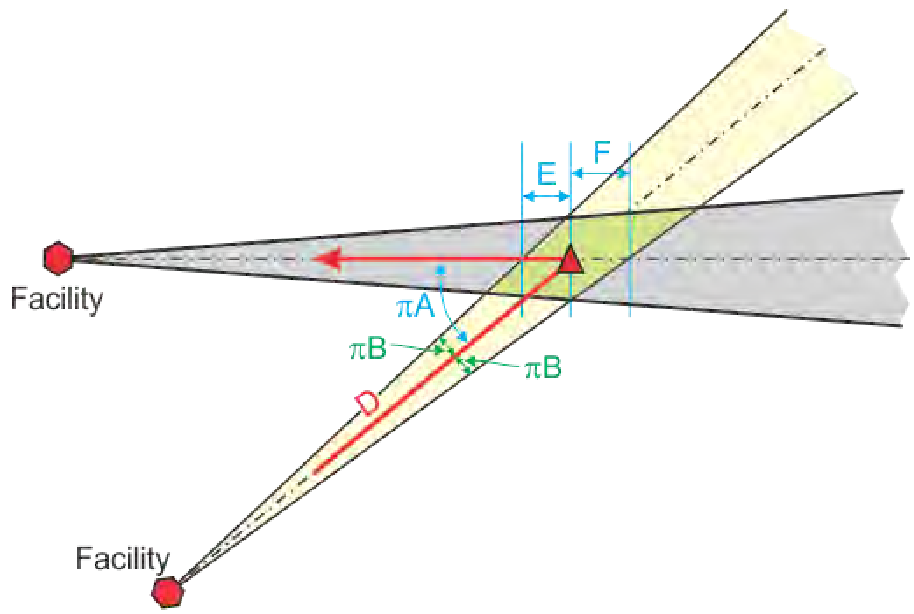
Where:
E = Fix displacement on turn side (feet)
A = Angle between along course track and crossing course
B = Crossing course accuracy
D = Distance (NM) from crossing facility to intersection

Formula 2-9-2. Fix Displacement Calculations

$$F = \frac{1852 \times D \times \sin(B)}{0.3048 \times \sin([A - B])}$$

Where:
F = Fix displacement opposite of turn side (feet)
A = Angle between along course track and crossing course
B = Crossing course accuracy
D = Distance (NM) from crossing facility to intersection

Figure 2-9-2. Fix Displacement



2-9-7. Other Fix Displacement Factors.

a. Radar. Plus-or-minus 500 feet or three percent of the distance to the antenna, whichever is greater.

b. DME. Plus-or-minus 0.5 NM or three percent of the distance to the antenna, whichever is greater.

c. 75 MHz marker beacon.

(1) Normal powered fan marker**,** plus-or-minus 2 NM.

(2) Bone-shaped fan marker**,** plus-or-minus 1 NM.

(3) Low powered fan marker, plus-or-minus 0.5 NM.

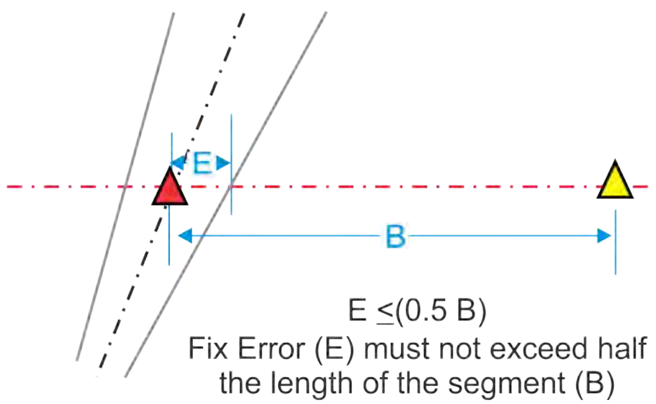
Note: Where these 75 MHz marker values are restrictive, the actual coverage of the fan marker (2 milliamp signal level) at the specific location and altitude may be used instead.

d. Overheading a station. The fix error involved in station passage is not considered significant in terminal applications. The fix is therefore considered to be at the plotted position of the navigation facility. The use of TACAN station passage as a fix is not acceptable for holding fixes or high altitude IAFs.

2-9-8. Satisfactory Fixes.

a. Intermediate, initial, or feeder fix. To be satisfactory as an intermediate, initial, or feeder approach fix, the fix error must not be larger than 50 percent of the appropriate segment distance that follows the fix. Measurements are made from the plotted fix position (see Figure 2-9-3).

Figure 2-9-3. Intermediate, Initial, or Feeder Approach Fix Errors



b. Holding fixes. Any terminal area fix, except overheading a TACAN or a 75 MHz marker beacon, may be used for holding. The following conditions must exist when the fix is an intersection formed by courses or radials:

(1) The angle of divergence of the intersecting courses or radials must not be less than 45 degrees.

(2) If the facility which provides the crossing courses is not an NDB, it may be as much as 45 NM from the point of intersection.

(3) If the facility which provides the crossing course is an NDB, it must be within 30 NM of the intersection point.

(4) If distances stated in paragraphs 2-9-8.b(2) or 2-9-8.b(3) are exceeded, the minimum angle of divergence of the intersecting courses must be increased at the following rate:

(a) If an NDB facility is involved, 1 degree for each NM over 30 NM.

(b) If an NDB facility is not involved, 0.5 degree for each NM over 45 NM.

c. PFAF. For a fix to be satisfactory for use as a PFAF, the fix error should not exceed plus-or-minus 1 NM (see Figure 2-9-4). It may be as large as plus-or-minus 2 NM when:

(1) The MAP is marked by overheading an air navigation facility (except 75 MHz markers); or

(2) Where DME is required for identification of the MAP (FAF to MAP timing is not published); or

(3) Where DME is not required for identification of the MAP (FAF to MAP timing is either required or optional for identification of the MAP), a buffer of equal length to the excessive fix error after the PFAF is provided between the published MAP and the point where the missed approach surface begins. The area between the MAP and the start of the 40:1 (20:1 for helicopters) surface rise is considered missed approach primary area. When PCG is available, the 12:1 secondary area may begin where the 40:1 (20:1 for helicopters) surface rise starts (see Figure 2-9-5).

Figure 2-9-4. Measurement of PFAF Error

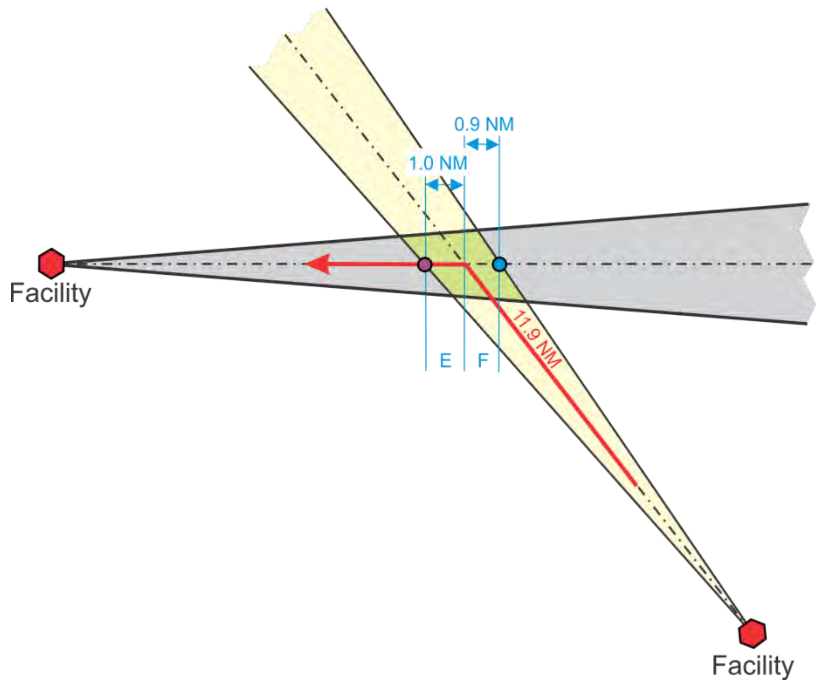
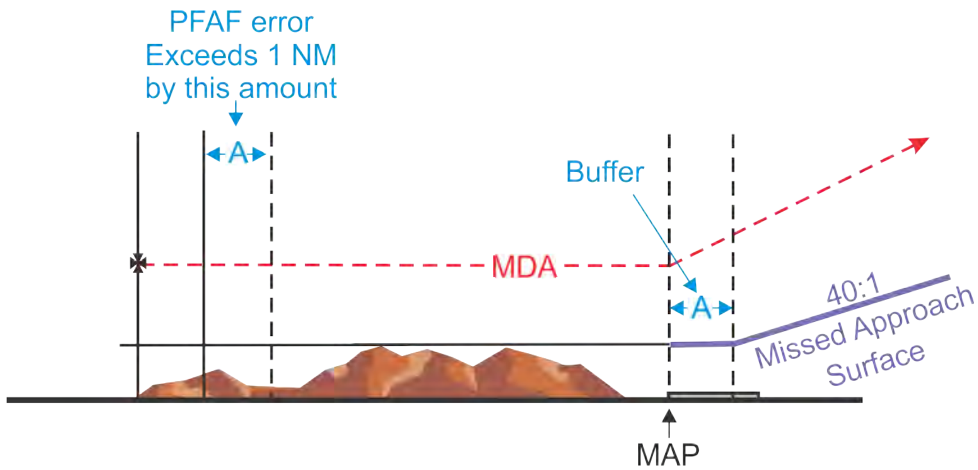


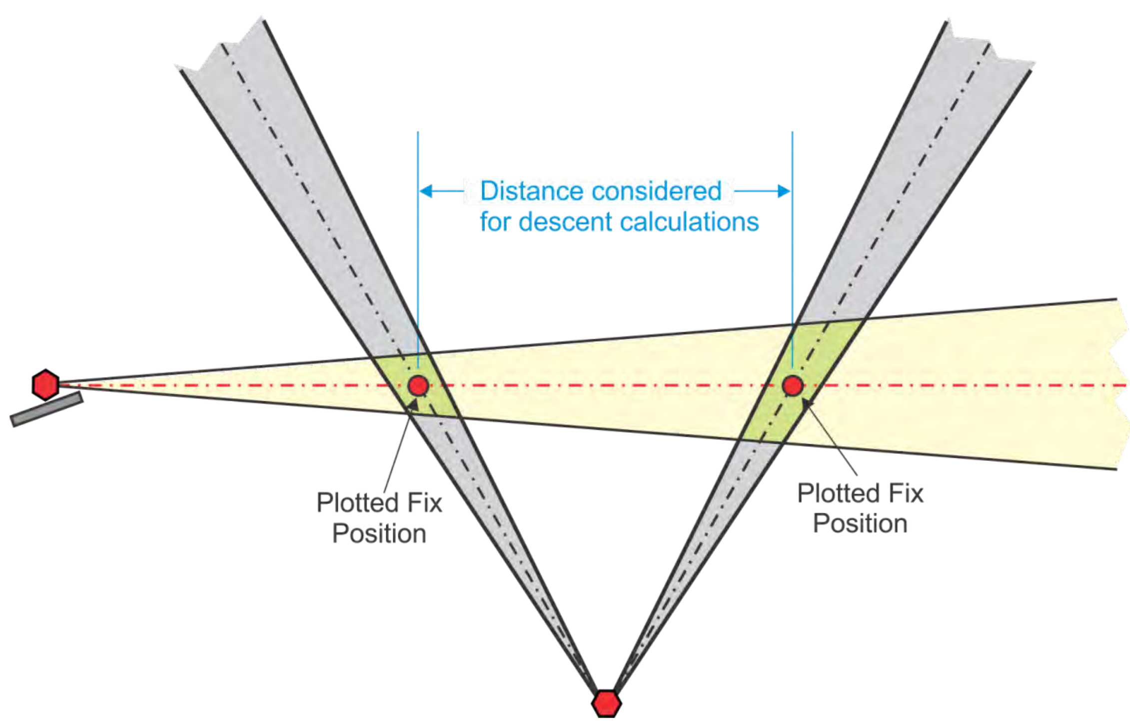
Figure 2-9-5. PFAF Error Buffer



2-9-9. Using Fixes for Descent.

a. Descent gradients. When applying descent gradient criteria applicable to a STAR, feeder, or approach segment (initial, intermediate, or final approach), the measuring points are the plotted position of the fix (see Figure 2-9-6) with the lower altitude restriction, and the plotted position of the fix with the higher altitude restriction. Fixes without an altitude restriction are ignored for descent gradient calculations. Calculate using the minimum altitude authorized at each fix for a minimum, mandatory, or block altitude restriction. For maximum altitude restrictions, calculate using the maximum altitude authorized at the fix.

Figure 2-9-6. Distance for Descent Gradient Application



b. Obstacle clearance after passing a fix. Descent is assumed to occur at the earliest point a fix can be received. Full obstacle clearance must be provided from this point to the plotted point of the next fix. Therefore, the altitude to which descent is to be made at the fix must provide the same clearance over obstacles in the fix error area as it does over those in the approach segment which is being entered (see Figure 2-9-7 and Figure 2-9-8).

Figure 2-9-7. Obstacle Clearance Area Between Fixes

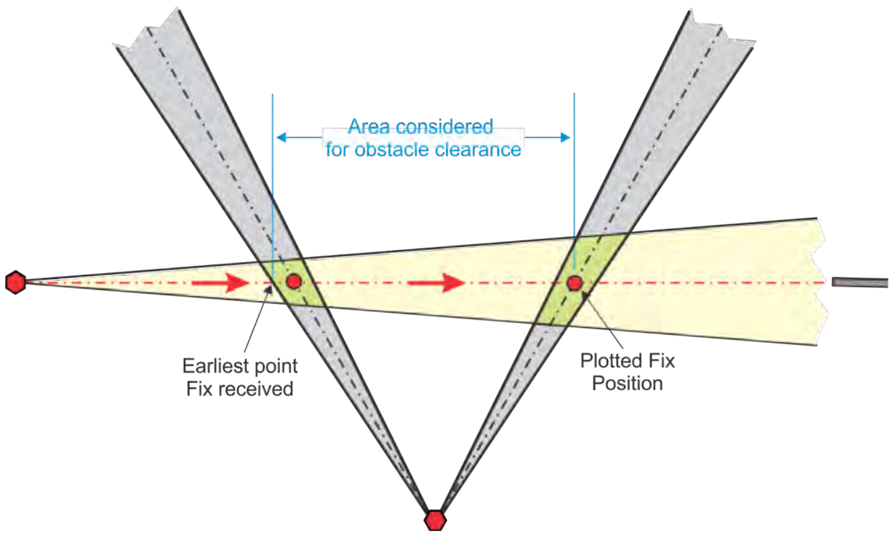
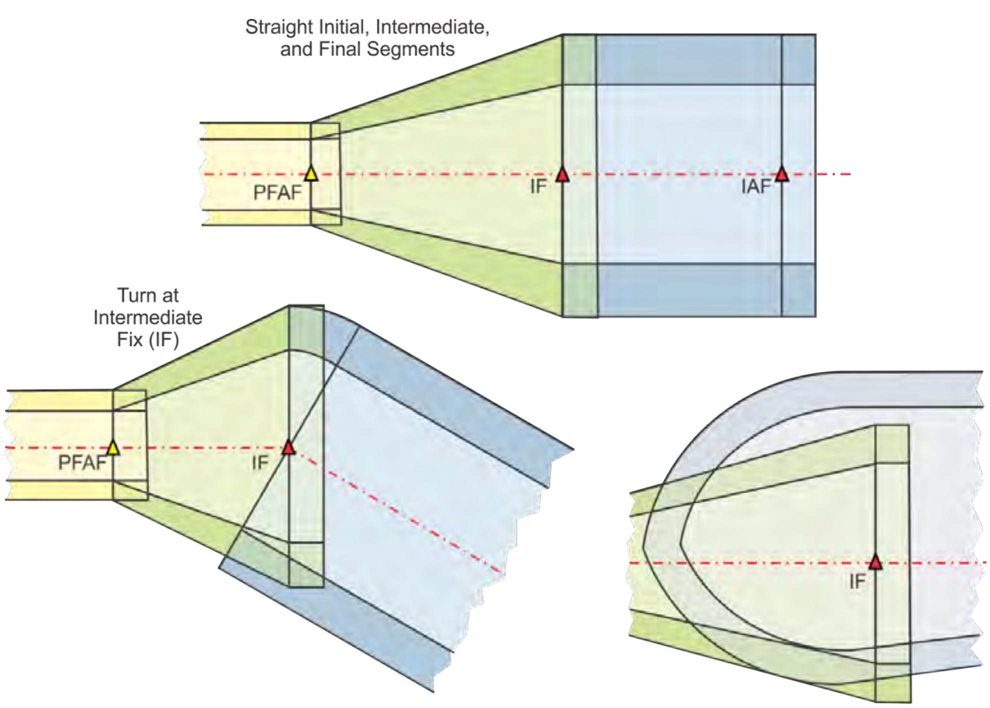


Figure 2-9-8. Construction of Fix Displacement Area for Obstacle Clearance



c. Stepdown fixes (see Figure 2-9-9).

(1) DME, ATD, RNAV WP, or radar fixes. Except in the intermediate segment within a PT (see paragraph 2-5-5), there is no maximum number of stepdown fixes in any segment when DME, an RNAV WP, an ATD fix, or radar is used. DME and ATD fixes may be denoted in tenths of a NM. The distance between fixes must not be less than 1 NM.

(2) Intersection fixes.

(a) Only one stepdown fix is permitted in the final and intermediate segments.

(b) If an intersection fix forms a PFAF, IF, or IAF:

1. The same crossing facility must be used for the stepdown fix(es) within that segment.

2. All fixes from the IF to a stepdown fix in final must be formed using the same crossing facility.

(c) Table 2-9-1 must be used to determine the number of stepdown fixes permitted in the initial segment. The distance between fixes must not be less than 1 NM.

(3) Altitude at the fix. The minimum altitude at each stepdown fix must be specified in 100-foot increments, except the altitude of a stepdown fix in the final segment may be specified in a 20-foot increment.

(4) In the final segment:

(a) Refer to paragraph 2-6-4.e for establishment of stepdown fix altitudes.

(b) A stepdown fix must not be established unless a decrease of at least 60 feet in MDA or a reduction in visibility minimums is achieved.

(c) The last stepdown fix error must not exceed plus-or-minus 2 NM or the distance to the MAP, whichever is less. The fix error for other stepdown fixes in the FAS must not exceed 1 NM.

(d) Minimums must be published both with and without the stepdown fix, except for procedures requiring DME or NDB procedures which use a VOR radial to define the stepdown fix.

Figure 2-9-9. Final Segment Stepdown Fix

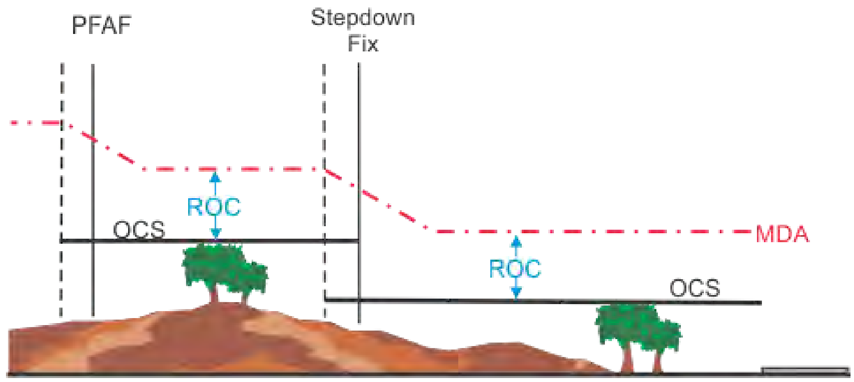


Table 2-9-1. Stepdown Fixes in Initial Segment

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 SDF. Obstacles close to the PFAF/SDF (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

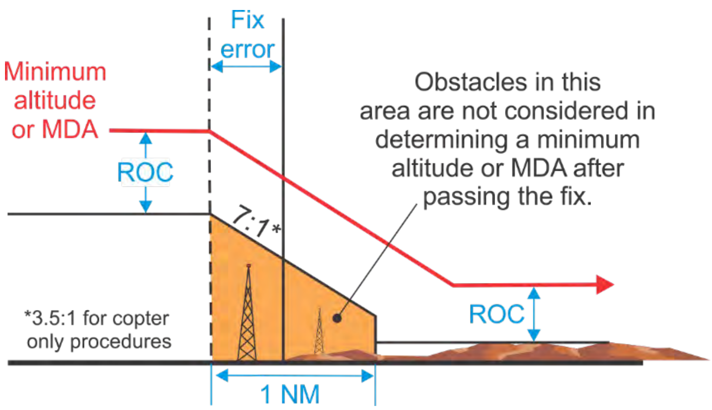


Table 3-1-3. PA/APV TCH Upper Limits for Allowing Approach Lighting Credit

<table>
<tr><th>HAT (Feet)</th><th>Glidepath Angle (Degrees)</th><th>TCH upper limit (Feet)</th><th>HAT (Feet)</th><th>Glidepath Angle (Degrees)</th><th>TCH Upper Limit (Feet)</th></tr>
<tr><td rowspan="11">*200 to 249</td><td># 2.50 - 3.20</td><td>75</td><td rowspan="9">300 to 349</td><td># 2.50 - 4.90</td><td>75</td></tr>
<tr><td>3.21 - 3.30</td><td>70</td><td>4.91 - 5.00</td><td>71</td></tr>
<tr><td>3.31 - 3.40</td><td>66</td><td>5.01 - 5.10</td><td>66</td></tr>
<tr><td>3.41 - 3.50</td><td>63</td><td>5.11 - 5.20</td><td>61</td></tr>
<tr><td>3.51 - 3.60</td><td>59</td><td>5.21 - 5.30</td><td>56</td></tr>
<tr><td>3.61 - 3.70</td><td>55</td><td>5.31 - 5.40</td><td>52</td></tr>
<tr><td>3.71 - 3.80</td><td>50</td><td>5.41 - 5.50</td><td>48</td></tr>
<tr><td>3.81 - 3.90</td><td>47</td><td>5.51 - 5.60</td><td>43</td></tr>
<tr><td>3.91 - 4.00</td><td>43</td><td>5.61 - 5.70</td><td>39</td></tr>
<tr><td>4.01 - 4.10</td><td>39</td><td colspan="3"></td></tr>
<tr><td>4.11 - 4.20</td><td>35</td><td rowspan="9">350 and above</td><td># 2.50 - 5.60</td><td>75</td></tr>
<tr><td colspan="3"></td><td>5.61 - 5.70</td><td>70</td></tr>
<tr><td rowspan="10">250 to 269</td><td># 2.50 - 4.10</td><td>75</td><td>5.71 - 5.80</td><td>65</td></tr>
<tr><td>4.11 - 4.20</td><td>71</td><td>5.81 - 5.90</td><td>60</td></tr>
<tr><td>4.21 - 4.30</td><td>67</td><td>5.91 - 6.00</td><td>55</td></tr>
<tr><td>4.31 - 4.40</td><td>62</td><td>6.01 - 6.10</td><td>50</td></tr>
<tr><td>4.41 - 4.50</td><td>58</td><td>6.11 - 6.20</td><td>45</td></tr>
<tr><td>4.51 - 4.60</td><td>54</td><td>6.21 - 6.30</td><td>40</td></tr>
<tr><td>4.61 - 4.70</td><td>50</td><td>6.31 - 6.40</td><td>35</td></tr>
<tr><td>4.71 - 4.80</td><td>45</td><td colspan="3" rowspan="11"></td></tr>
<tr><td>4.81 - 4.90</td><td>41</td></tr>
<tr><td>4.91 - 5.00</td><td>37</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="7">270 to 299</td><td># 2.50 - 4.40</td><td>75</td></tr>
<tr><td>4.41 - 4.50</td><td>73</td></tr>
<tr><td>4.51 - 4.60</td><td>68</td></tr>
<tr><td>4.61 - 4.70</td><td>64</td></tr>
<tr><td>4.71 - 4.80</td><td>59</td></tr>
<tr><td>4.81 - 4.90</td><td>55</td></tr>
<tr><td>4.91 - 5.00</td><td>51</td></tr>
</table>

***** 100 feet – 199 feet HAT for DoD PAR only

\# Approval required for angles less than 3 degrees [(see paragraph 1-4-2) (USAF & USN NA)]

Section 3-2. Establishing Minimum Altitudes/Heights

3-2-1. Establish minimum altitudes/heights for each authorized approach category. Minimum altitudes/height types are:

a. Decision altitude. A DA is a specified minimum altitude (feet MSL) in a PA or APV instrument approach procedure at which a decision is made to either continue the approach or to initiate a missed approach. Determine the DA using the appropriate criteria and specify in a one-foot increment (for example, 234.10 rounds to 235).

b. Decision height (DH). A DH serves the same purpose as a DA for CAT II ILS, but is expressed as a radio altimeter height above terrain.

c. Height above touchdown (HAT). Calculate by subtracting the TDZE (rounded to the nearest foot) from the DA/MDA. For example, if TDZE is 632.6 and MDA is 1040, then the HAT is 407 (1040 – 633 = 407). The minimum HAT for a PA/APV procedure is specified in Table 3-2-2 unless otherwise specified in the applicable design chapter. The minimum HAT for an NPA is equal to the minimum ROC applicable to the final approach segment primary area as specified in the applicable design chapter (for example, 300 feet for VOR no FAF, 250 feet for VOR/DME and LOC, etc.).

d. Height above airport (HAA). Calculate by subtracting the airport elevation (rounded to the nearest foot) from the CMDA. For example, if airport elevation is 437.4 and CMDA is 920, then the HAA is 483 (920 – 437 = 483). The HAA specified for each aircraft CAT must not be less than those specified in Table 3-2-1.

Table 3-2-1. Minimum Authorized HAA

CAT	A	B	C	D	E
HAA	350	450		550	

e. PinS Approaches. HAL is used for Proceed Visual approaches. Calculate HAL by subtracting the appropriate elevation (rounded to the nearest foot) from DA/MDA. For a Proceed Visual approach to a heliport, use the heliport elevation. For all other Proceed Visual approaches, use the elevation of the intended landing point. For example, if the heliport elevation is 403.4 and the MDA is 620, the HAL is 217 (620 – 403 = 217). HAS is used for Proceed VFR approaches. Calculate HAS by subtracting the surface elevation (see paragraph 12-2-4.c(1)(a)) (rounded to the nearest foot) from DA/MDA.

f. Radio altimeter (RA). When necessary to establish an RA height, first determine the elevation of the terrain directly beneath the DA point along the FAC. The RA is the difference between the DA and the terrain elevation and is calculated by applying Formula 3-2-1. Determine the distance from LTP to the DA point by applying Formula 3-2-2 (see example in Figure 3-2-1).

Formula 3-2-1. Calculating RA

$$RA = DA - terrain_{elev}$$

Where:

$terrain_{elev}$ = Terrain elevation on FAC at DA point

Formula 3-2-2. DA Point Distance from LTP (feet)

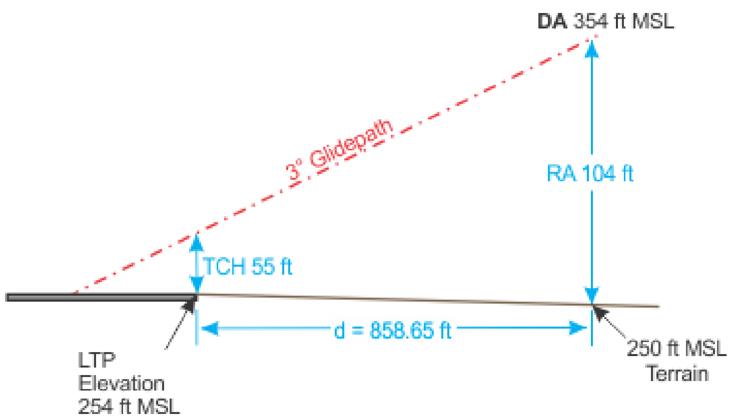
$$d_{LTP} = \frac{DA - (LTP_{elev} + TCH)}{\tan \theta}$$

Where:

LTP_{elev} = LTP elevation

θ = Glidepath angle

Figure 3-2-1. RA Example



g. Minimum descent altitude (MDA). MDA represents the final approach segment minimum altitude for NPA procedures. Each MDA must provide at least the minimum final approach segment (FAS) and missed approach segment (MAS) ROC as specified by the applicable chapter/standard. Express MDAs in 20-foot MSL increments; round upwards when necessary (for example, 820 remains 820, 821 rounds to 840). The MDA must not be higher than the PFAF altitude.

h. Circling MDA (CMDA). In addition to the requirements of paragraphs 3-2-1.d and 3-2-1.f, each CMDA must provide the minimum ROC in the circling maneuvering area and must not be lower than the highest straight-in or sidestep MDA (same CAT) published on the same chart.

Note: When dual minimums are authorized, the CMDA is compared against the straight-in MDA associated with the corresponding minima set (for example, circling with stepdown minimums checked against straight-in with stepdown minimums).

3-2-2. Adjustments to Minimum Altitudes/Heights. The MDA or DA may require an increase under the conditions described below:

a. PA/APV approaches. Determine the minimum HAT based on glidepath angle and aircraft category using Table 3-2-2.

Table 3-2-2. Minimum HAT for PA and APV Approach Procedures

<table>
<tr><th></th><th colspan="5">CAT</th></tr>
<tr><th>Glidepath Angle</th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th></tr>
<tr><td>2.50° - 2.99°[1]</td><td colspan="5">200[2,3]</td></tr>
<tr><td>3.00° - 3.10°</td><td colspan="5">200[2,3]</td></tr>
<tr><td>3.11° - 3.30°</td><td colspan="2">200[3]</td><td colspan="2">250</td><td>NA[5]</td></tr>
<tr><td>3.31° - 3.50°</td><td colspan="2">200[3]</td><td colspan="2">270</td><td>NA[6]</td></tr>
<tr><td>3.51° - 3.77°</td><td colspan="2">200[3,4]</td><td>300</td><td colspan="2">NA</td></tr>
<tr><td>3.78° - 3.80°</td><td colspan="2">200[3,4]</td><td colspan="3">NA</td></tr>
<tr><td>3.81° - 4.20°</td><td>200[3,4]</td><td>250</td><td colspan="3">NA</td></tr>
<tr><td>4.21° - 5.00°</td><td>250</td><td colspan="4">NA</td></tr>
<tr><td>5.01° - 5.70°</td><td>300</td><td colspan="4">NA</td></tr>
<tr><td>5.71° - 6.40°
Airspeed NTE
80 knots</td><td>350</td><td colspan="4">NA</td></tr>
</table>

1. Approval required for angles less than three degrees (see paragraph 1-4-2) (DoD NA)
2. PAR minimum HAT = 100 (DoD only)
3. LNAV/VNAV, RNP AR, and LDA with GS minimum HAT = 250
4. LPV w/GPA > 3.5° = 250
5. USN and USAF only = 250
6. USN and USAF only = 270

b. Precipitous terrain. In areas characterized by precipitous terrain (in or outside of designated mountainous areas) consideration must be given to induced altimeter errors and pilot control problems.

(1) Precipitous terrain adjustments must be accomplished using software implementing the algorithms in Appendix C paragraph 1 for instrument approach procedure segments and level holding associated with a DP.

(a) Precipitous terrain identified in the final segment**.**

1. NPA. Increase ROC values by the amount specified by the software.

2. PA and APV. For approaches that permit precipitous terrain in the final segment, increase the HAT by 10 percent of the value determined by evaluation of the final and

missed segments; for example, 200-foot HAT increases to 220 feet, 350-foot HAT increases to 385 feet. Do not include adjustments for RASS before determining the precipitous terrain adjustment.

(b) Precipitous terrain identified in initial, intermediate, missed approach OEA (applicable to the missed approach obstruction altitude), and missed approach and departure holding segments. Increase ROC by the amount specified by the software. Precipitous terrain adjustments are not applied to the missed approach sloping OCS.

(2) Determination of precipitous terrain should be accomplished using the algorithms in Appendix C or other methods for other evaluations such as radar vectoring altitude charts, STAR, feeder routes, TAA, and ATS routes.

(3) Where operationally advantageous, results from the Precipitous Point Value (PPV) algorithms in Appendix C paragraph 2 may be used with approval.

c. Remote altimeter setting source (RASS). Not applicable to MSAs, initials, en route, feeder routes, or segment/areas based on en route criteria. When the altimeter setting is obtained from a source more than 5 NM from the ARP for an airport, heliport reference point (HRP) for a heliport, or the MAP for a Proceed VFR PinS approach, a RASS adjustment must be considered. A RASS is not authorized for a remote distance greater than 75 NM or for an elevation differential between the RASS and the landing area that is greater than 6000 feet. To determine which formula applies, evaluate the terrain between the RASS and the airport/heliport/PinS MAP for adverse atmospheric pressure pattern effect. Solicit the best available climatological information from the Aviation Weather Center, National Weather Service (NWS), and/or the Center Weather Service Unit (CWSU).

Note: When a secondary altimeter source must be specified and either the primary or secondary altimeter source (or both) is considered remote (more than 5 NM from the ARP), establish separate landing minima. If establishing separate minima is impractical, publish a chart note specifying the difference between the MDA/DA for primary and secondary sources.

(1) Where intervening terrain does not adversely influence atmospheric pressure patterns, use Formula 3-2-3 to compute the basic RASS adjustment in feet (see Figure 3-2-2).

Formula 3-2-3. Basic RASS adjustment (no intervening terrain)

$$Adjustments = 2.30 \times D_r + 0.14 \times E_1$$

Where:

D_r = Horizontal dist (NM) altimeter source to ARP/HRP*

E_1 = Elevation differential (feet) between RASS elevation and airport/heliport/ elevation (use heliport elevation for helicopter PinS approaches; if multiple landing areas are utilized by the approach procedure, use the landing area elevation with the greatest differential to the RASS elevation)

***** Copter PinS Approaches/Departures. When annotated “Proceed Visually”: D_r = Horizontal distance from altimeter source to HRP. When annotated “Proceed VFR”: D_r = Horizontal distance from altimeter source to MAP/IDF.

Examples:

<u>Airport</u>

D_r = 10.8 NM

E_1 = 1000 - 800 = 200 feet

$(2.30 \times 10.8) + (0.14 \times 200) = 52.84$ feet basic RASS adjustment

In intermediate segment: $52.84 \times 0.6 < 200$ (no ROC increase)

In PA/APV final segment: DA = 200 + 52.84 = increase DA to 253

In NPA final segment: 1225 (Controlling obs) + 250 ROC + 52.84 = 1540 MDA

<u>Heliport</u>

D_r = 6.4 NM

E_1 = 1200 - 1000 = 200 feet

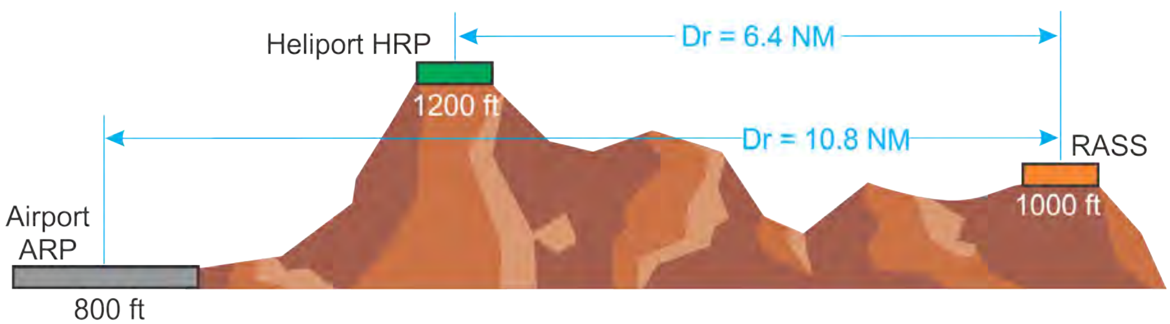
$(2.30 \times 6.4) + (0.14 \times 200) = 42.72$ feet basic RASS adjustment

In intermediate segment $42.72 \times 0.6 < 200$ (no ROC increase)

In PA/APV final segment: DA = 200 + 42.72 = increase DA to 243

In NPA final segment: 1225 (Controlling obs) + 250 ROC + 42.72 = 1520 MDA

Figure 3-2-2. Basic RASS adjustment (no intervening terrain)



(2) Where intervening terrain adversely influences atmospheric pressure patterns, an Elevation Differential Area (EDA) must be evaluated. The EDA is defined as an area 5 NM each side of a line connecting the ARP/HRP (or MAP/IDF for "Proceed VFR" PinS approaches/departures) and the RASS, and includes a circular area enclosed by a 5 NM radius at each end of this line. Use Formula 3-2-4 to compute the basic adjustment in feet (see Figure 3-2-3).

Formula 3-2-4. RASS Adjustment Adverse Terrain

$$Adjustments = 2.30 \times D_r + 0.14 \times E_2$$

Where:

D_r = Horizontal dist (NM) altimeter source to ARP/HRP*

E_2 = The elevation differential (feet) between lowest and highest elevation points within the EDA

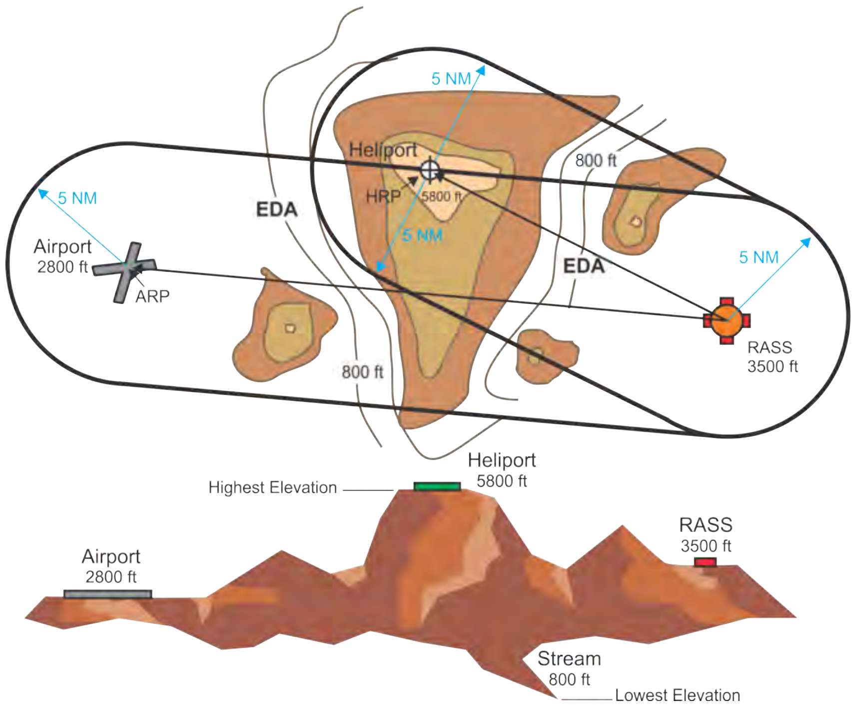
* Copter PinS Approaches/Departures. When annotated "Proceed Visually": D_r = Horizontal distance from altimeter source to HRP. When annotated "Proceed VFR": D_r = Horizontal distance from altimeter source to MAP/IDF.

Examples:

<u>Airport</u>
D_r = 25 NM
E_2 = 5800 - 800 = 5000 feet
$(2.30 \times 25) + (0.14 \times 5000) = 757.5$ feet basic RASS adjustment
In intermediate segment $757.5 \times 0.6 = 454.5 - 200$ (254.5 feet ROC increase)
In PA/APV final segment: DA = 350 + 757.5 = increase DA to 1108
In NPA final segment: 3052.2 (Controlling obs) + 250 ROC + 757.5 = 4060 MDA

<u>Heliport</u>
D_r = 15 NM
E_2 = 5800 - 800 = 5000 feet
$(2.30 \times 15) + (0.14 \times 5000) = 734.5$ feet basic RASS adjustment
In intermediate segment $734.5 \times 0.6 = 440.7 - 200$ (240.7 feet ROC increase)
In PA/APV final segment: DA = 294 + 734.5 = increase DA to 1029
In NPA final segment: 6000 (Controlling obs) + 250 ROC + 734.5 = 7000 MDA

Figure 3-2-3. Elevation Differential Area (EDA)
Intervening Terrain Influences Atmospheric Pressure Patterns



(3) Final approach segment adjustments.

(a) NPA final segments (including the circling maneuvering area). Increase primary area ROC by the full basic RASS adjustment.

(b) PA/APV final segments. Increase the DA (prior to rounding) by the full basic RASS adjustment.

(c) To determine separate landing minima for a secondary altimeter source, or to determine the increase for a secondary altimeter RASS by chart note:

1. If the primary altimeter source is local (not remote), the MDA/DA adjustment will be the full secondary source RASS adjustment, rounded up to the next publishable increment.

Example:
Secondary altimeter RASS: 72.3 feet
Value for secondary MDA adjustment: 80 feet
Value for secondary DA adjustment: 73 feet

Primary MDA calculation:
1832 (obs. elev.) + 250 (ROC) = 2082 feet (round to 2100 for publication)
Secondary MDA calculation:
2100 (primary MDA) + 80 (secondary RASS adjustment) = 2180

2. If the primary altimeter source is remote, the MDA/DA adjustment from the primary landing minima is the difference between the secondary source RASS adjustment and the primary source RASS adjustment rounded up to the next publishable increment.

Example:
Primary altimeter RASS (remote): 43.7 feet
Secondary altimeter RASS: 72.3 feet
Difference: 72.3 – 43.7 = 28.6 feet
Value for secondary MDA adjustment: 40 feet
Value for secondary DA adjustment: 29 feet

Primary MDA calculation:
1832 (obs. elev.) + 250 (ROC) + 43.7 (RASS) = 2125.7 feet (round to 2140 for publication)
Secondary MDA calculation:
2140 (primary MDA) + 40 (secondary RASS adjustment) = 2180

(4) For the intermediate segment, use 60 percent of the basic RASS adjustment from Formula 3-2-3 or Formula 3-2-4, and increase the intermediate segment primary area ROC by the amount this value exceeds 200 feet.

(5) When the missed approach design utilizes a turn at altitude prior to the clearance limit and a part-time altimeter source is specified, decrease the turning section OCS starting height by the difference between RASS adjustments for the two remote altimeter sources. Where one altimeter source is local, subtract the full raw RASS adjustment. Do not decrease these surface starting heights to less than the OCS at the MAP. If this results in an OCS penetration that cannot be resolved by other methods, provide a second climb-to-altitude determined by adding the difference between the RASS adjustments to the climb-to-altitude and rounding to the next higher appropriate increment. This application must not produce a turn altitude above the missed approach clearance-limit altitude.

Example: "MISSED APPROACH: Climb to 6000 (6100 when using Denver Intl altimeter setting) then…"

Note: Combination straight-portion length extension is not required to accommodate the worst-case altimeter source.

(6) Minimum reception altitude (MRA). Where a minimum altitude is MRA based, increase the MRA by the required RASS adjustment.

(7) Where the altimeter setting is based on a remote source(s), annotate the procedure and/or publish the appropriate minima lines in accordance with Order 8260.19.

d. Excessive length, non-precision final approach. When a procedure incorporates a PFAF, and the PFAF-to-MAP length exceeds 6 NM (plotted positions), increase the final segment primary area ROC five feet for each one-tenth NM over 6 NM.

Exception: If a stepdown fix exists and the remaining segment length is less than 6 NM, the basic ROC may be applied between the stepdown fix and the MAP (see Formula 3-2-5).

Formula 3-2-5. Excessive Length Adjustment

$$Adjustments = 50\left(Length_{final} - 6\right)$$

Where:

$length_{final}$ = Horizontal distance (NM) from PFAF to MAP (plotted position)

Example:
Distance PFAF to MAP = 6.47
Adjustment = 50(6.47- 6) = 23.5
250 ROC + 23.5 = 273.5 adjusted ROC

e. Multiple adjustment sources. When multiple adjustments are required, the resulting MDA/DA will be the sum of the raw values of the adjustments, rounded to the next higher altitude increment for publication.

Example:
For an airport with both remote primary and secondary source, with both precipitous terrain and excessive length of final adjustments:

Primary altimeter RASS (remote):	43.7 feet
Secondary altimeter RASS:	72.3 feet
Difference (72.3 – 43.7):	28.6 feet

Primary MDA

Nonprecision approach controlling obstruction elevation	1250.3	MSL
ROC	250	feet
Primary RASS	43.7	feet
Precipitous terrain adjustment	25.1	feet
Excessive length of final adjustment	23.5	feet
	1592.6	MSL
Published rounded value	**1600**	**MSL**

Secondary MDA

Primary published MDA	1600	MSL
RASS adjustment difference (rounded)	40	feet
Published secondary MDA	**1640**	**MSL**

Section 3-3. Visibility Minimums

3-3-1. Visibility Minimums Authorization.

a. Straight-in visibility minimums are authorized when:

(1) Applicable straight-in alignment standards are met, and

(2) The final approach segment VDA (when applicable) does not exceed tolerances (see paragraphs 2-6-2 and 2-6-4).

b. Circling visibility minimums are authorized when:

(1) Straight-in alignment requirements cannot be met, or

(2) Straight-in alignment requirements are met, but descent angle precludes publication of straight-in minimums (see paragraph 2-6-2.c), or

(3) Published in conjunction with straight-in NPA minimums.

Note: Do not establish circling minimums when PA or APV procedures are established without accompanying straight-in NPA minimums.

3-3-2. Establishing Straight-in Visibility Minimums. Establish as RVR where applicable, otherwise as a statute mile (SM) value. Meter (M) values are for locations outside the U.S.

a. Visibility without approach lights. Determine visibility without approach lights as the highest of:

(1) The value specified in the applicable row and the NALS column of Table 3-3-1, Table 3-3-2, Table 3-3-3, or Table 3-3-4 (as applicable) for the type approach and CAT.

(a) Use Table 3-3-1 for all procedures and CATs except for CAT A and B NPA, CAT II/III ILS, Special Authorization (SA) CAT I/II ILS and helicopter approaches.

(b) Use Table 3-3-3 for CAT A straight-in NPA procedures.

(c) Use Table 3-3-4 for CAT B straight-in NPA approaches.

(2) The MAP-to-LTP distance (NPA only, and only if MAP is located prior to LTP) (see Figure 3-3-1).

(a) Determine the MAP-to-LTP distance in feet.

(b) Regardless of approach CAT for which visibility is being determined, convert the distance to a SM or M value contained within the NALS column of Table 3-3-1; round upwards when necessary. For example, if the MAP-to-LTP distance is 5121.44 feet (converts to 0.97 SM), select 1 SM from Table 3-3-1 since it is the next value contained on the table greater than 0.97 SM.

(c) For RVR minimums, use the RVR value associated with the SM visibility selected in paragraph 3-3-2.a(2)(b). Use RVR 5000 for 1 SM.

(d) If the MAP-to-LTP distance is greater than 3 SM, then round to the next whole mile increment (1000 M increments when meters are applicable).

(3) The DA point-to-LTP distance (PA/APV only and only if greater than 3 SM).

(a) Determine the DA point-to-LTP distance in feet by applying Formula 3-2-2.

(b) Convert the distance to a SM value (or M when applicable); if not in a whole SM increment, then round upwards to the next whole SM (1000 M increment for meters). For example, use 4 SM if the DA point-to-LTP distance is 19694 feet (converts to 3.73 SM).

(4) The minimum visibility based on evaluation of the visual area (see paragraph 3-3-2c(4)).

(5) The minimum visibility based on runway requirements (see paragraph 3-3-2.d).

b. Visibility with approach lights. When authorized approach light credit (see paragraph 3-1-2.c(2)), determine visibility with approach lights as the highest of:

(1) The value specified in the applicable row and column of Table 3-3-1, Table 3-3-2, Table 3-3-3, Table 3-3-4, and Table 3-3-5 (as applicable) for the type approach and CAT.

(a) Use Table 3-3-1 for all procedures and CATs except for CAT A and B NPA, CAT II/III ILS, Special Authorization (SA) CAT I/II ILS and helicopter approaches.

(b) Use Table 3-3-3 for CAT A straight-in NPA procedures. Use Table 3-3-4 for CAT B straight-in NPA approaches.

(c) Use Table 3-3-5 for CAT C/D/E straight-in NPA procedures to runways with FALS after determining the visibility minimums prescribed by Table 3-3-1.

(2) The MAP-to-LTP distance [(NPA only, and only if MAP is located prior to LTP) (see Figure 3-3-1)].

(a) Determine the MAP-to-LTP distance in feet, then subtract 2400 feet for a FALS, 1400 feet for an IALS, or 700 feet for a BALS.

(b) Convert the distance to a SM or M value (as appropriate) contained within the appropriate ALS column of Table 3-3-1 (regardless of approach CAT for which visibility is being determined); round upwards when necessary. For example, if the MAP-to-LTP distance is 5186.23 feet, and a FALS system is applicable, subtract 2400 feet for the FALS to arrive at 2786.23 feet (converts to 0.53 SM). Then select 5/8 SM from Table 3-3-1 since it is the next incremental value greater than 0.53 SM found on the table.

Table 3-3-2. U.S. Military Standard Minimums PAR with HAT < 200 feet (all CATs)

ALSF TDZ and CL			ALSF/SSALR/SALS/SSALS			MALSR/MALS/ODALS			NO LIGHTS		
RVR	SM	M	RVR	SM	M	RVR	SM	M	RVR	SM	M
1200	-	350	1600	1/4	500	2400	1/2	750	2400	1/2	750

Table 3-3-3. CAT A Straight-in NPA, Authorized RVR/Visibility

	FALS			IALS			BALS			NALS		
HAT/HAA	RVR	SM	M	RVR	SM	M	RVR	SM	M	RVR	SM	M
250-880	2400[1]	1/2 [1]	750[1]	4000	3/4	1200	4000	3/4	1200	5500	1	1600
881-above	4000	3/4	1200	5500	1	1600	5500	1	1600		1 1/4	2000

1. RVR 4000, 3/4 SM, 1200m (NDB)

Table 3-3-4. CAT B Straight-in NPA, Authorized RVR/Visibility

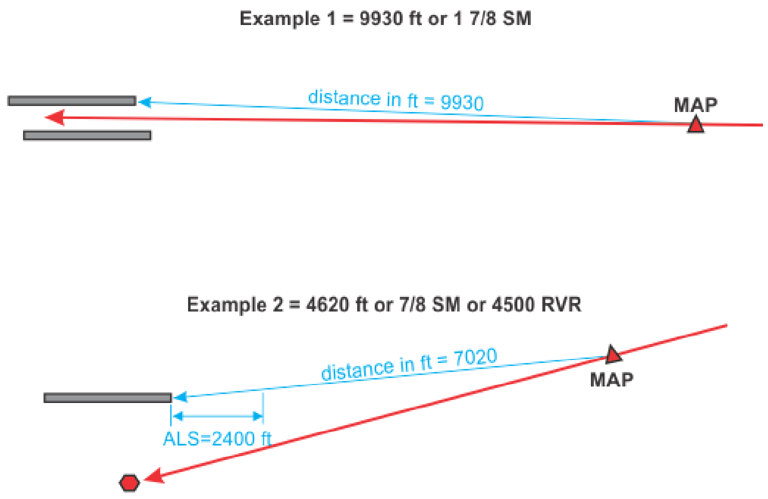
	FALS			IALS			BALS			NALS		
HAT/HAA	RVR	SM	M	RVR	SM	M	RVR	SM	M	RVR	SM	M
250-740	2400[1]	1/2[1]	750[1]	4000	3/4	1200	4000	3/4	1200	5500	1	1600
741-950	4000	3/4	1200	5500	1	1600	5500	1	1600		1 1/4	2000
951-above	5500	1	1600		1 1/4	2000		1 1/4	2000		1 1/2	2400

1. RVR 4000, 3/4 SM, 1200m (NDB)

Table 3-3-5. Minimum Straight-in RVR/Visibility NPA Procedures CAT C/D/E

Procedure Design					
- Final approach guidance is not NDB, AND - Final Course-RWY C/L offset: ≤ 5°, AND - Final Approach segment ≥ 3 NM, AND - With PFAF procedure, AND- *PFAF to LTP ≤ 8 NM (*If time/distance table is published)			ALL OTHERS		
RVR	**SM**	**M**	**RVR**	**SM**	**M**
2400	1/2	750	4000	3/4	1200

Figure 3-3-1. MAP to LTP Distance Straight-in Aligned



c. Determine visibility based on evaluation of the visual portion of the final approach segment. Apply the circling visual area to runways to which an aircraft is authorized to circle (either in association with a straight-in procedure or a circling only approach) and to runways to which a sidestep maneuver is authorized. Apply the straight-in visual area to runways with approach procedures aligned with the runway centerline (less than or equal to ± 0.03 degrees). Apply the offset visual area to evaluate the visual portion of a straight-in approach that is not aligned with the runway centerline (more than ± 0.03 degrees). These evaluations determine if visibility minimums and/or night operations must be restricted.

Note: Assess the appropriate visual area separately for each line of minima on the same approach plate.

(1) Circling visual area (see Figure 3-3-2).

(a) Alignment. Align with the RCL extended.

(b) Width. The beginning width is ± 200 feet either side of RCL. The sides splay outward relative to RCL. Calculate the half-width of the area at any distance "d" from its origin using Formula 3-3-1.

(c) Length. The area begins 200 feet from LTP and extends 10000 feet out RCL.

(2) Straight-in visual area. Procedure need not meet straight-in descent criteria (see Figure 3-3-2). Straight-in visual areas are also applied to helicopter procedures to IFR heliports.

(a) Alignment. Align with the RCL for approaches to a runway, and the FAC for approaches to IFR heliports.

(b) Width. Calculate the half-width of the area at any distance "d" from its origin using Formula 3-3-1.

1. For approaches to a runway, the beginning width is ± 200 feet either side of RCL. The sides splay outward relative to RCL.

2. For approaches to an IFR heliport, the beginning width is the width of the heliport safety area.

(c) Length. The area begins 200 feet from LTP (or leading edge of the heliport safety area for IFR heliports) and extends to the calculated DA point for each PA or APV procedure, and to the VDP location (even if one is not published) for NPA procedures (see paragraph 2-6-5).

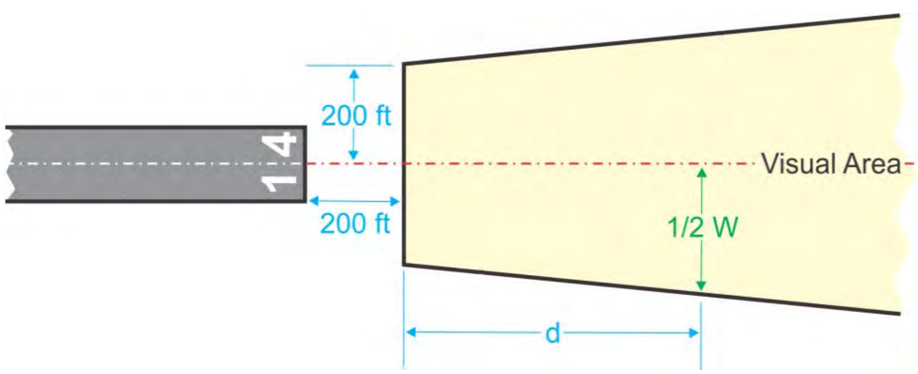
Note: When multiple NPA minimums are published on the same chart (such as dual minimums or applicable RNAV procedures), use the lowest MDA to determine VDP location and to determine the length of the visual area. For PA/APV approaches, calculate the DA point based on the primary altimeter source.

Formula 3-3-1. Visual Area ½ Width

$$1/_2\, W = (0.15 \times d) + 200 \text{ (for runways)}$$
$$1/_2\, W = (0.15 \times d) + w_h \text{ (for IFR heliports)}$$

Where:
½W = Perpendicular distance (feet) from RCL (FAC for IFR heliports) to area edge
d = Distance (feet) measured along RCL (FAC for IFR heliports) from area origin
w_h = one-half the width of the safety area (feet)

Figure 3-3-2. Circling and Straight-In Visual Area for Approach to a Runway



(3) Offset visual areas. Procedure need not meet straight-in descent criteria.

(a) When the final course is not aligned within ± 0.03° of the RCL (FAC for IFR heliports) or is not within ± 5 feet of LTP (± 5 feet of the center of the heliport safety area for IFR heliports), modify the straight-in visual area as follows (see Figure 3-3-3):

1. *Step 1*. Draw the straight-in area aligned with the RCL (FAC for IFR heliports) as previously described.

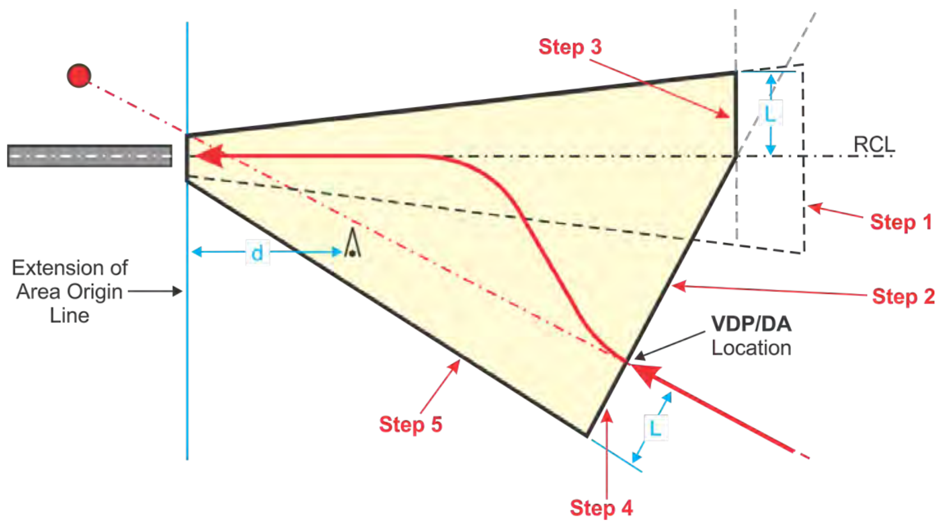
<u>2.</u> *Step 2*. Extend a line perpendicular to the FAC from the DA point or VDP (even if one is not published) to the point it crosses the RCL (FAC for IFR heliports).

<u>3.</u> *Step 3*. Extend a line from this point perpendicular to the RCL (FAC for IFR heliports) to the outer edge of the straight-in area, noting the length (L).

<u>4.</u> *Step 4*. Extend a line in the opposite direction of the line in step 2 from the DA/VDP perpendicular to the FAC for distance (L).

<u>5.</u> *Step 5*. Connect the end of the line constructed in step 4 to the end of the inner edge of the area origin line 200 feet from LTP (edge of the heliport safety area for IFR heliports).

Figure 3-3-3. Offset Visual Area



(b) In cases where the FAC does not intercept the extended RCL, but lies within 500 feet laterally of the extended RCL at a point 3000 feet outward from the LTP and is within ± 5 feet of LTP, apply the straight-in visual area from paragraph 3-3-2.c(2).

(4) OIS. When evaluating a straight-in or offset visual area, apply both a 34:1 and a 20:1 OIS. When evaluating the circling visual area or helicopter procedures to an IFR heliport, apply a 20:1 surface only. Calculate the OIS height above LTP elevation (TLOF elevation for helicopter approaches to IFR heliports) at any distance "d" from an extension of the area origin line using Formula 3-3-2:

Formula 3-3-2. Visual Area OIS Height Above LTP Elevation

$$20{:}1\ OIS\ Height = \frac{d}{20}$$

$$34{:}1\ OIS\ Height = \frac{d}{34}$$

Where:

d = Dist. (feet) measured along RCL from area origin extended

(a) 34:1 OIS. If penetrated, limit visibility to no lower than 4000 RVR or ¾ SM.

(b) 20:1 OIS. If penetrated, limit visibility to no lower than 5000 RVR or 1 SM, do not publish a VDP, and if the obstacle is unlighted, annotate the chart to deny the approach or the applicable minimums at night.

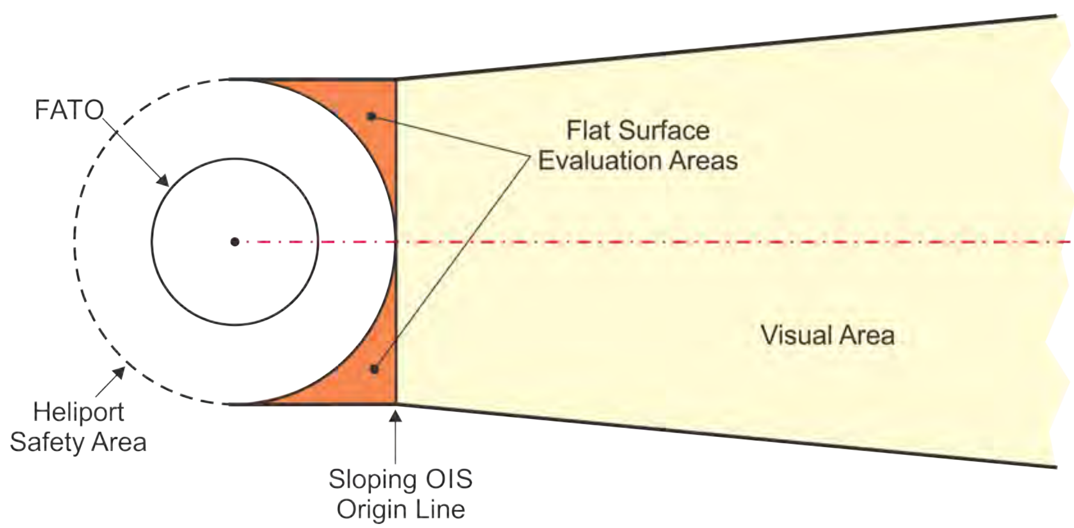
1. A VGSI may be used in lieu of obstruction lighting with approval (see paragraph 1-4-2).

2. If a straight-in approach is restricted at night due to a 20:1 OIS penetration, deny circling at night to the same runway on all approach procedures.

(5) Light units and associated support hardware of an approach lighting system and runway and taxiway guidance signs, installed in accordance with FAA (or military) standards may be disregarded if they penetrate the 34:1 or 20:1 OIS.

(6) For helicopter approaches to IFR heliports with a circular FATO, the VGS origin line will be perpendicular to the FAC and tangent to the circular heliport safety area (see Figure 3-3-4). The origin width will be equal to the diameter of the safety area. The OIS evaluation will be the same as paragraph 3-3-2.c(4). If any obstacles are located in the areas between the origin line and the edge of the safety area abeam the center of the TLOF, the limitations of paragraph 3-3-2.c(4). will be applied.

Figure 3-3-4. Helicopter Visual Area with Circular FATO



d. Runway Requirements. Table 3-3-6 specifies minimum visibility based on runway characteristics.

Table 3-3-6. Minimum Visibility Based on Runway Characteristics

Runway Characteristics	RVR	SM	M
Runway does not have a full length parallel taxiway[1]	5000	1	1500
Edge lighting is not HIRL or MIRL	NA	1	1500
Surface is not asphalt or concrete	4000	3/4	1200
Does not have precision runway markings	4000	3/4	1200
Length is less than 4200 feet	4000	3/4	1200
Runway survey type does not support vertical guidance[2]	4000	3/4	1200

1. This line is not applicable if:
   a. The airport is serviced by a full time ATC control tower.
   b. The airport is serviced by a part-time ATC control tower and the chart is annotated to increase the visibility when the tower is closed.
   c. Taxiway(s) are available that permit entry/exit along the full extent of the runway without requiring back-taxi operations.
2. Refer to AC 150/5300-18, General guidance and Specification for Submission of Aeronautical Surveys to NGS: Field Data Collection and Geographic Information System (GIS) Standards, for a description of survey types.

e. Inoperative Lighting Components. Where an ALS is installed, determine the applicability of the U.S. Terminal Procedures Publication (TPP) “Inoperative Components and Visual Aids” table. This step is not applicable to the USAF.

(1) Compare the visibility without approach lights (see paragraph 3-3-2.a) with the visibility with approach lights (paragraph 3-3-2.b) for each approach CAT.

(2) If there is no difference between the “without lights” and the “with lights” values, or if the difference is not equal to the required increase found in the “Increase Visibility” column of the Inoperative Components and Visual Aids table, then annotate the procedure in accordance with Order 8260.19, paragraph 8-6-5.

(3) If the difference between the “without lights” and the “with lights” values is equal to the required increase found in the “Increase Visibility” column of the Inoperative Components and Visual Aids table, then no action or annotation is required.

3-3-3. Establishing Circling Visibility Minimums. Establish as a statute (SM) value. Meter (M) values are for locations outside the United States only. Determine circling visibility as the highest of:

a. The value specified in the applicable row and column of Table 3-3-7.

b. The distance from the MAP to the nearest surface authorized for landing by a circling aligned procedure [(only if MAP is located prior to the nearest landing surface) (see Figure 3-3-5)]. For procedures meeting straight-in alignment, use the distance from the MAP to the LTP (see Figure 3-3-1).

(1) Determine the distance in feet and then convert to SM or M (as appropriate).

(2) The converted value must be in an incremental value contained within Table 3-3-7; round upwards when necessary. For example, if the MAP distance is 10664.81 feet (2.02 SM), select 2 1/4 SM (3600 M if applicable) from Table 3-3-7 since it is the next value contained on the table.

(3) If the MAP distance is greater than 3 SM, then round to the next whole mile increment (1000 M increments when meters are applicable).

c. Evaluation of the visual portion of the final approach segment (see paragraph 3-3-2.c).

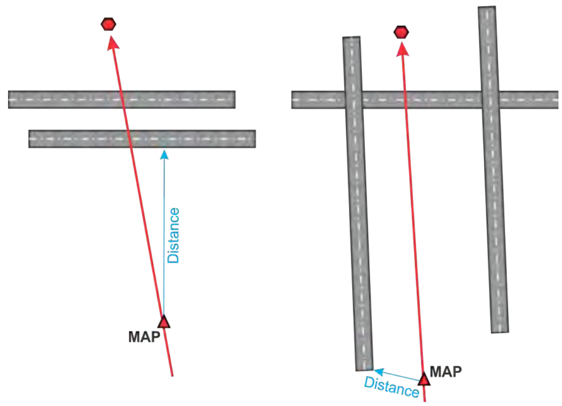
d. The "without approach lights" (see paragraph 3-3-2.a) visibility of the highest straight-in or sidestep line of minima (same CAT) published on the same chart.

Note: For dual minimums, the circling visibility is compared to the corresponding straight-in visibility set (for example, "UKENE FIX MINIMUMS" circling visibility compared to "UKENE FIX MINIMUMS" straight-in visibility).

Table 3-3-7. Authorized Circling Visibility Minimums

CAT →	A		B		C		D		E	
HAA	**SM**	**M**	**SM**	**M**	**SM**	**M**	**SM**	**M**	**SM**	**M**
350 - 449	1	1600								
450 - 549	1	1600	1	1600	1 1/2	2400				
550 - 600	1	1600	1	1600	1 1/2	2400	2	3200	2	3200
601 - 670	1	1600	1	1600	1 3/4	2800	2	3200	2 1/4	3600
671 – 740	1	1600	1	1600	2	3200	2 1/4	3600	2 1/2	4000
741 - 810	1	1600	1	1600	2 1/4	3600	2 1/2	4000	2 3/4	4400
811 - 880	1 1/4	2000	1 1/4	2000	2 1/2	4000	2 3/4	4400	3	4800
881 - 950	1 1/4	2000	1 1/4	2000	2 3/4	4400	3	4800	3	4800
951 and above	1 1/4	2000	1 1/2	2400	3	4800	3	4800	3	4800

Figure 3-3-5. MAP to Nearest Landing Surface, Circling Aligned



3-3-4. Establishing Sidestep Visibility Minimums. Apply the circling visual area (see paragraph 3-3-2.c(1)) to the sidestep runway and assess the 20:1 surface. If penetrated, publish a note denying the sidestep maneuver at night unless the obstacle is lighted. Use of VGSI may be used in lieu of obstruction lighting with approval (see paragraph 1-4-2).

a. Establish published visibility as follows:

(1) Determine visibility without approach lights by applying Table 3-3-7.

(a) Substitute the sidestep height above touchdown (HAT) for HAA.

(b) If the HAT is less than 450 feet for CAT B and C, then the minimum visibility is 1 SM for CAT B, and 1 ½ SM for CAT C. If the HAT is less than 550 feet for CAT D and E, then the minimum visibility is 2 SM for both CATs.

(2) One-half SM visibility reduction is authorized when a full approach light system (FALS) is installed to the sidestep runway (see Table 3-1-2). The minimum visibility after applying this reduction must not be less than 1 SM.

(3) When the sidestep runway threshold is offset/staggered, and is more than 1000 feet closer to the PFAF than the runway with course guidance, increase the published visibility by an additional 1/4 SM, or by the actual offset distance, whichever is greater.

(4) The published sidestep visibility must not be less than the highest straight-in visibility for the primary approach (for each CAT).

(5) Publish 1 SM visibility as RVR 5500 when the provisions of paragraph 3-1-2.b are met.

3-3-5. Fly Visual to Airport. Where the DA/MAP-to-LTP distance (straight-in procedures) or the MAP-to-nearest landing surface distance (circling procedures) exceeds 3 SM, and the DA/MDA is greater than 900 feet above airport elevation, 3 SM visibility may be established with approval (see paragraph 1-4-2). Such procedures must be annotated with "Fly Visual to Airport."

Section 3-5. Takeoff Minimums

3-5-1. Civil Standard Takeoff Minimums. Title 14 CFR part 91.175(f) defines civil takeoff minimums for aircraft operating under part 121, 125, 129, or 135 as shown in Table 3-5-1. A ceiling value may also be required to see and avoid an obstacle. In this case, the published procedure must identify the location of the obstacle(s) that must be avoided. See Order 8260.46, Departure Procedure (DP) Program, for guidance on how and when other than standard takeoff minimums and/or obstacles are defined.

Table 3-5-1. Standard Civil Takeoff Minimums

Number of Engines	Visibility (SM)
1 or 2	1
3 or more	1/2
Helicopter	1/2

Section 10-5. CAT II/III ILS Evaluation

10-5-1. General Information. This section describes criteria for the evaluation of CAT II and III ILS procedures.

10-5-2. Final Approach Segment. The CAT I ILS final approach segment obstacle evaluation applies to the CAT II/III approach authorization. The CAT I procedure must support a 200-foot HAT and lowest possible visibility (no restrictions incurred by lack of infrastructure or obstacle surface penetrations). The GPA must be 3.0 degrees unless approved (see paragraph 1-4-2).

10-5-3. Approach Light Area. Obstructions must not penetrate the approach light plane or the inner-approach OFZ in accordance with AC 150/5300-13.

10-5-4. Approach Minimums. The lowest CAT II HAT is 100 feet. Apply Table 10-5-1 to determine the minimum RVR associated with the lowest authorized CAT II HAT (see paragraph 10-5-6 for CAT III RVR requirements).

Table 10-5-1. Minimum Authorized CAT II RVR

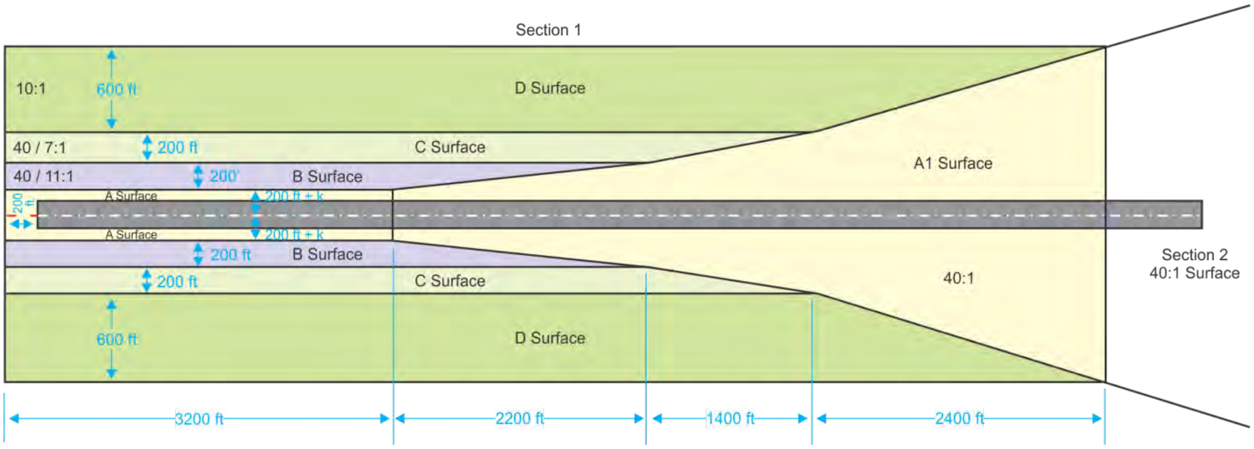
HAT (feet)	RVR
100 - 140	1200
141- 180	1600
181 - 199	1800

10-5-5. Missed Approach Segment. The CAT II/III missed approach area is comprised of two sections.

a. Section 1 (see Figure 10-5-1).

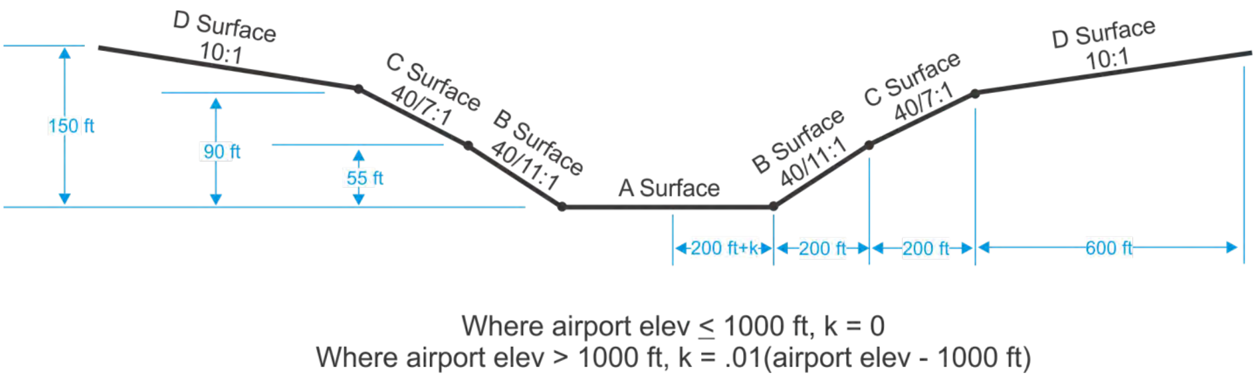
(1) The section 1 area begins at the end of the final approach OCS and is aligned with a continuation of the FAC, continuing in the direction of landing for a distance of 9200 feet excluding extensions. It is comprised of five surfaces: A, B, C, D, and A1.

Figure 10-5-1. Section 1 Plan View



(2) The OCS slopes associated with surface A, B, C, and D are depicted in Figure 10-5-2. Surface A1 has a slope of 40:1 rising in the direction of the missed approach.

Figure 10-5-2. Section 1 Profile View and OCS Slopes



(a) Apply Formula 10-5-1 to calculate the MSL height of the surface A, B, C, or D OCS at any given distance (X) from the LTP and (Y) from the runway centerline when X is 3000 feet or less.

Formula 10-5-1. Surface A, B, C, D Surface Height Where X ≤ 3000 and Y:

$Y < (200 + k)$: $h = e$ A surface

$Y \geq (200 + k)$:

$h = \frac{11(Y-(200+k))}{40} + e$ B surface

$Y > (400 + k)$: $h = \frac{7\times(Y-(400+k))}{40} + 55 + e$ C surface

$Y > (600 + k)$: $h = \frac{Y-(600+k)}{10} + 90 + e$ D surface

Where:
h = MSL height of OCS
X = Distance (feet) from runway threshold measured parallel to runway centerline
Y = Perpendicular distance (feet) from runway centerline
e = MSL elevation of the runway centerline at distance X
k = 0 if airport elevation ≤ 1000 MSL, otherwise k = 0.01(airport elevation – 1000)

(b) Apply Formula 10-5-2 to calculate the MSL height of the B, C, D, or A1 OCS at any given distance (X) from the LTP and (Y) from the runway centerline when X is greater than 3000 feet but equal to or less than 9000 feet.

Formula 10-5-2. Surface B, C, and D Surface Height Where X > 3000 and Y:

$Y > (200 + k)$: $h = \frac{11\times(Y-(200+k))}{40} + f$ B surface

$Y > (400 + k)$: $h = \frac{7\times(Y-(400+k))}{40} + 55 + f$ C surface

$Y > (600 + k)$: $h = \frac{Y-(600+k)}{10} + 90 + f$ D surface

Where:
h = MSL height of OCS
X = Distance (feet) from runway threshold measured parallel to runway centerline
Y = Perpendicular distance (feet) from runway centerline
f = MSL elevation of the runway centerline 3000 feet from threshold
k = 0 if airport elevation ≤ 1000 MSL, otherwise k = 0.01(airport elevation – 1000)

(c) Apply Formula 10-5-3 to calculate the MSL height of the surface A1 at any given distance (X) from the LTP and (Y) from the runway centerline when X is greater than 3000 feet but equal to or less than 9000 feet.

Formula 10-5-3. Surface A1 Surface Height

$$h = \frac{X - 3000}{40} + f$$

Where:
h = MSL height of OCS
X = Distance (feet) from runway threshold measured parallel to runway centerline
f = MSL elevation of the runway centerline 3000 feet from LTP

(3) An obstacle must not penetrate the OCS of surface A, B, C, D, or A1 unless the obstacle is either deemed acceptable under Table 10-6-1, or the minimums are adjusted as follows:

(a) Surface A or inner approach OFZ. Adjust the HAT upward one foot for each foot of surface penetration. A CAT II procedure is not authorized if the resultant HAT is greater than 199 feet.

(b) Surface B, C, or D. Increase RVR as specified in Table 10-5-1 as if the HAT was adjusted, but do not raise the HAT.

(c) Surface A1. This surface must not be penetrated unless the obstacle is deemed acceptable under Table 10-6-1.

b. Section 2 (see Figure 10-5-3).

(1) Straight-ahead missed approach area (applies to turns 15 degrees or less). This area starts at the end of the A1 surface and is centered on the specified missed approach course. The width increases uniformly from +/- (1200 + k) feet at the beginning to en route width at a point 15 NM from the LTP. When PCG is provided for the missed approach procedure, secondary areas that are zero miles wide at the point of beginning and which increase uniformly to initial secondary width may be added to section 2.

Chapter 12. Helicopter Procedures

Section 12-1. Administrative

12-1-1. General. This chapter contains criteria for application to "helicopter only" procedures. These criteria are based on the premise that helicopters are capable of special maneuvering characteristics. Refer to Order 8260.58 for specific guidance related to RNAV helicopter procedures. Helicopter criteria may be utilized for lighter-than-air aircraft procedure development without special consideration or minimum speed limitations.

a. A procedure intended as "helicopter only" (as identified by a "COPTER" designation according to paragraph 1-6-2) may use any combination of criteria within this, or any associated order. A procedure may be designated as "helicopter only" even if no unique helicopter criteria is utilized in the design and evaluation of the procedure.

b. Circling approach and high altitude teardrop turn criteria do not apply to helicopter procedures.

12-1-2. Type of Procedure. Helicopter only procedures are designed to meet low altitude straight-in requirements only. The type of approach procedure allowed depends on the qualification of the landing area. The allowable types of approaches are:

- IFR to an IFR heliport (Deferred pending development of applicable IFR heliport design standards. See paragraph 1-2-1.d.)
- IFR to a VFR heliport – PinS
- IFR to an IFR runway
- IFR to a VFR runway – PinS
- IFR to an unmarked landing area – PinS

Section 12-2. General Criteria

12-2-1. Application. These criteria are based on the unique maneuvering capability of the helicopter at airspeeds not exceeding 90 knots.

12-2-2. PinS Approach. Where the center of the landing area is not within 2600 feet of the MAP, an approach procedure to a PinS may be developed using any of the facilities for which criteria are provided in this chapter. PinS approach procedures will not contain alternate minima. PinS are designed to allow IFR operations to VFR landing areas. The 8:1 VFR approach surface may not be penetrated as described in AC 150/5390-2, Heliport Design, without Flight Standards approval. The optimum location of the MAP will be within 1 NM of the FATO. When developing PinS procedures, consideration must be given to the type of aircraft flying the procedure and the specific flight characteristic limitations that aircraft may have. For approaches to landing areas other than runways, final approach airspeed is limited to a maximum of 90 knots when the MAP is at least 0.9 NM from the landing area to allow for deceleration. If the MAP is less than 0.9 NM from the landing area, restrict the final approach airspeed to 70 knots.

a. PinS procedures are categorized into two types, Proceed Visual and Proceed VFR.

(1) Proceed Visual PinS requirements:

(a) Course change at the MAP between the final approach course and the course to the landing area shall not exceed 30 degrees.

(b) The MAP may not be closer than 2600 feet from the landing area.

(c) Visual segment evaluation is required.

(2) Proceed VFR PinS requirements:

(a) MAP must be within 10 NM of the landing area.

(b) VFR transition area evaluation is required.

b. PinS procedures may only be developed using certain types of final approach course navigation. See Table 12-2-1 for the allowable navigation types.

Table 12-2-1. Final Approach Segment Navigation for PinS Procedures

Final Approach Segment Navigation Source	Allowed?
VOR/TACAN	Yes
NDB	Yes
LOC	Yes
ILS	No
LDA	N/A
LDA w/GS	No
SDF	Yes
ASR	Yes
PAR	No
LNAV	Yes
LNAV/VNAV	No
LP	Yes
LPV/GLS	Yes
RNP AR APCH	No

12-2-3. Approach Categories. When helicopters use instrument flight procedures designed for fixed-wing aircraft, CAT "A" approach minima apply regardless of helicopter weight.

12-2-4. Procedure Construction. Apply paragraph 2-1-8 except for the reference to circling. Procedure construction should be allowed to provide the best benefit for the procedure while ensuring maximum safety.

a. For procedures designed to an IFR heliport, the FAC should be aligned with the helipad on the designated ingress/egress course with the MAP no closer than 2600 feet from the helipad for non-precision approaches, and to DA for precision approaches.

b. For procedures designed to a runway, the alignment of the FAC should be to the threshold on RCL, or a designated helipad on the runway with the MAP on the RCL or RCL extended no more than 2600 feet from the threshold. A PinS procedure not aligned with the RCL may be developed to a helipoint if an obstacle evaluation based on the helipoint is conducted.

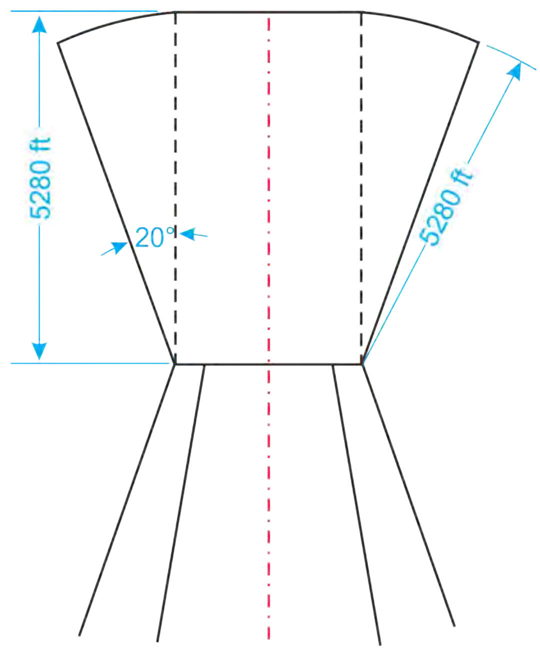
c. The type of PinS visual evaluation depends on the type of PinS approach.

(1) Proceed VFR procedure:

(a) A VFR surface elevation is established within a 5200-foot radius around the MAP. The HAS is determined by subtracting the highest terrain elevation within the area (adverse vegetation assumptions are not applied) from the DA/MDA.

(b) A VFR transition area extends 5280 feet beyond the end of the final approach segment OEA. The lateral boundaries of the area are established on either side of the area as a 20-degree splay from the final approach course, beginning at the end of the secondary area boundary. On each side of the area, an arc with radius 5280 feet, with arc-center at the end of the primary boundary is drawn to the lateral boundary. The two arcs are connected by a line segment perpendicular to the final approach course. The elevation of the evaluation surface is determined by subtracting 250 feet plus any adjustments for RASS and precipitous terrain from the DA/MDA. If penetrations of this surface exist, either the MDA should be raised until the surface is clear of penetrations, or the penetrations must be charted and annotated in accordance with Order 8260.19 paragraph 8-6-9.q(5).

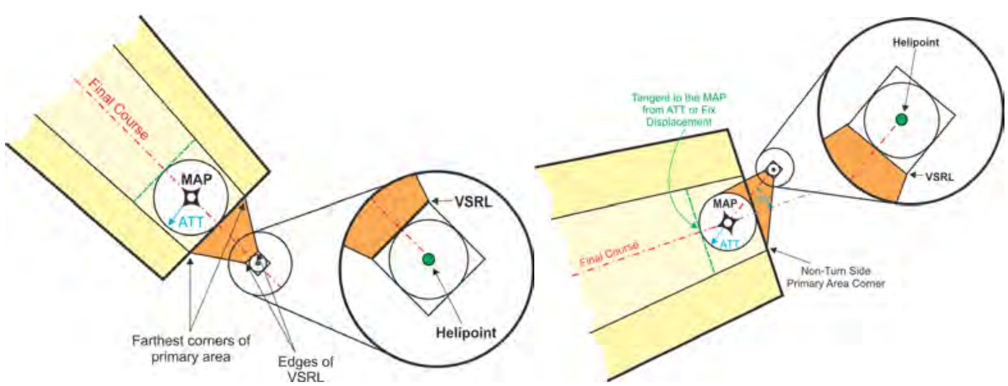
Figure 12-2-1. VFR Transition Area



(2) Proceed visual procedure:

(a) A visual segment extends from the end of the final approach segment to the closest edges of the FATO identified by the visual segment reference line (VSRL). If the helipoint is not located on final approach course extended beyond the MAP, evaluate from the closest MAP abeam point to the VSRL. If the path from the visual segment to the FATO is not aligned with the helipad layout, rotate the VSRL to be perpendicular to the path.

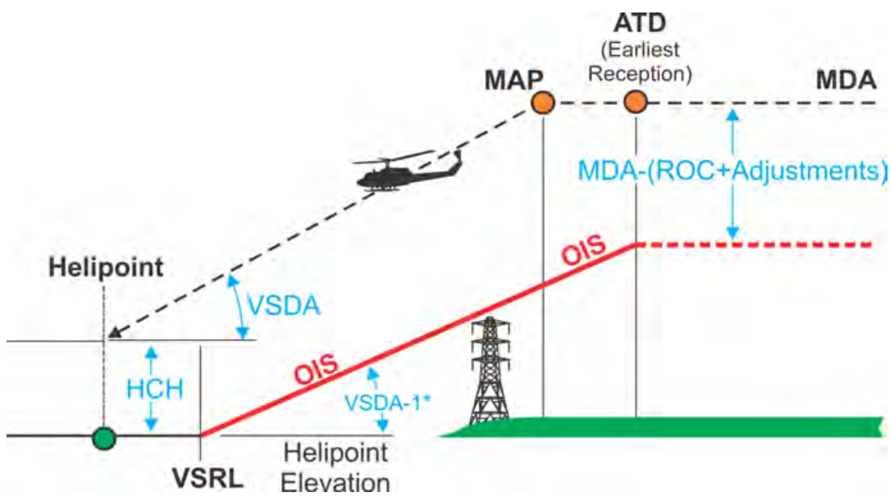
Figure 12-2-2. Visual Segment Area



(b) A visual segment descent angle (VSDA) is established from the MAP to the center of the helipad at the desired HCH/hover height. The optimum HCH/hover height is five (5) feet, but may be increased up to 20 feet if necessary to mitigate penetrations of the visual segment surface. The optimum VSDA is six (6) degrees, but may not exceed 7.5 degrees. A VSDA greater than 7.5 degrees may be used with Flight Standards approval.

(c) An OIS (identified as VSDA-1) is associated with the VSDA. The VSDA-1 angle is 1 degree less than the VSDA angle. The VSDA-1 extends from the VSRL at helipoint elevation to the earliest reception point of the MAP at an elevation of MDA/DA minus 250 feet plus adjustments. The VSDA-1 may not be penetrated. If penetrated, remove or adjust the location of the obstacle, adjust the HCH/hover height, raise the MDA/DA, or publish a note to remain at a specific altitude until clear of the obstacle in accordance with Order 8260.19 paragraph 8-6-10.q(4).

Figure 12-2-3. VSDA and Associated OIS



(d) The slope of the missed approach OCS is 20:1.

12-2-5. Descent Gradient/Vertical Descent Angle. The descent gradient/VDA criteria specified in other chapters of this order do not apply. The optimum descent gradient in all segments of helicopter approach procedures is 400 ft/NM. Where a higher descent gradient is necessary, the recommended maximum is 600 ft/NM. However, where an operational requirement exists, a gradient up to 800 ft/NM may be authorized with Flight Standards approval, provided the gradient used is depicted on approach charts (see special procedure turn criteria in paragraph 12-2-7).

12-2-6. Initial Approach Segments Based on Straight Courses and Arcs with Positive Course Guidance. Apply paragraph 2-4-3 except as follows:

a. Alignment.

(1) Courses. The 2-NM lead radial specified in paragraph 2-4-3.a(1) is reduced to 1 NM.

(2) Arcs. The minimum arc radius specified in paragraph 2-4-3.a(2) is reduced to 4 NM. The 2-NM lead radial may be reduced to 1 NM.

12-2-7. Initial Approach Based on Procedure Turn. Apply paragraph 2-4-5, except for all of paragraph 2-4-5.d. Within paragraph 2-4-5.e(1), 300 feet is changed to 600 feet.

a. Area. Since helicopters operate at CAT A speeds the 5 NM-procedure turn will normally be used (see Figure 12-2-1). However, the larger 10 NM and 15 NM areas may be used if considered necessary.

b. Descent gradient. Because the actual length of the track will vary with environmental conditions and pilot technique, it is not practical to specify a descent gradient solely in feet per NM for the procedure turn. Instead, the descent gradient is controlled by requiring the procedure turn completion altitude to be as close as possible to the PFAF altitude. The difference between the procedure turn completion altitude and the altitude over the PFAF must not be greater than those shown in Table 12-2-1.

Figure 12-2-4. Helicopter Procedure Turn Area

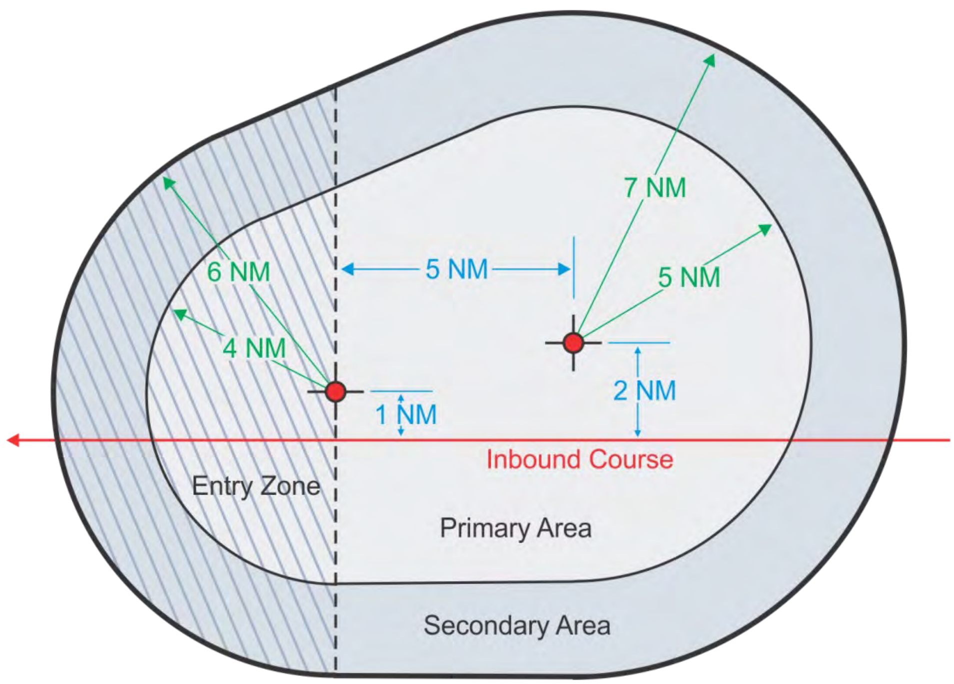


Table 12-2-2. Procedure Turn Completion Altitude Difference

Type Procedure Turn	Altitude Difference
15 NM PT from PFAF	Within 6000 ft of alt over PFAF
10 NM PT from PFAF	Within 4000 ft of alt over PFAF
5 NM PT from PFAF	Within 2000 ft of alt over PFAF
15 NM PT, no PFAF	Not Authorized
10 NM PT, no PFAF	Within 4000 ft of MDA on Final
5 NM PT, no PFAF	Within 2000 ft of MDA on Final

12-2-8. Intermediate Approach Segment Based On Straight Courses. Apply paragraph 2-5-3 except as follows:

a. Alignment. The intermediate course must not differ from the FAC by more than 60 degrees.

b. Length. The optimum length of the intermediate approach segment is 2 NM. The minimum length is 1 NM and the recommended maximum is 5 NM. A distance greater than 5 NM should not be used unless an operational requirement justifies the greater distance. The minimum length specified in Table 12-2-2 applies when the angle at which the initial approach course joins the intermediate course exceeds 30 degrees (see Figure 2-4-1).

12-2-9. Intermediate Approach Segment Based on an Arc. Apply paragraph 2-5-4 except as follows: Arcs with a radius of less than 4 NM or more than 30 NM from the navigation facility must not be used. The optimum length of the intermediate segment is 2 NM. The minimum length is 1 NM and the recommended maximum is 5 NM. A distance greater than 5 NM should not be used unless an operational requirement justifies the greater distance. The minimum length specified in Table 12-2-2 applies when the angle at which the initial approach course joins the intermediate course exceeds 30 degrees (see Figure 2-4-1).

Table 12-2-3. Minimum Intermediate Course Length
(Not applicable to PAR and ILS)

Angle (degrees)	Minimum Length (NM)
0 - 30	1.0
> 30 - 60	2.0
> 60 - 90	3.0
> 90 - 120	4.0

Note: This table may be interpolated.

12-2-10. Intermediate Segment within a Procedure Turn Segment. Apply paragraph 2-5-5 except as follows: The normal procedure turn distance is 5 NM from the fix or from the facility. This produces an intermediate segment 5 NM long. The portion of the intermediate segment considered for obstacle clearance will always have the same length as the procedure turn distance. A distance greater than 5 NM should not be used unless an operational requirement justifies the greater distance.

12-2-11. Final Approach. Paragraph 2-6-1 applies except that the word runway is understood to include landing area and the reference to circling approach does not apply. The FAC of a PA procedure must be aligned as indicated in paragraphs 12-9-3 and 12-10-3. FAC alignment for NPA procedures is as follows:

a. Approach to a landing area. See paragraph 12-2-4.

b. PinS approach. See paragraph 12-2-2. The FAC should be aligned to provide for the most effective operational use of the procedure consistent with safety.

12-2-12. Missed Approach Point. Apply paragraph 2-8-3 except the specified distance may not be more than the distance from the PFAF to a point not more than 2600 feet from the center of the landing area. The MAP may be located more than 2600 feet from the landing area provided the minimum visibility agrees with the increased distance; for example, if the MAP is 3800 feet from the landing area, then the minimum visibility (NALS) is ¾ SM (see Figure 12-5-1). For PinS approaches, the MAP is on the FAC at the end of the final approach area.

12-2-13. Straight Missed Approach Area. Apply paragraph 2-8-4 except that the missed approach area expands uniformly to the width of an en route airway at a point 7.5 NM from the MAP.

12-2-14. Straight Missed Approach Obstacle Clearance. Apply paragraph 2-8-5 except that the slope of the missed approach surface is changed from 40:1 to 20:1; and the secondary area slope is changed from 12:1 to 4:1.

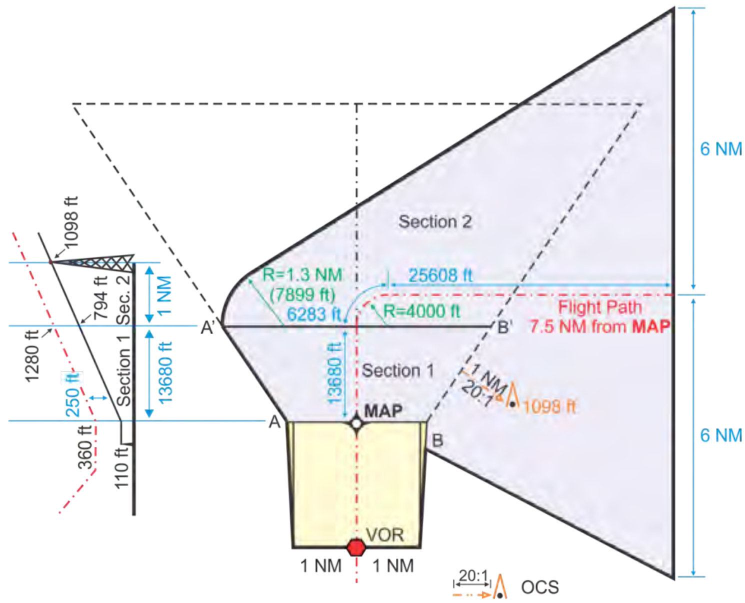
12-2-15. Turning Missed Approach Area. Apply paragraph 2-8-6 except that when applying missed approach criteria shown in Figure 2-8-4 thru Figure 2-8-9, and Table 2-8-1, change all flight path lengths to 7.5 NM, missed approach surface slope to 20:1, secondary slopes to 4:1, obstacle clearance radius (R) to 1.3 NM, and flight path radius (R_1) to 4000 feet (0.66 NM). The area width will expand uniformly to the width of an en route airway.

12-2-16. Turning Missed Approach Obstacle Clearance. All missed approach areas described in paragraph 2-8-7 and depicted in Figure 2-8-10 and Figure 2-8-11 will be adjusted for helicopter operation using the values shown in paragraph 12-2-15. The area width will expand uniformly to the appropriate en route airway width.

12-2-17. Combination Straight and Turning Missed Approach. Apply paragraph 2-8-8 except that the values in paragraph 12-2-15 must be used and point B is relocated to a position abeam the MAP. The area width will expand uniformly to the width of an en route airway (see Figure 12-2-2).

12-2-18. Holding. Apply Chapter 16, except within paragraph 16-9-2, when the PFAF is a facility, the inbound holding course must not differ from the final approach course by more than 90 degrees.

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 an IFR heliport (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 an IFR heliport (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. No credit for lights will be authorized. Alternate minimums are not authorized. Do not apply Table 12-3-1.

(1) Proceed VFR. The minimum visibility is 3/4 SM day / 1 SM night. If the HAS exceeds 800 feet, the minimum visibility is 1 SM.

(2) Proceed Visual. The minimum visibility is the greater of 3/4 SM or the distance from the MAP to the landing area.

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 helicopter approach lighting systems is established. Apply the concepts stated in paragraph 3-1-2.c(2), except heliport markings may be substituted for the runway marking requirements specified therein.

12-3-5. Takeoff Minimums. Apply Section 3-5 for departures from an IFR heliport. Apply appropriate FAA/DoD directives when departing VFR heliports, VFR runways, or unmarked landing areas.

Section 12-4. On-Airport/Heliport VOR (No PFAF)

12-4-1. General. Do not apply paragraph 4-1-1. Those criteria apply to procedures based on a VOR facility located within 2600 feet of the center of the landing area in which no PFAF is established. These procedures must incorporate a procedure turn.

12-4-2. Initial and Intermediate Segments. Apply criteria contained in Section 12-2.

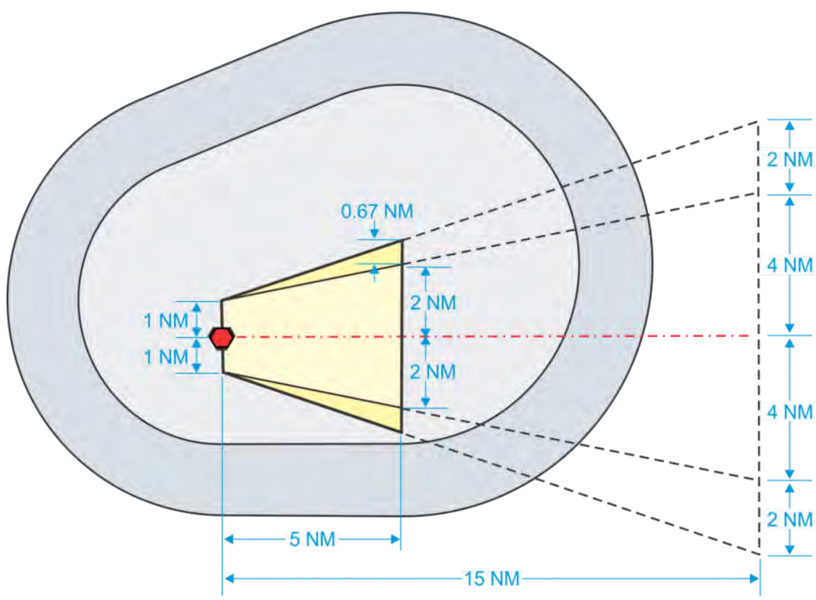
12-4-3. Final Approach Segment. Do not apply paragraph 4-2-4, except as noted below. The final approach begins where the PT intersects the FAC inbound.

a. Alignment. Apply paragraphs 12-2-11.

b. Area. The primary area is longitudinally centered on the final approach course. The minimum length is 5 NM. This may be extended if an operational requirement exists. The primary area is 2 NM wide at the facility and expands uniformly to 4 NM wide at 5 NM from the facility. A secondary area is on each side of the primary area. It is 0 NM wide at the facility and expands uniformly to 0.67 NM on each side of the primary area at 5 NM from the facility (see Figure 12-4-1).

c. Obstacle clearance. Apply paragraph 4-2-4.c(1).

Figure 12-4-1. Final Approach Primary and Secondary area On-Airport/Heliport VOR, No PFAF



d. Procedure turn altitude. The procedure turn completion altitude must be in accordance with Table 12-2-1.

e. Use of stepdown fix. Apply paragraph 4-2-4.e, except that 4 NM is changed to 2.5 NM.

f. MDA. Apply criteria for determining MDA contained in Sections 12-3 and 3-2.

Section 12-5. TACAN, VOR/DME, and VOR with PFAF

12-5-1. Final Approach Segment. Do not apply paragraph 5-2-4, except as noted below.

a. Alignment. Apply paragraph 12-2-11.

b. Area. Apply paragraph 5-2-4.b, except when the PFAF is the facility providing course guidance, the minimum length specified in Table 12-5-1 applies.

c. Obstacle clearance. Apply paragraph 5-2-4.c(1).

Table 12-5-1. Minimum Length of Final Approach Segment When PFAF is the Facility

Turn Magnitude Over Facility	0 – 30 Degrees	60 Degrees	90 Degrees
Minimum Length	1.0 NM	2.0 NM	3.0 NM

Note: This table may be interpolated.

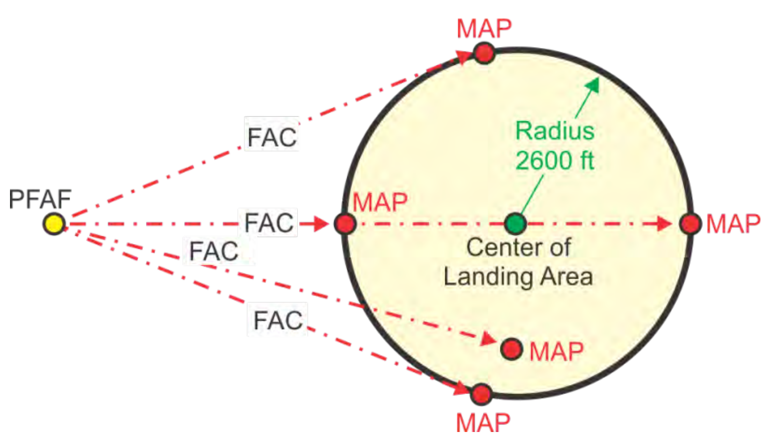
12-5-2. Missed Approach Point. Apply paragraph 5-2-5, except the MAP is a point on the FAC which is not farther than 2600 feet from the center of the landing area (see Figure 12-5-1). For PinS approaches the MAP is on the FAC at the end of the final approach area.

12-5-3. Arc Final Approach Segment. Paragraph 5-3-4.b(1) does not apply. The final approach arc should be a continuation of the intermediate arc. It must be specified in NM and tenths thereof.

a. Radius. The minimum arc radius on final approach is 4 NM.

b. Alignment. The final approach arc should be aligned so as to pass through the landing area. Where an operational advantage can be achieved, a final approach arc which does not pass through the landing area may be established provided the arc lies within 2600 feet of the landing area at the MAP.

Figure 12-5-1. Missed Approach Points, Off-Airport/Heliport VOR With PFAF



Section 12-6. On-Airport/Heliport NDB, No PFAF

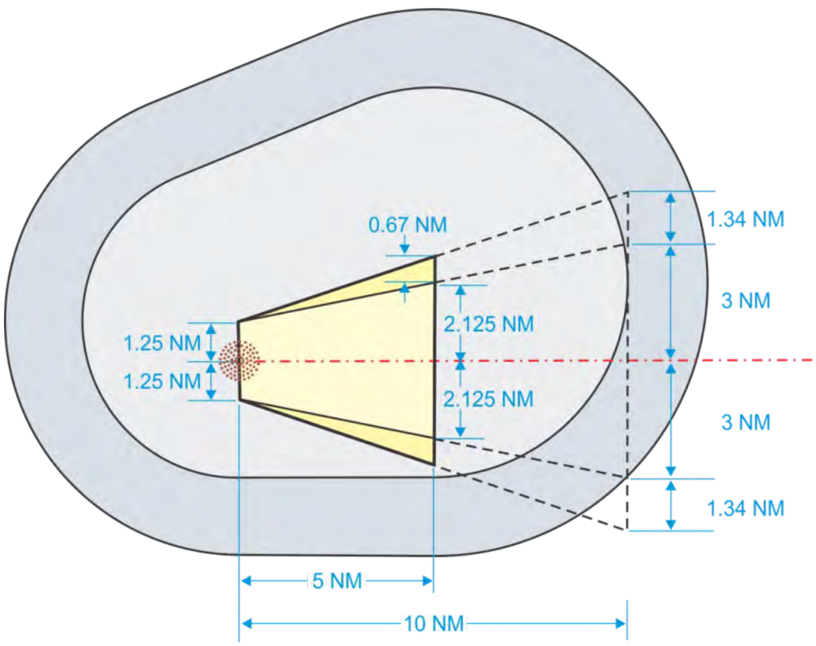
12-6-1. General. Do not apply paragraph 6-1-1 These criteria apply to procedures based on an NDB facility located within 2600 feet of the center of the landing area in which no PFAF is established. These procedures must incorporate a procedure turn.

12-6-2. Final Approach Segment. Do not apply paragraph 6-2-4, except as noted below. The final approach begins where the PT intersects the FAC inbound.

a. Alignment. Apply paragraph 12-2-11.

b. Area. The primary area is longitudinally centered on the final approach course. The minimum length is 5 NM. This may be extended if an operational requirement exists. The primary area is 2.5 NM wide at the facility, and expands uniformly to 4.25 NM wide at 5 NM from the facility. A secondary area is on each side of the primary area. It is 0 NM wide at the facility, and expands uniformly to 0.67 NM wide on each side of the primary area at 5 NM from the facility. Figure 12-6-1 illustrates the primary and secondary areas.

Figure 12-6-1. Final Approach Primary and Secondary Areas, On-Airport/Heliport NDB, No PFAF



c. Obstacle clearance. Apply paragraph 6-2-4.c(1).

d. Procedure turn altitude. The procedure turn completion altitude must be in accordance with Table 12-2-1.

e. Use of stepdown fix. Apply paragraph 6-2-4.e, except that 4 NM is changed to 2.5 NM.

f. MDA. Apply criteria for determining the MDA contained in Sections 12-3 and 3-2.

Section 12-7. NDB Procedures with PFAF

12-7-1. General. These criteria apply to procedures based on an NDB facility which incorporates a PFAF.

12-7-2. Final Approach Segment. Do not apply paragraph 7-1-5, except as noted below:

a. Alignment. Apply paragraph 12-2-11.

b. Area. Apply paragraph 7-1-5.b, except when the PFAF is the facility providing course guidance, the minimum length specified in Table 12-5-1 applies.

c. Obstacle clearance. Apply paragraph 7-1-5.c(1).

12-7-3. Missed Approach Point. Apply paragraph 5-2-5, except the MAP is a point on the FAC which is not farther than 2600 feet from the center of the landing area (see Figure 12-5-1). For PinS approaches the MAP is on the FAC at the end of the final approach area.

Section 12-8. Localizer and LDA Procedures

12-8-1. Localizer and LDA. Apply Chapter 8, except as noted in this paragraph.

a. Alignment. Apply paragraph 8-1-2 for localizer alignment. Apply paragraph 12-2-11 for LDA alignment.

b. Area. Apply paragraph 8-1-3, except the minimum length specified in Table 12-5-1 applies.

c. MAP. Apply paragraph 8-1-7, except the MAP is a point on the FAC which is not farther than 2600 feet from the center of the landing area (see Figure 12-5-1). For PinS approaches the MAP is on the FAC at the end of the final approach area. The MAP must be at least 3000 feet from the LOC/LDA facility.

Section 12-9. ILS Procedures

12-9-1. General. Apply Chapter 10 except as noted in this section.

12-9-2. Intermediate Approach Segment. Table 12-10-1 specifies the minimum length of the intermediate segment based on the angle of intersection of the initial approach course with the localizer course.

12-9-3. Final Approach Segment.

a. The optimum length of the final approach course is 3 NM. The minimum length is 2 NM. A distance in excess of 4 NM should not be used unless a special operational requirement exists.

b. Final approach termination. The final approach must terminate at a landing point (runway) or at a hover point between the decision height and the GPI. Where required, visual hover/taxi routes will be provided to the terminal area.

12-9-4. Missed Approach Area. Normally existing missed approach criteria will be utilized for helicopter operations. However, if an operational advantage can be gained, the area described in paragraphs 12-10-11 through 12-10-14 may be substituted.

Section 12-10. Precision Approach Radar (PAR)

12-10-1. Intermediate Approach Segment. Apply paragraph 11-2-3 with the exception that Table 12-10-1 specifies the minimum length of the intermediate segment based on the angle of intersection of the initial approach course with the intermediate course.

Table 12-10-1. Intermediate Segment Angle of Intercept VS. Segment Length

Angle of Intercept	0 – 30 Degrees	60 Degrees	90 Degrees
Minimum Length	1.0 NM	2.0 NM	3.0 NM

Note: This table may be interpolated.

12-10-2. Final Approach Segment. Apply paragraph 11-2-4, except that the minimum distance from the glide slope intercept point to the GPI is 2 NM.

12-10-3. Final Approach Alignment. The final approach course must be aligned to a landing area. Where required, visual hover/taxi routes must be established leading to terminal areas.

12-10-4. Final Approach Area.

a. Length. The final approach area is 25000 feet long, measured outward along the final approach course from the GPI. Where operationally required for other procedural considerations or for existing obstacles, the length may be increased or decreased symmetrically, except when glide slope usability would be impaired or restricted (see Figure 12-10-1).

b. Width. The final approach area is centered on the final approach course. The area has a total width of 500 feet at the GPI and expands uniformly to a total width of 8000 feet at a point 25000 feet outward from the GPI. The widths are further uniformly expanded or reduced where a different length is required as in paragraph 12-10-4.a (see Figure 12-10-1). The width either side of the centerline at a given distance "D" from the point of beginning can be found by using the Formula 12-10-1.

Formula 12-10-1. PAR Final Approach Area ½ Width

$$250 + .15 \times D = \frac{1}{2} width$$

Where:

The width either side of the centerline at a given distance “D” from the point of beginning.

12-10-5. Final Approach Obstacle Clearance Surface. The final approach obstacle clearance surface is divided into two sections.

a. Section 1. This section originates at the GPI and extends for a distance of 775 feet in the direction of the PFAF. It is a level plane, the elevation of which is equal to the elevation of the GPI.

b. Section 2. This section originates 775 feet outward from the GPI. It connects with section 1 at the elevation of the GPI. The gradient of this section varies with the glidepath angle used. To identify the glide slope angle and associated final approach surface gradient to clear obstacles in section 2:

(1) Determine the distance "D" from the GPI to the controlling obstacle and the height of the controlling obstacle above the GPI.

Figure 12-10-1. PAR Final Approach Area

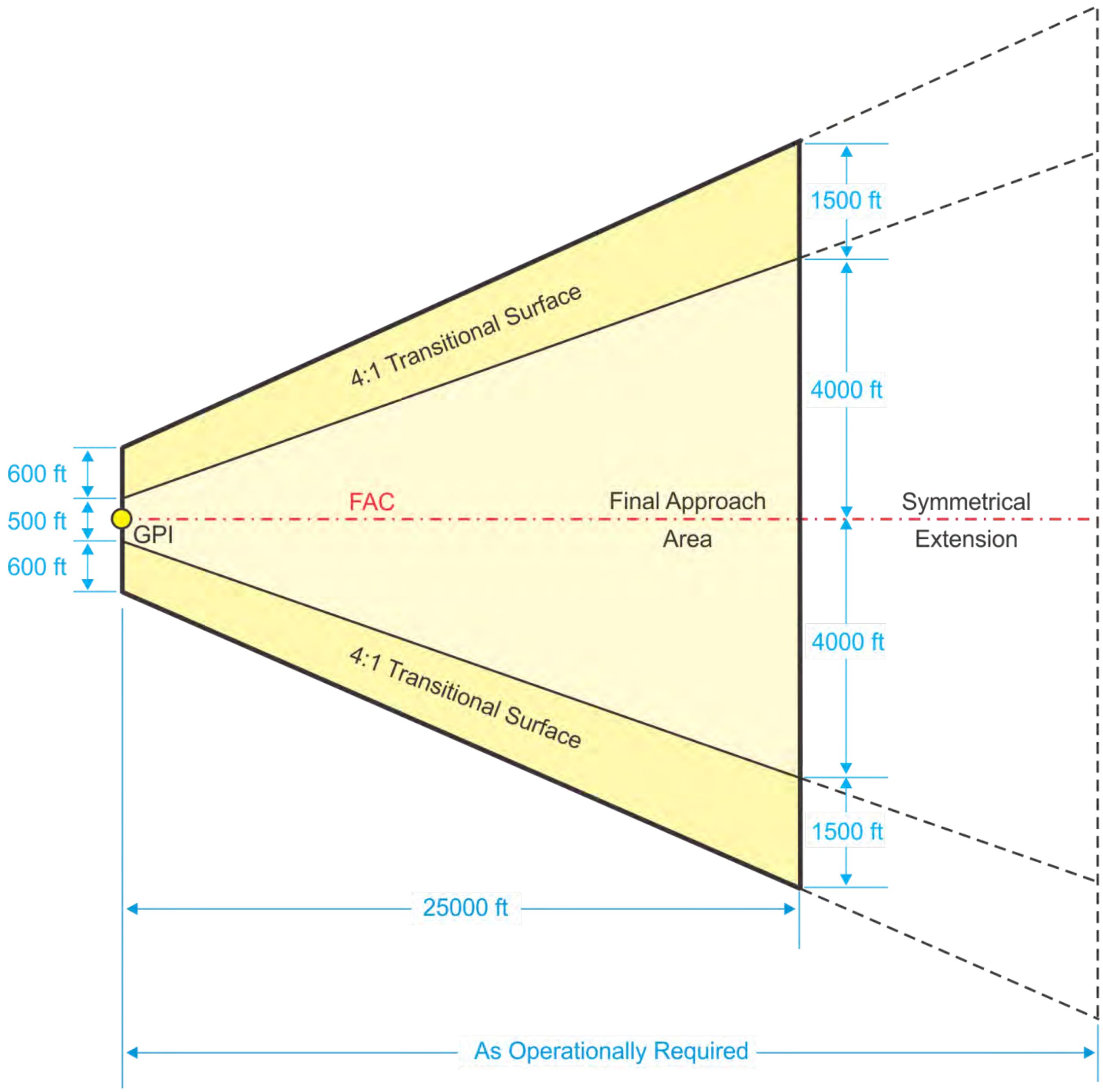


Table 12-10-2. Final Approach Glide Slope – Surface Slope Angles

Glide Slope Angle (Degrees)	Less Than 3	3	4	5	6
Section 2 obstacle clearance surface gradient (degrees)	NA	1.65	2.51	3.37	4.23

Note: This table may be interpolated.

(2) Enter these values in Formula 12-10-2:

Formula 12-10-2. PAR Section 2 Approach Surface Gradient

$$\mathrm{TanAngle} = \frac{\mathrm{ObstacleHeight}}{\mathrm{D} - 775}$$

(3) Convert the tangent angle. This is the angle of the section 2 approach surface gradient measured at the height of the GPI.

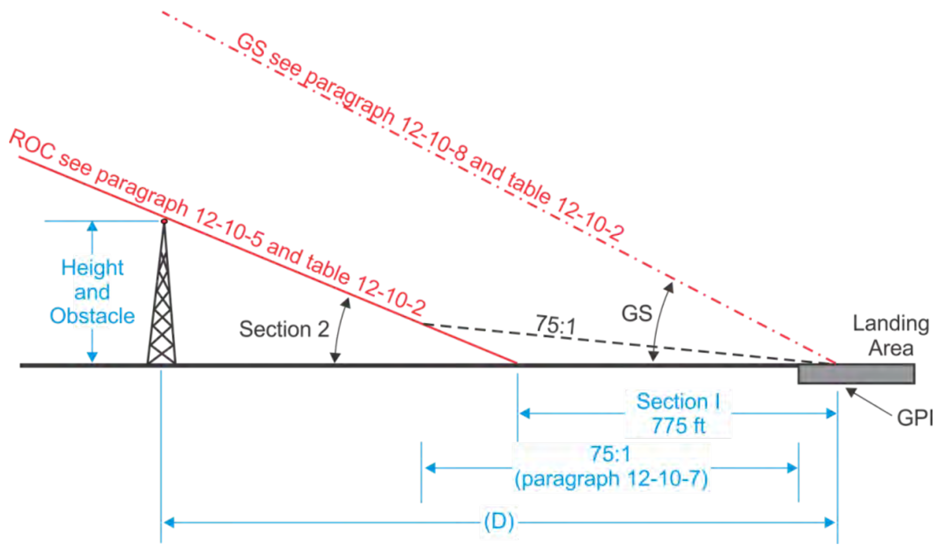
(4) The minimum glide slope angle required is found in Table 12-10-2.

12-10-6. Transitional Surfaces. Transitional surfaces for PAR are inclined planes with a slope of 4:1 which extend outward and upward from the edges of the final approach surfaces. They start at the height of the applicable final approach surface and are perpendicular to the final approach course. They extend laterally 600 feet at the GPI and expand uniformly to a width of 1500 feet at 25000 feet from the GPI.

12-10-7. Obstacle Clearance. No obstacle may penetrate the applicable final approach surfaces specified in paragraphs 12-10-5 and 12-10-6. Obstacle clearance requirements greater than 500 feet need not be applied unless required in the interest of safety due to precipitous terrain or radar system peculiarities (see Figure 12-10-2).

Note: The terrain in section 1 may rise at a gradient of 75:1 without adverse effect on minimums provided the surface is free of obstacles.

Figure 12-10-2. Final Approach Area Surface and Obstacle Clearance



12-10-8. Glide Slope. Required obstacle clearance is specified in paragraph 12-10-7. In addition, consideration must be given to the following in the selection of the glide slope angle:

a. Angles less than three degrees are not authorized.

b. Angles greater than six degrees must not be established without authorization of the approving authority. The angle selected should be no greater than that required to provide obstacle clearance.

c. Angles selected should be increased to the next higher tenth of a degree, for example, 4.71 degrees becomes 4.8; 4.69 degrees becomes 4.7.

12-10-9. Relocation of the Glide Slope. The GPI must normally be located at the arrival edge of the landing area. If obstacle clearance requirements cannot be satisfied, or if other operational advantages will result, the GPI may be moved into the landing area provided sufficient landing area is available forward of the displaced or relocated GPI.

12-10-10. Adjustment of DH. An adjustment is required whenever the angle to be used exceeds 3.8 degrees (see Table 12-10-3). This adjustment is necessary to provide ample deceleration distance between the DH point and the landing area.

Table 12-10-3. Minimum DH - GS Angle Relationship

GS Angle (degrees)	up to 3.80	3.81 to 5.70	Over 5.70
Minimum DH (feet)	100	150	200

12-10-11. Missed Approach Obstacle Clearance. No obstacle may penetrate a 20:1 missed approach surface which overlies the missed approach areas illustrated in Figure 12-10-5, Figure 12-10-6, and Figure 12-10-7. The missed approach surface originates at the GPI. However, to gain relief from obstacles in the missed approach area the point at which the surface originates may be relocated as far backward from the GPI as a point on the final approach course which is directly below the MAP. In such cases the surface originates at a height below the DH as specified in Table 12-10-4 (see Figure 12-10-3 and Figure 12-10-4).

Note: When penetration of the 20:1 surface originating at the GPI occurs, an upward adjustment to the DH equal to the maximum penetration of the surface should be considered.

12-10-12. Straight Missed Approach Area. The straight missed approach (maximum of 15-degree turn from final approach course) area starts at the MAP and extends to 7.5 NM.

a. Primary area. This area is divided into three sections.

(1) Section 1a is a continuation of the final approach area. It starts at the MAP and ends at the GPI. It has the same width as the final approach area at the MAP.

(2) Section 1b is centered on the missed approach course. It begins at the GPI and extends to a point 1 NM from the MAP outward along the missed approach course. It has a beginning width the same as the final approach area at the MAP and expands uniformly to 4000 feet at 1 NM from the MAP.

Table 12-10-4. Beginning Point of Missed Approach Surface

GS Angle (Degrees)	3	6	9
Dist. below DH point (feet)	100	150	200

Note: This table may be interpolated.

Figure 12-10-3. Missed Approach Surface at GPI

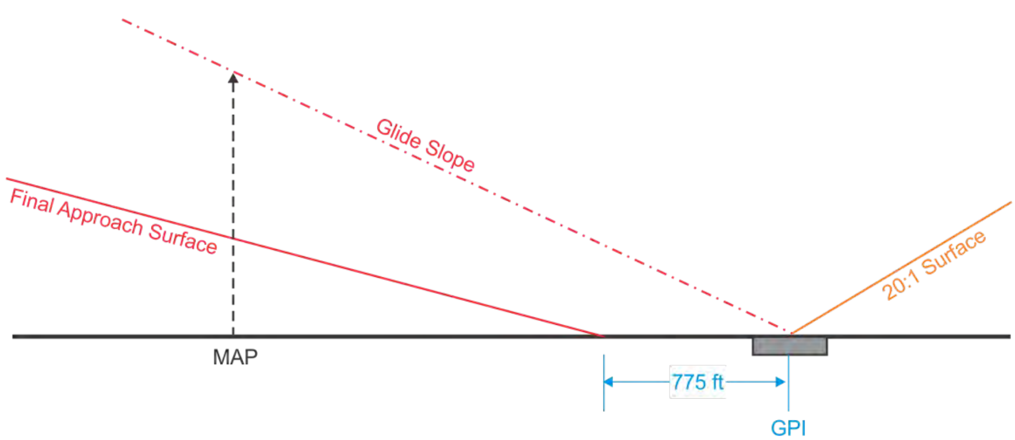
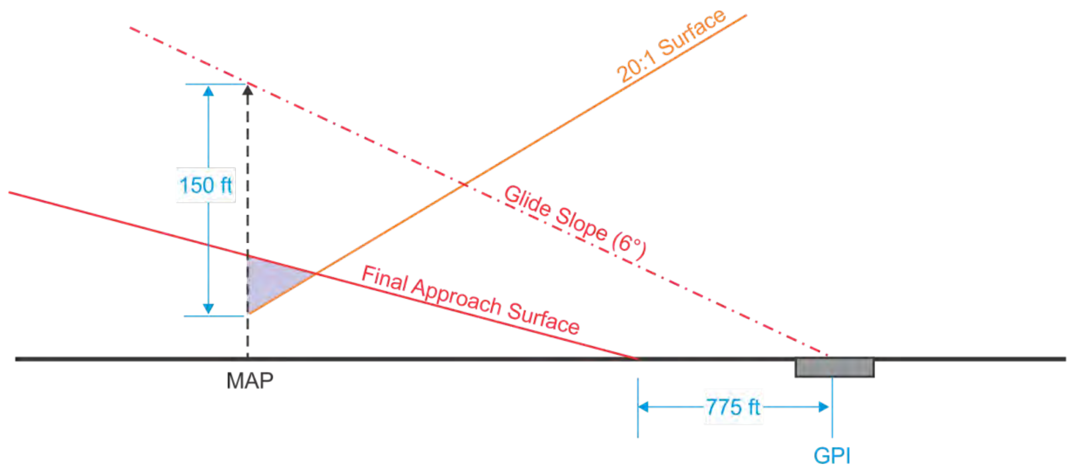


Figure 12-10-4. Missed Approach Surface at MAP

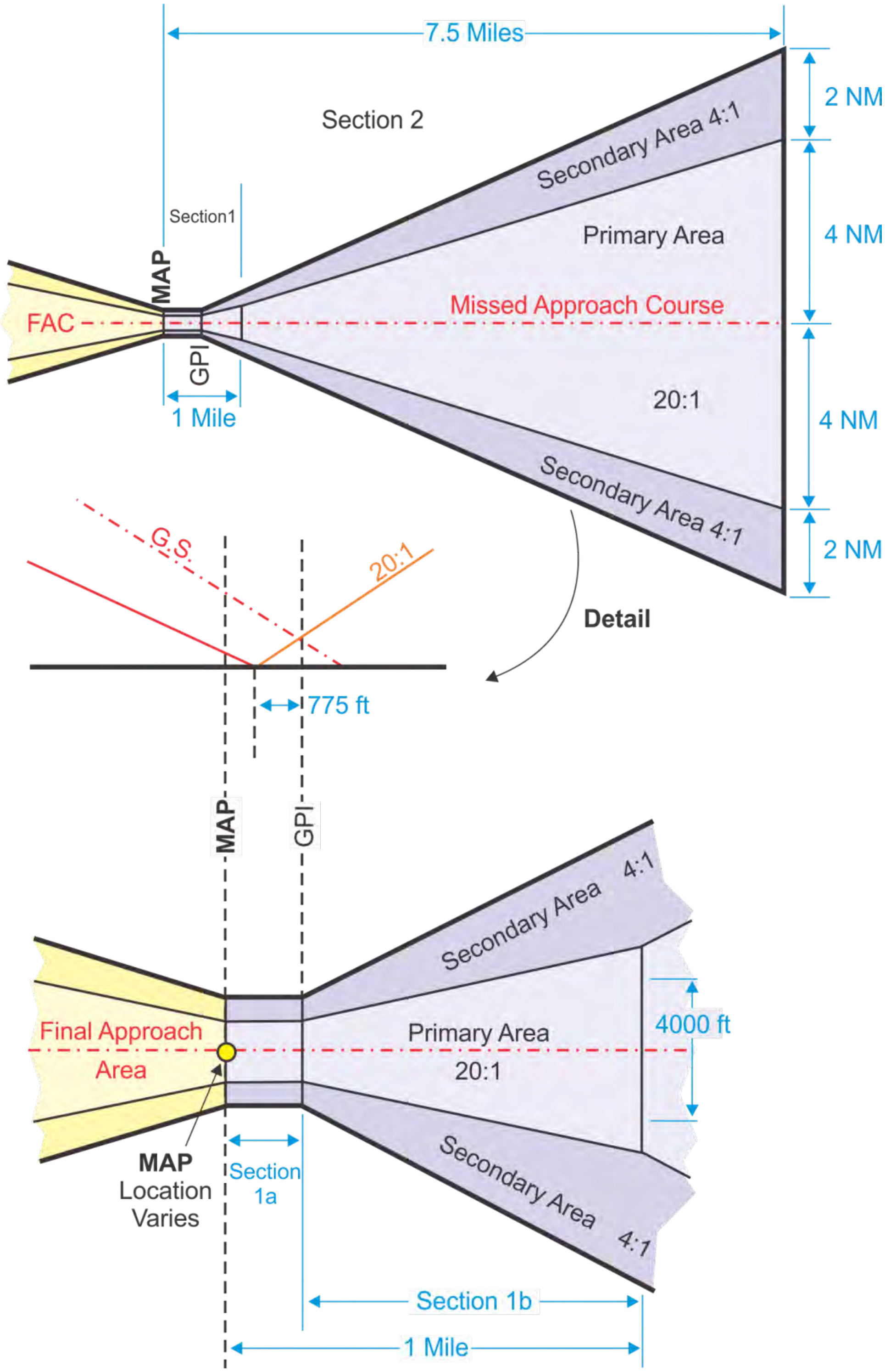


Note: Obstacles in shaded area not considered.

(3) Section 2 is centered on the continuation of the section 1b course. It begins 1 NM from the MAP and ends 7.5 NM from the MAP. It has a beginning width of 4000 feet, expanding uniformly to a width equal to that of an initial approach area at 7.5 NM from the MAP.

b. Secondary area. The secondary area begins at the MAP, where it has the same width as the final approach secondary area. In section 1a the width remains constant from the MAP to the GPI, after which it increases uniformly to the appropriate airway width at 7.5 NM from the MAP (see Figure 12-10-5).

Figure 12-10-5. Straight Missed Approach

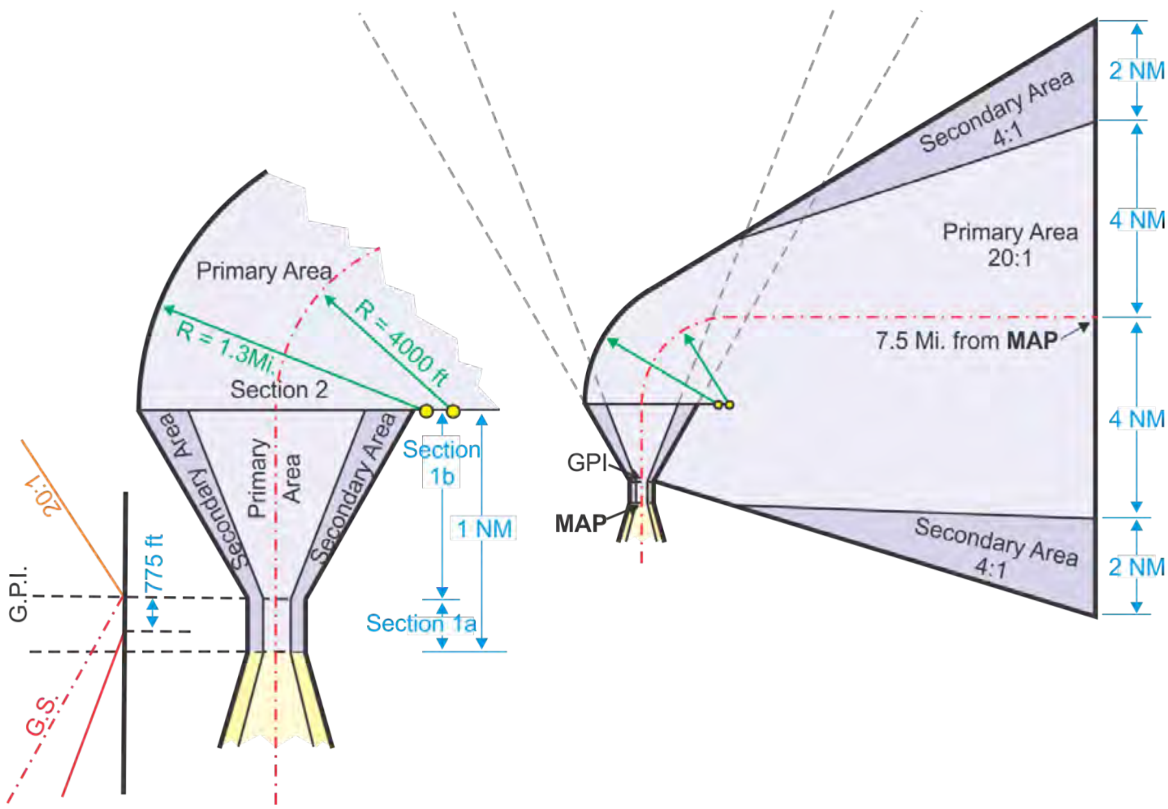


12-10-13. Turning Missed Approach Area. Where turns of more than 15 degrees are required in a missed approach procedure, they must commence at an altitude which is at least 400 feet above the elevation of the landing area rounded to the nearest foot. Such turns are assumed to commence at the point where section 2 begins. The turning flight track radius must be 4000 feet (0.66 NM).

a. Primary areas. The outer boundary of the section 2 primary area must be drawn with a 1.3-NM radius. The inner boundary must commence at the beginning of section 1b. The outer and inner boundaries expand uniformly to the width of an initial approach area 7.5 NM from the MAP.

b. Secondary area. Secondary areas for reduction of obstacle clearance are identified with section 2. The secondary areas begin after completion of the turn. They are 0 NM wide at the point of beginning and increase uniformly to the appropriate airway width at the end of section 2. Positive course guidance is required to reduce obstacle clearance in the secondary area (see Figure 12-10-6).

Figure 12-10-6. Turning Missed Approach Area



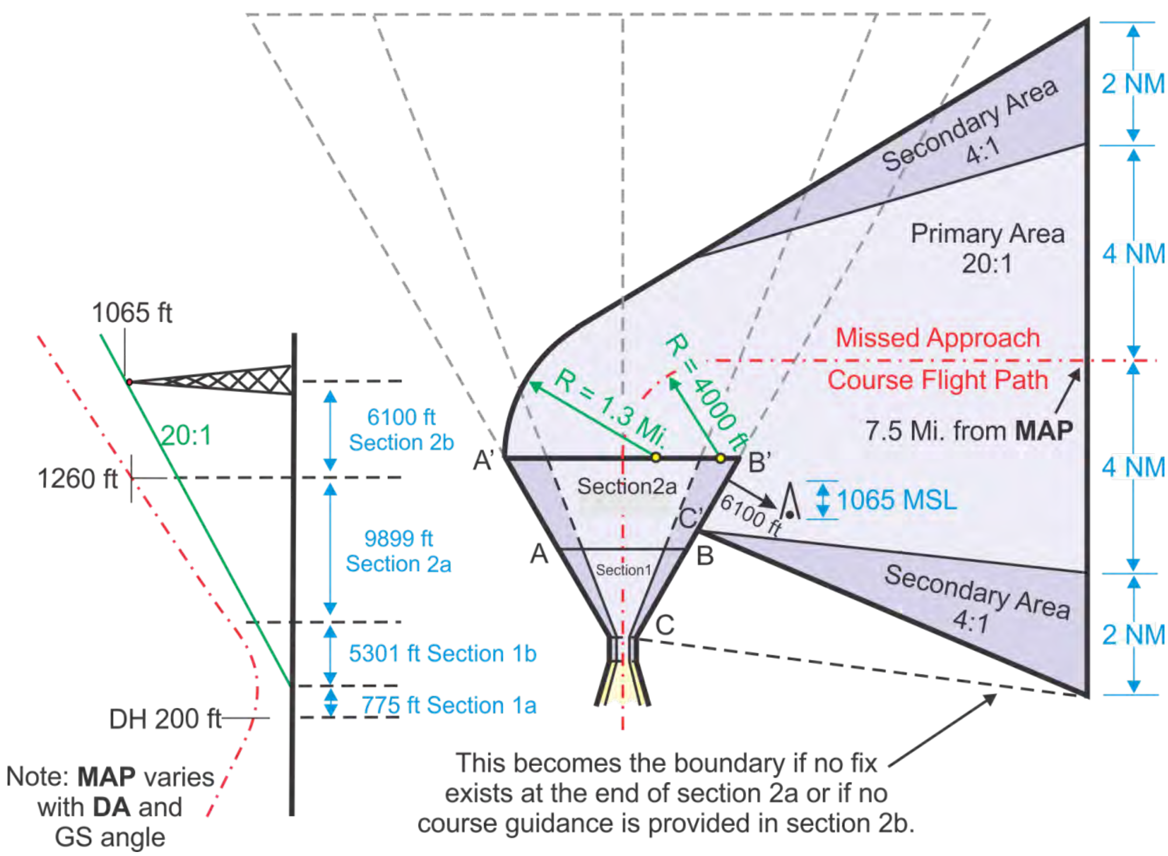
12-10-14. Combination Straight And Turning Missed Approach Area. If a straight climb to an altitude greater than 400 feet is necessary prior to commencing a missed approach turn, a combination straight and turning missed approach area must be constructed. The straight portion of this missed approach area is divided into sections 1 and 2a. The portion in which the turn is made is section 2b.

a. Straight portion. Sections 1 and 2a correspond respectively to sections 1 and 2 of the normal straight missed approach area and are constructed as specified in paragraph 12-10-12 except that section 2a has no secondary areas. Obstacle clearance is provided as specified in paragraph 12-2-14. The length of section 2a is determined as shown in Figure 12-10-7, and relates to the need to climb to a specified altitude prior to commencing the turn. The line A'-B' marks the end of section 2a. Point C' is 5300 feet from the end of section 2a.

b. Turning portion. Section 2b is constructed as specified in paragraph 12-10-12 except that it begins at the end of section 2a instead of the end of section 1. To determine the height which must be attained before commencing the missed approach turn, first identify the controlling obstacle on the side of section 2a to which the turn is to be made. Then measure the distance from this obstacle to the nearest edge of the section 2a area. Using this distance as illustrated in Figure 12-10-7, determine the height of the 20:1 slope at the edge of section 2a. This height plus 250 feet (rounded off to the next higher 20-foot increment) is the height at which the turn should be started. Obstacle clearance requirements in section 2b are the same as those specified in paragraph 12-10-7 except that section 2b is expanded to start at point C if no fix exists at the end of section 2a or if no course guidance is provided in section 2 (see Figure 12-10-7).

Note: The missed approach areas expand uniformly to the appropriate airway width.

Figure 12-10-7. Combination Straight and Turning Missed Approach



Example:

Given:

1. DA/DH is 200 feet
2. Obstacle height: 1065 MSL
3. Obstacle in section 2 = 6100 feet from the near edge of section 2a
4. Missed approach surface begins at GPI

Determine:

1. Distance from DA point to end of section 2a
2. Minimum turn altitude
3. Missed approach instructions

Solution:

1. Distance from DA point to end of section 2a
   a. $\frac{6100}{20} = 305\ ft$
   b. 1065 - $305 = 760$ MSL, required section 2a end OCS height
   c. $760 - 0$ (20:1 origin height) $= 760$ feet of total rise in sections 1 and 2a
   d. $760 \times 20 = 15200$ feet, distance from 20:1 origin to end of section 2a
   e. $15200\ + 775$ (distance from DA point to 20:1 origin) = 15975 feet

2. Minimum turn altitude
   a. $\frac{15975}{15.19} + DA = 1251.68$
   b. Round to next higher 20-foot increment = 1260 MSL

3. Missed approach instructions “Climb to 1260 then turn right…”

Section 12-11. Airport Surveillance Radar (ASR)

12-11-1. Initial Approach Segment. Apply paragraph 11-2-2, except that 90 degrees is changed to 120 degrees.

12-11-2. Intermediate Approach Segment. Apply paragraph 11-2-3. The maximum angle of interception between the intermediate and initial segment is 120 degrees. Table 12-2-2 is used to determine the required minimum length of the intermediate segment.

12-11-3. Final Approach Segment. Apply paragraph 11-2-5, except for paragraphs 11-2-5.a and 11-2-5.f. Apply paragraph 12-2-11.

12-11-4. Missed Approach Point. The MAP is a point on the FAC which is not farther than 2600 feet from the center of the landing area (see Figure 12-5-1). For PinS approaches the MAP is on the FAC at the end of the final approach area.

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, 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). If a clearway exists, then evaluate a 40:1 departure OCS originating at the end of the clearway at an elevation determined by application of Formula 13-1-1. See Figure 13-1-2 for application of OCS when a clearway is present. For helicopter departures from an IFR heliport, 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.

Note: A clearway is present when the Takeoff Distance Available (TODA) exceeds the Takeoff Run Available (TORA). When TODA exceeds TORA, the airport will declare and publish these values within the applicable Chart Supplement. Clearway evaluation is not a TERPS responsibility.

Formula 13-1-1. OCS Start Elevation (Runways with Clearway)

$$OCS_{Start} = \frac{TODA - TORA}{80} + DER_{elev}$$

Where:

DER_{elev} = DER elevation

Figure 13-1-1. OCS Starting Elevation

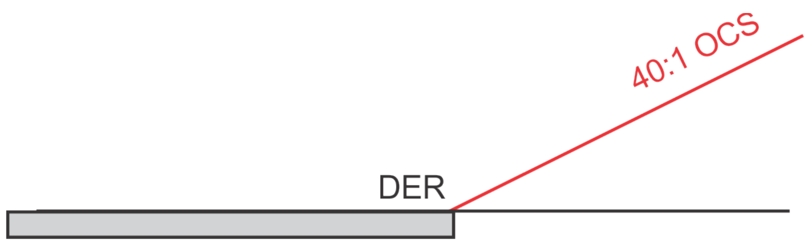
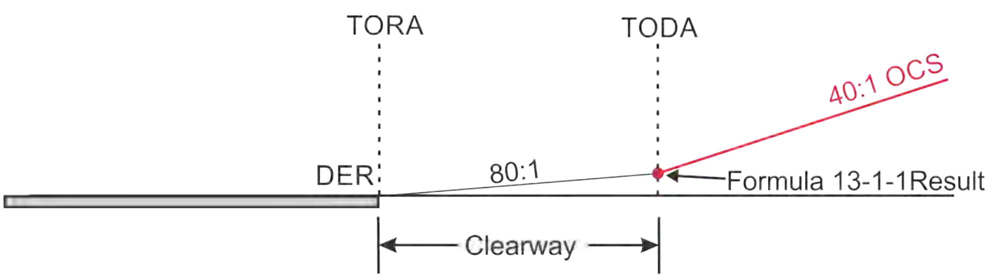


Figure 13-1-2. OCS Starting Elevation With Clearway



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 13-1-2 to calculate the OCS elevation.

Formula 13-1-2. 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 13-1-3). Use Formula 13-1-3 to calculate the secondary OCS elevation.

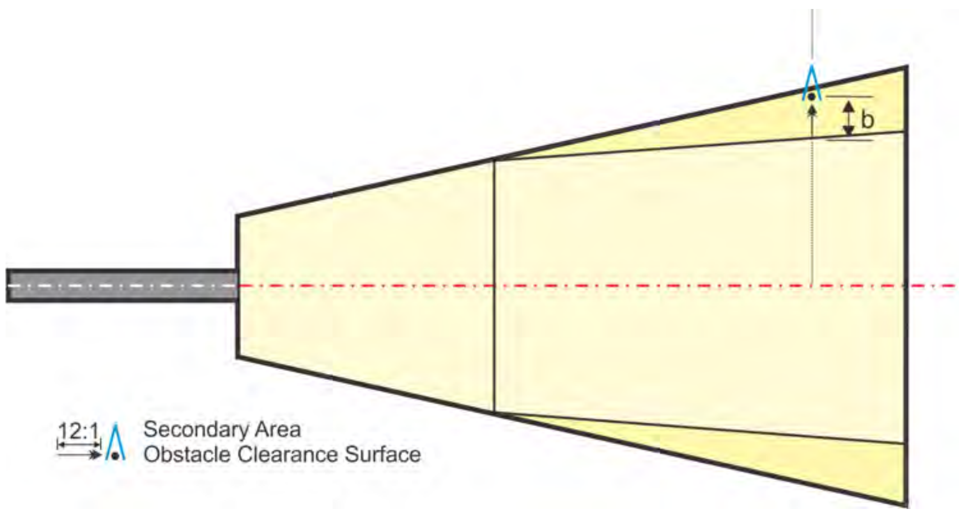
Formula 13-1-3. Secondary OCS Elevation

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

Where:

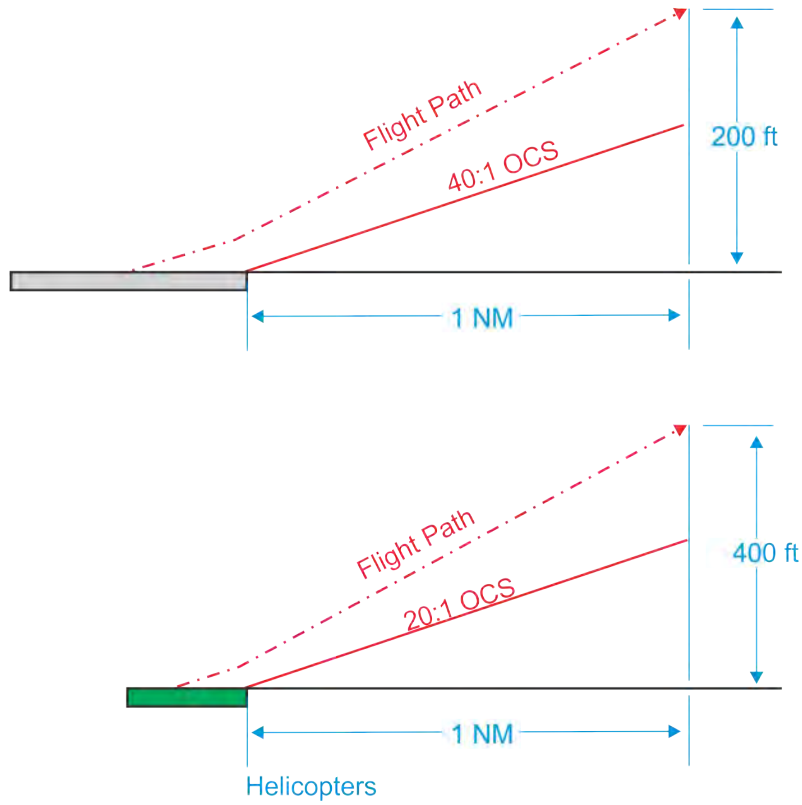
h_{OCS} = primary OCS height
b = perpendicular distance (feet) from edge of primary

Figure 13-1-3. 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 13-1-4).

Figure 13-1-4. 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 13-1-4.

Formula 13-1-4. 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 13-1-5.

Formula 13-1-5. 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 13-1-6.

Formula 13-1-6. 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 Formula 13-1-7. 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 13-1-7. 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). If a clearway is present, the ICAB is a line perpendicular to the extended RCL at the clearway end. It is the origin of the ICA (see Figure 13-1-5 or Figure 13-1-6 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 13-1-5 or Figure 13-1-6 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 13-1-5. Initial Climb Area: Standard

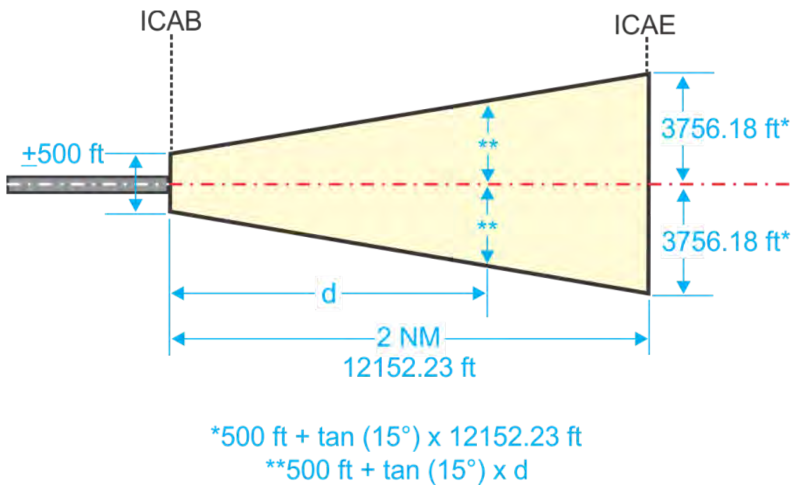
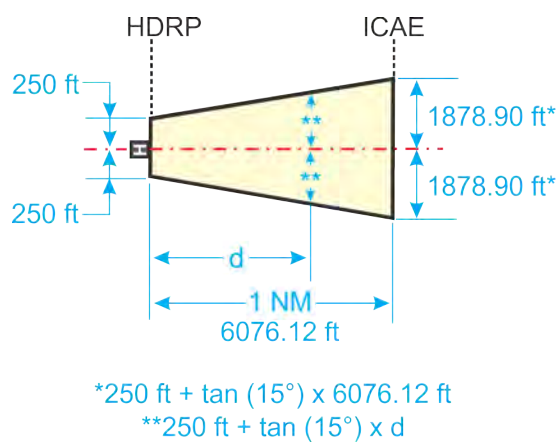


Figure 13-1-6. Initial Climb Area: Helicopters



(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 13-1-8.

Formula 13-1-8. 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).

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

Figure 13-2-1. Diverse Departure Assessment Areas

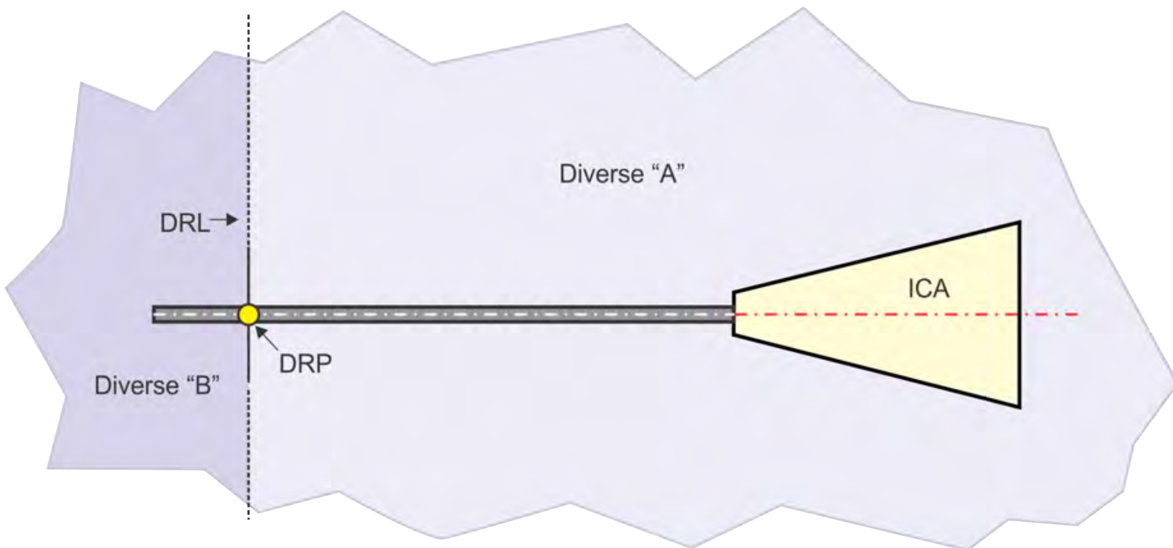
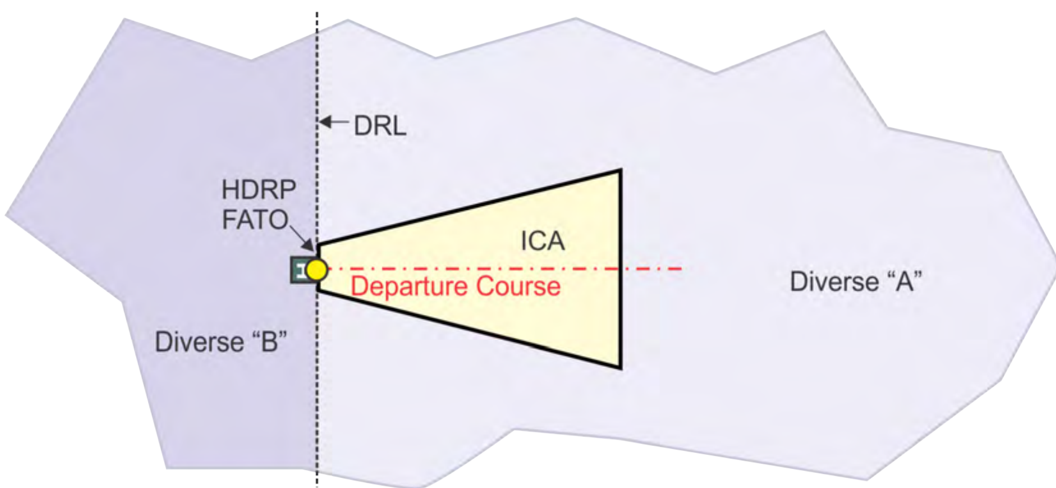


Figure 13-2-2. Heliport Diverse Departure Assessment Areas



(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). 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

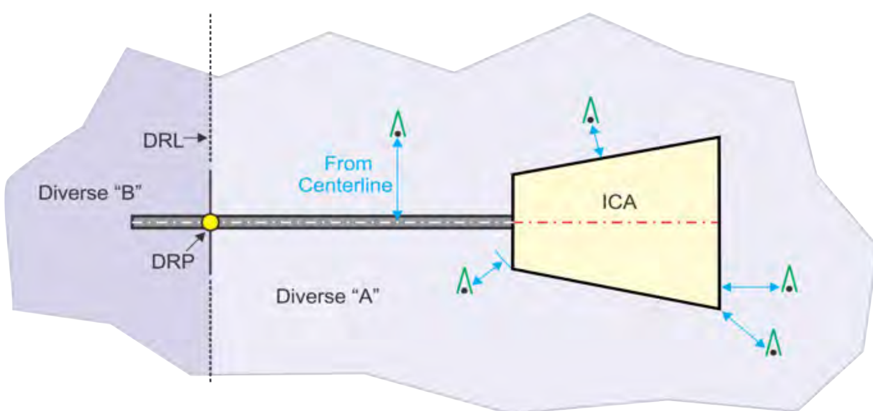
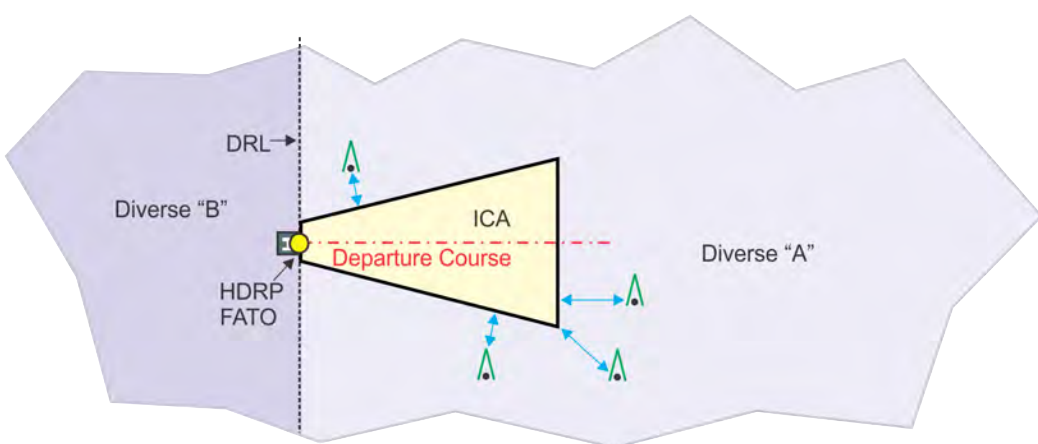


Figure 13-2-4. Heliport Diverse "A" Area Evaluation



(3) Diverse "B" area. All areas on the start end of runway side (non-departure side for helicopters) of the DRL (see Figure 13-2-1). Evaluate obstacles in the Diverse "B" area by measuring the distance in feet from the obstacle to the DRP (see Figure 13-2-5). 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

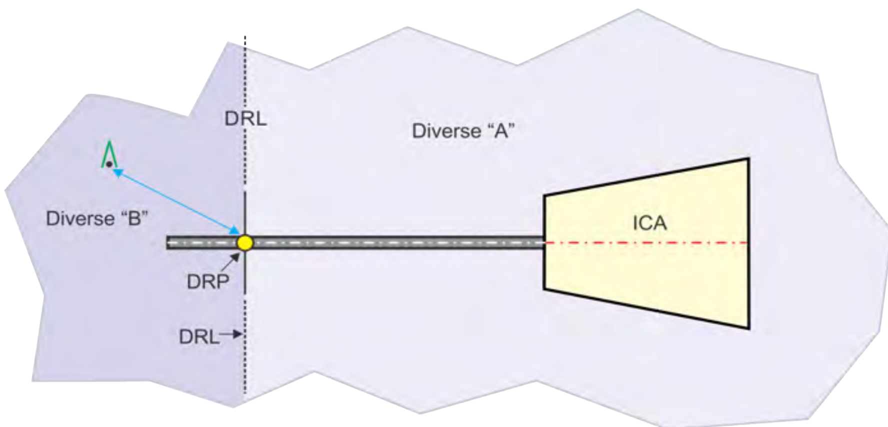
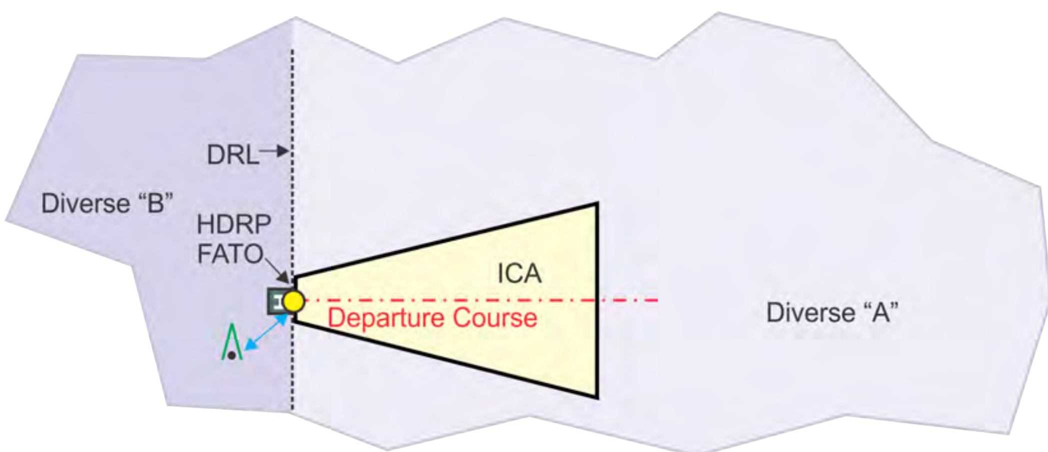


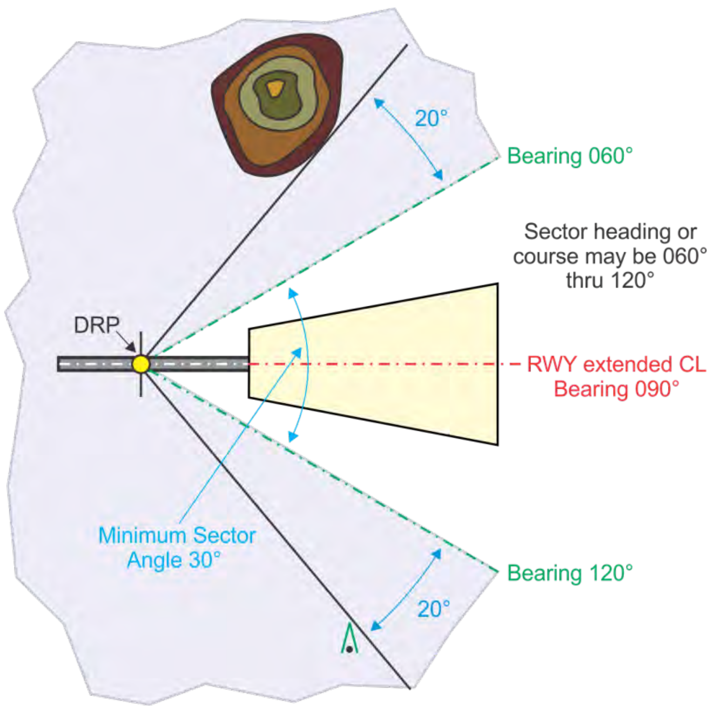
Figure 13-2-6. Heliport Diverse "B" Area



(4) Evaluation of the diverse area for helicopters may be conducted from the helipad in all directions from the FATO utilizing the 20:1 slope from the helipad elevation. If the evaluation reveals all surfaces clear in all directions, then the diverse area is considered clear and standard minimums apply and no departure course will be required. In this case, there is no distinction of Diverse "A" and "B" areas.

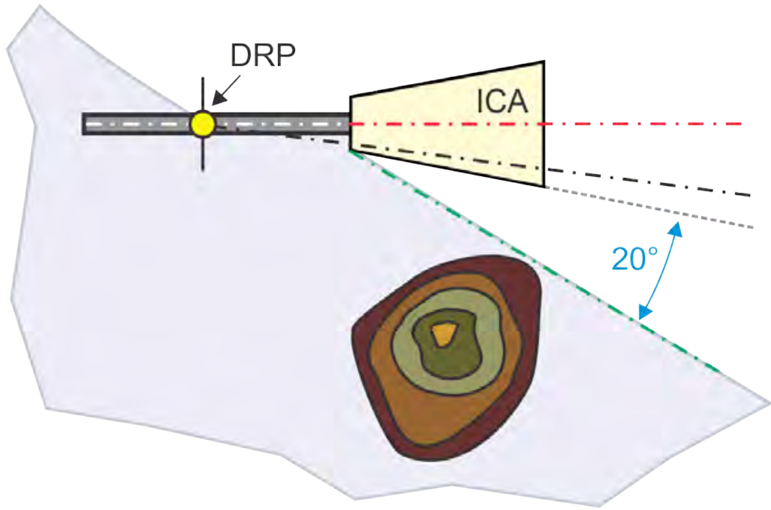
13-2-2. Departure Sectors. Where OCS penetrations prevent unrestricted diverse departure, consider constructing sectors within the diverse areas where departure flight is prohibited. Departure sectors may not be applied to helicopter departures from an IFR heliport. Departure instructions must assure the aircraft will maneuver clear of the prohibited sector boundaries. Separate sector boundaries from obstacles via a buffer established by a 20-degree splay from the DRP. The minimum angle between sector boundaries is 30 degrees. The ICA must be protected at all times (see Figure 13-2-7).

Figure 13-2-7. Minimum Sector Area



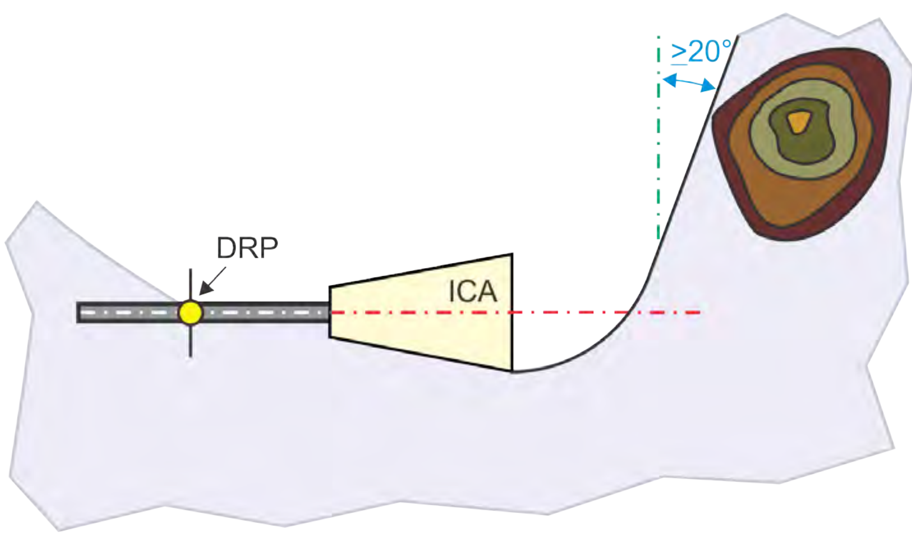
a. Boundary based on the ICA. When the 20-degree splay from the DRP cuts across the ICA, construct a line 20 degrees relative to the side of the ICA. To protect the ICA, no obstacle may lie inside this line (see Figure 13-2-8).

Figure 13-2-8. Boundary Based on ICA



b. Outer boundary involving a turn. Locate the turn point on runway centerline (extended) and establish the ICAE. Construct the outer boundary from the ICAE, using Table 13-3-2 for selection of the outer boundary radius. Construct a line from the obstacle tangent to the outer boundary radius. Establish the outer boundary buffer 20 degrees from this line on the maneuvering side. Begin the 20-degree buffer at the tangent point where the obstacle line intercepts the arc (see Figure 13-2-9).

Figure 13-2-9. Outer Boundary



c. Defining sector boundaries. Construct boundaries to define each sector. Sector boundaries originate at the DRP, or are defined tangentially from the outer boundary radius (see Figure 13-2-10). Define and publish sector boundaries by reference to aircraft magnetic headings. Sector “headings” must be equivalent to the magnetic bearing of the sector boundaries from their origins.

d. Climb Gradients. A departure sector 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 departure sector OEA, establish a climb gradient and climb gradient termination altitude in accordance with paragraph 13-1-4.

13-2-3. Sector Limitations.

a. The maximum turn from the takeoff runway in any one direction is 180 degrees relative to takeoff runway heading (see Figure 13-2-10). Figure 13-2-11 shows a sector of 360 degrees clockwise, 270 degrees could be assigned; however, the maximum turn to the right is a heading not in excess of the reciprocal of the takeoff runway heading.

Figure 13-2-10. Sector Limitations

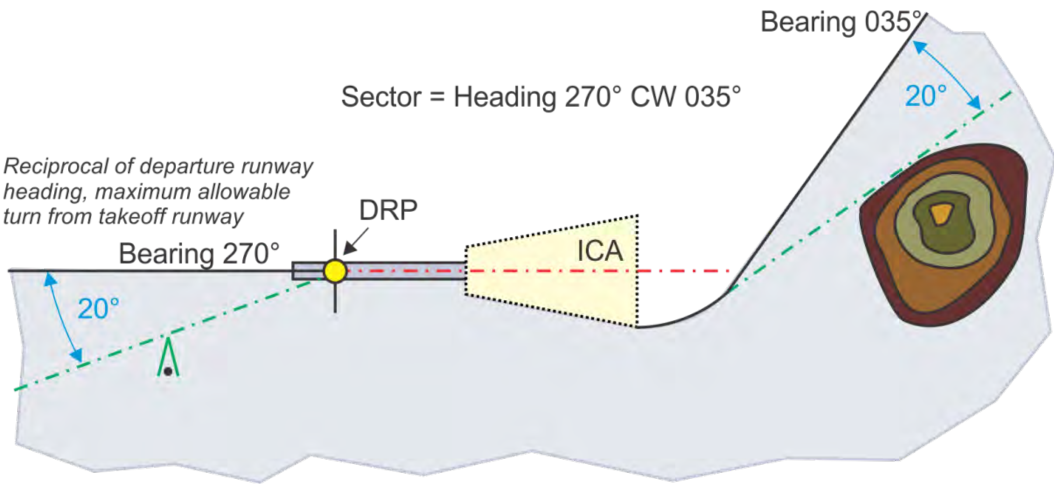
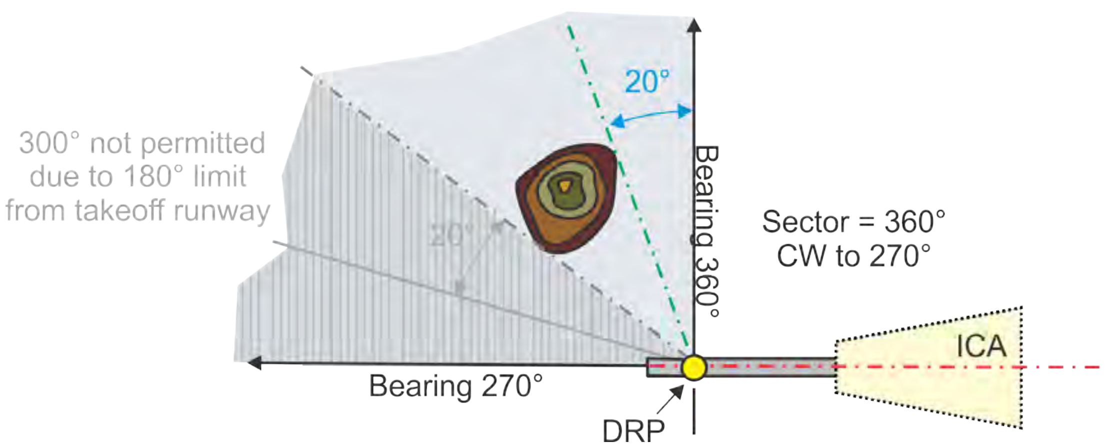
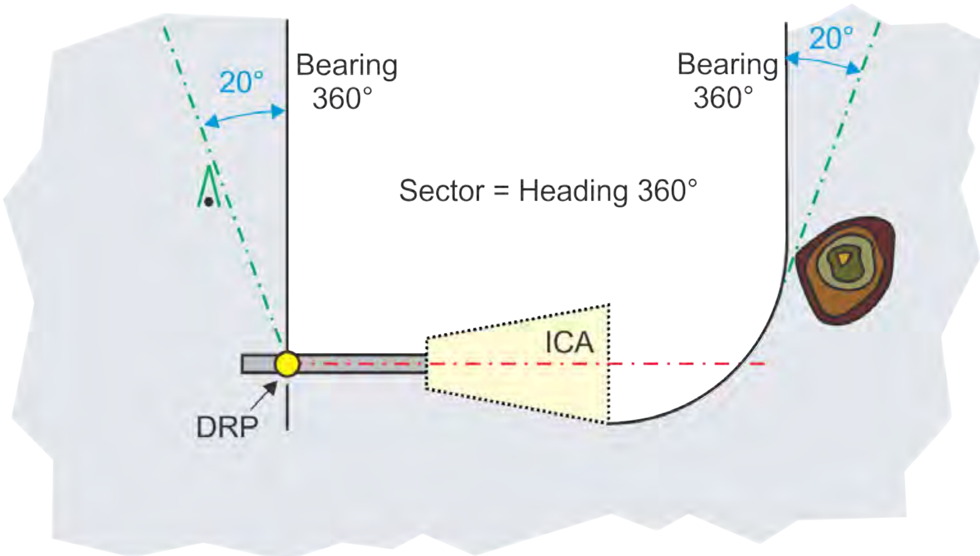


Figure 13-2-11. Maximum Heading Limitation



b. Assign a single heading for a sector which has parallel boundaries. The heading must parallel the boundaries. Figure 13-2-12 shows heading 360 degrees as the only heading allowable.

Figure 13-2-12. Parallel Boundaries



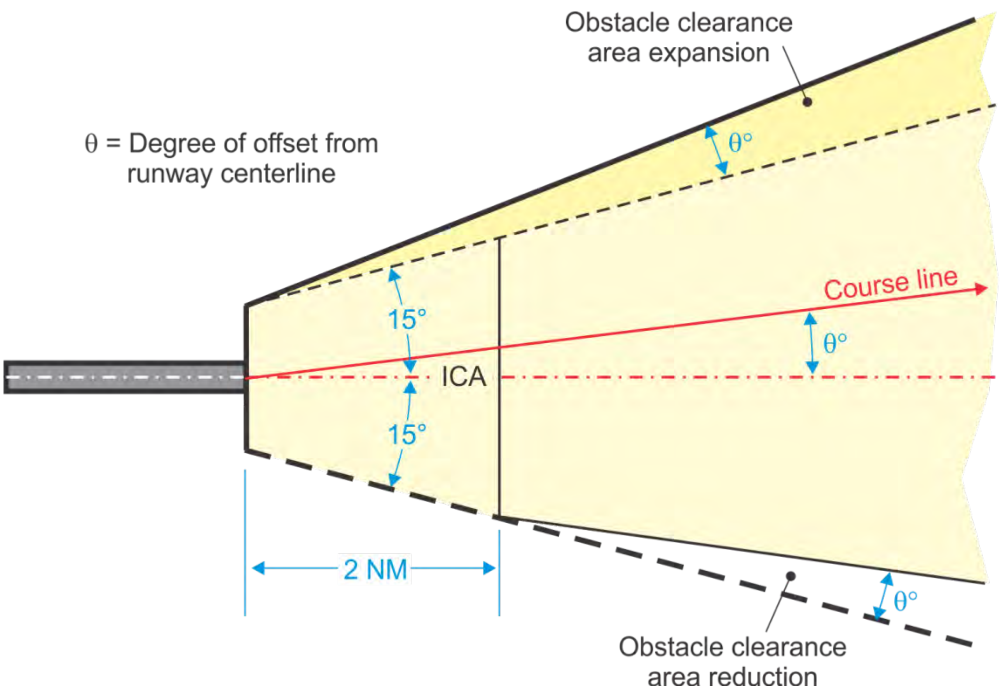
c. Do not establish a sector if the boundaries converge.

Example: In Figure 13-2-12, if the bearing from the DRP had been .001 degrees or greater or the outer bearing 359 degrees or less, the sector could not be established.

Section 13-3. Departure Routes

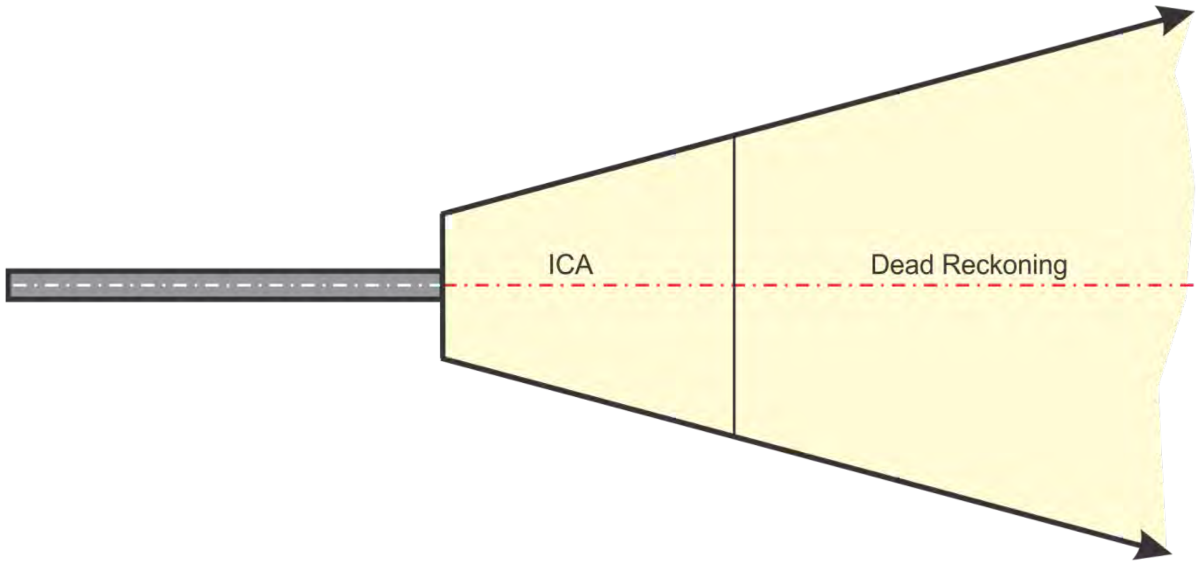
13-3-1. Straight Route Departure Segments. Straight departures are aligned within 15 degrees of the runway centerline. The ICA is aligned along the runway centerline for at least 2 NM (1 NM for helicopters) (see paragraph 13-1-6). If a turn at the DER (HDRP for helicopters) is desired, expand the obstacle clearance area in the direction of the turn an amount equal to the departure course degree of offset from runway centerline (departure course for helicopters) (see Figure 13-3-1). Reduce the obstacle clearance area following the ICA on the side opposite the turn an amount equal to the expansion on the opposite side.

Figure 13-3-1. Turn ≤15 degrees at DER



13-3-2. DR Departure. The boundary lines of the departure OEA splay outwards 15 degrees relative to the departure course from the end of the ICA (see Figure 13-3-1 and Figure 13-3-2). Limit the DR segment to a maximum distance of 10 NM from DER.

Figure 13-3-2. Dead Reckoning



13-3-3. Positive Course Guidance (PCG) Departure, 15 Degrees or less. Apply the values from Table 13-3-1 to Formula 13-3-1 and Formula 13-3-2 to calculate the obstruction primary area half width (½W_P), and the width of the secondary area (W_S). Refer to Table 13-3-1 for the values of k_P, D, A, and k_S.

Formula 13-3-1. Half Width of the Primary Area

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

Formula 13-3-2. Width of the Secondary Area

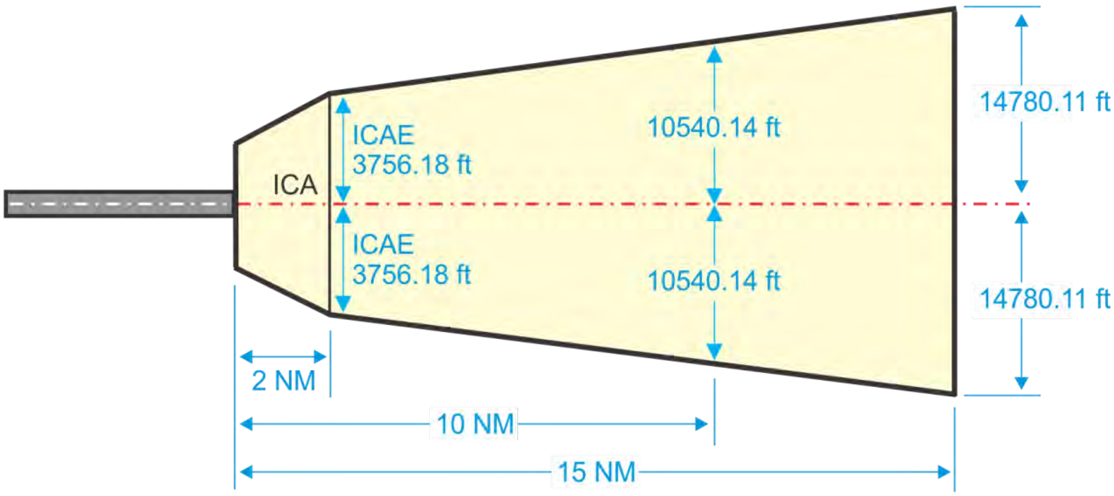
$$W_S = k_S \times D$$

Table 13-3-1. Obstruction Area Values

½ Width	k_p	k_s	D	A
Dep DR	0.267949	none	Distance (feet) from DER	500 feet
Localizer	0.139562	none	Distance (feet) from ICAE	3756.18 feet
NDB	0.0833	0.0666	Distance (NM) from facility	1.25 NM
VOR / TACAN	0.05	0.0333	Distance (NM) from facility	1 NM

a. Localizer guidance. The OEA begins at the ICAE. The maximum length of the segment is 15 NM from DER. Evaluate in accordance with paragraph 13-1-4.a. If necessary, calculate the required minimum climb gradient using Formula 13-1-4 where D is the shortest distance to the ICAB (see Figure 13-3-3).

Figure 13-3-3. Localizer Area



b. NDB guidance. Evaluate in accordance with paragraph 13-1-4.a. If necessary, calculate the required minimum climb gradient using Formula 13-1-4. Figure 13-3-4, Figure 13-3-5, and Figure 13-3-6 illustrate possible facility area configurations.

c. VOR/TACAN guidance. Evaluate in accordance with paragraph 13-1-4.a. If necessary, calculate the required minimum climb gradient using Formula 13-1-4. Figure 13-3-4, Figure 13-3-5, and Figure 13-3-6 illustrate possible facility area configurations.

Figure 13-3-4. Facility Area and DR Area Relationship

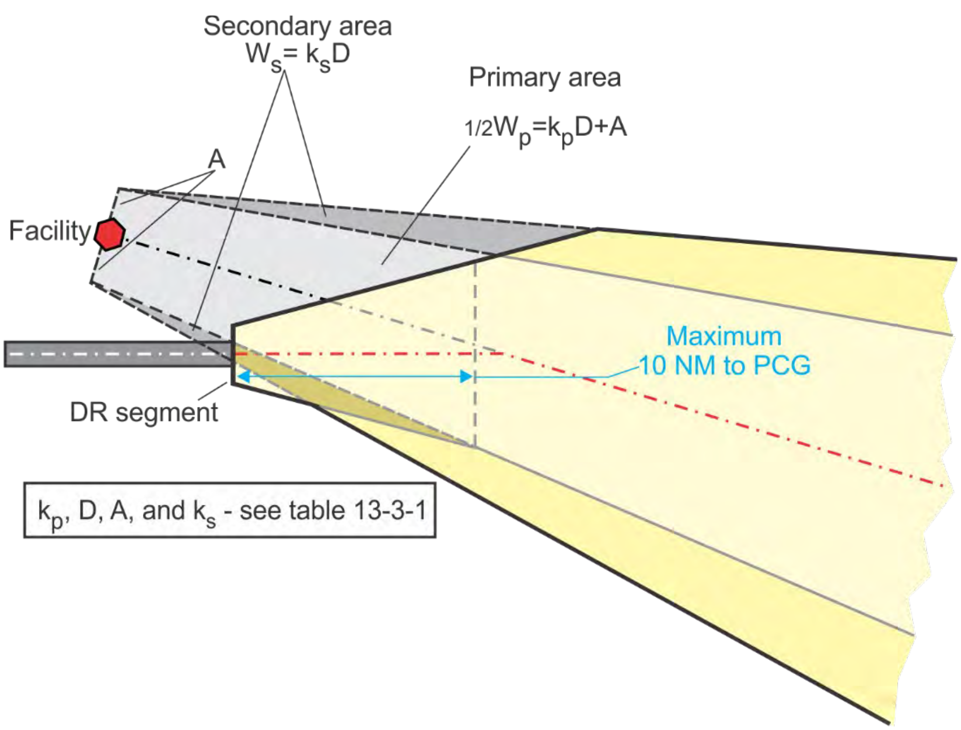
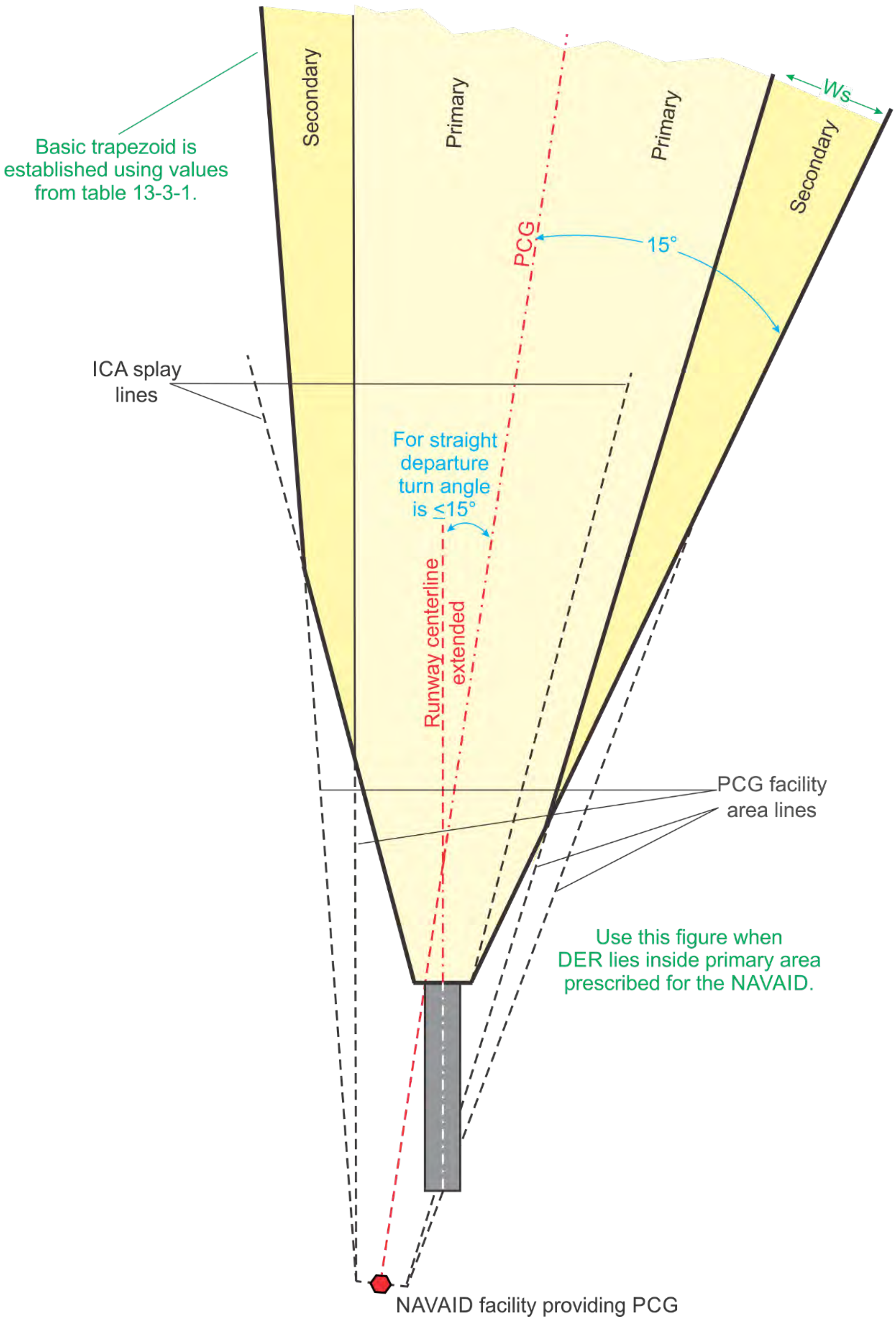
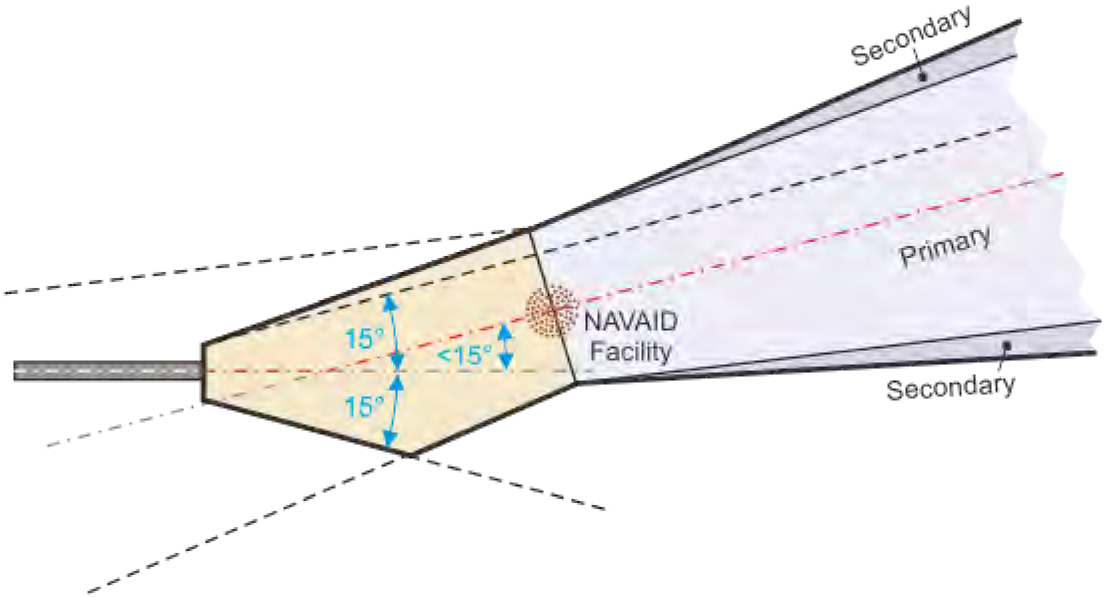


Figure 13-3-5. DER within Primary Area Facility



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. Turning Segment Construction. Construct turning segments when the course change is more than 15 degrees. Establish an ICA. For outer boundary radius use Table 13-3-2 and apply paragraphs 13-3-4.a through 13-3-4.d, 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 a turn radius of 0.9 NM for turns below 10000 feet MSL until intercepting the NAVAID course. Once established on the NAVAID course, use a 1.7 NM turn radius for subsequent turns unless a speed restriction other than 90 KIAS is noted.

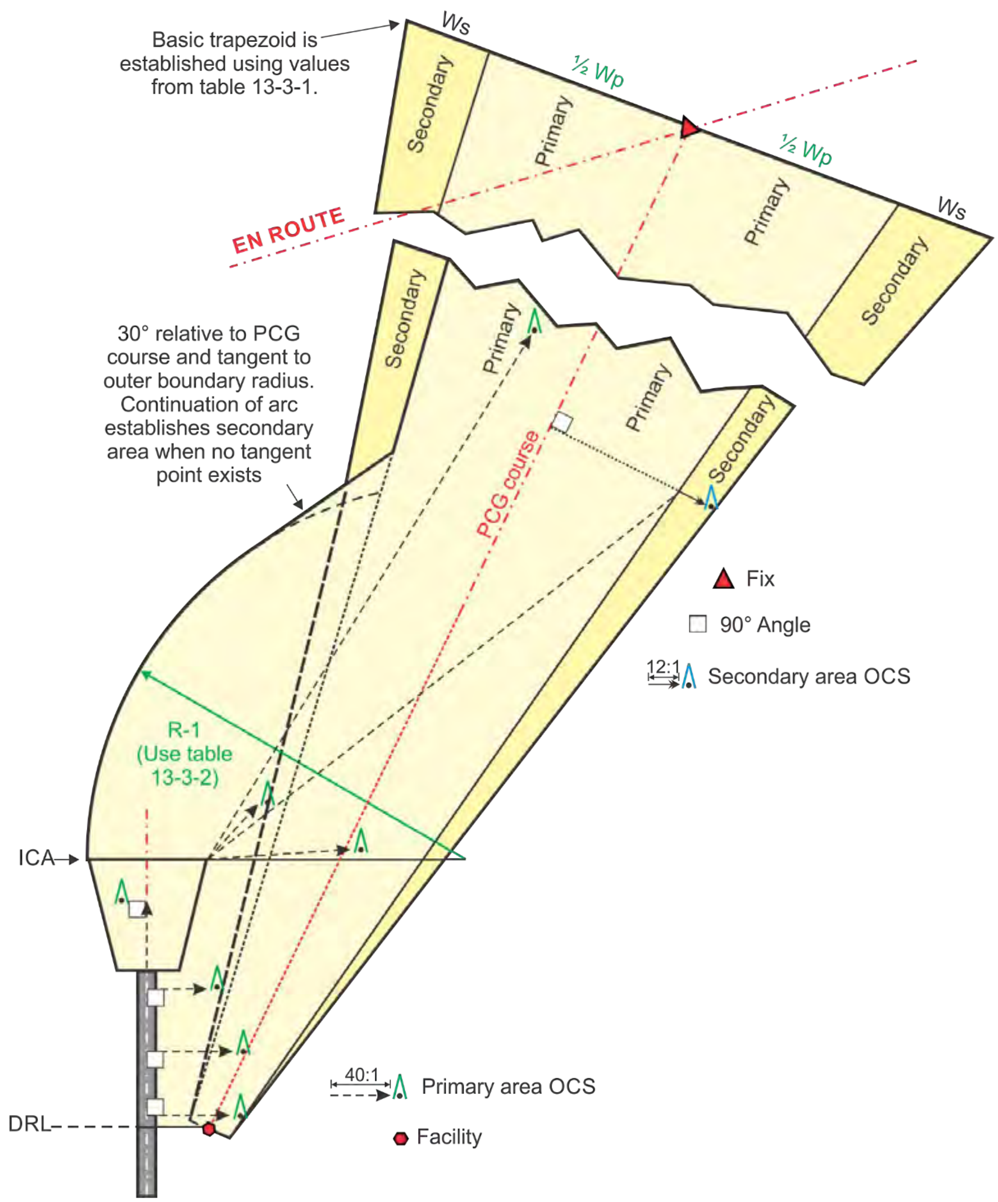
Table 13-3-2, Outer Boundary Radius

Aircraft Speeds	**90**	**120**	**150**	**175**
Turn radii:				
Below 10000 feet MSL	0.9	1.4	1.9	2.4
10000 feet MSL and above	1.4	2.0	2.7	3.3
Aircraft Speeds	**180**	**210**	**240**	**250**
Turn radii:				
Below 10000 feet MSL	2.5	3.2	3.9	4.2
10000 feet MSL and above	3.4	4.3	5.2	5.5
Aircraft speeds	**270**	**300**	**310**	**350**
Turn radii:				
Below 10000 feet MSL	4.7	5.6	6.0	7.3
10000 feet MSL and above	6.2	7.3	7.7	9.3

Note: Speeds include 60-knot omni winds below 10000 feet MSL; 90-knot omni winds at 10000 feet and above; bank angle 23 degrees.

13-3-5. 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



13-3-6. 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.

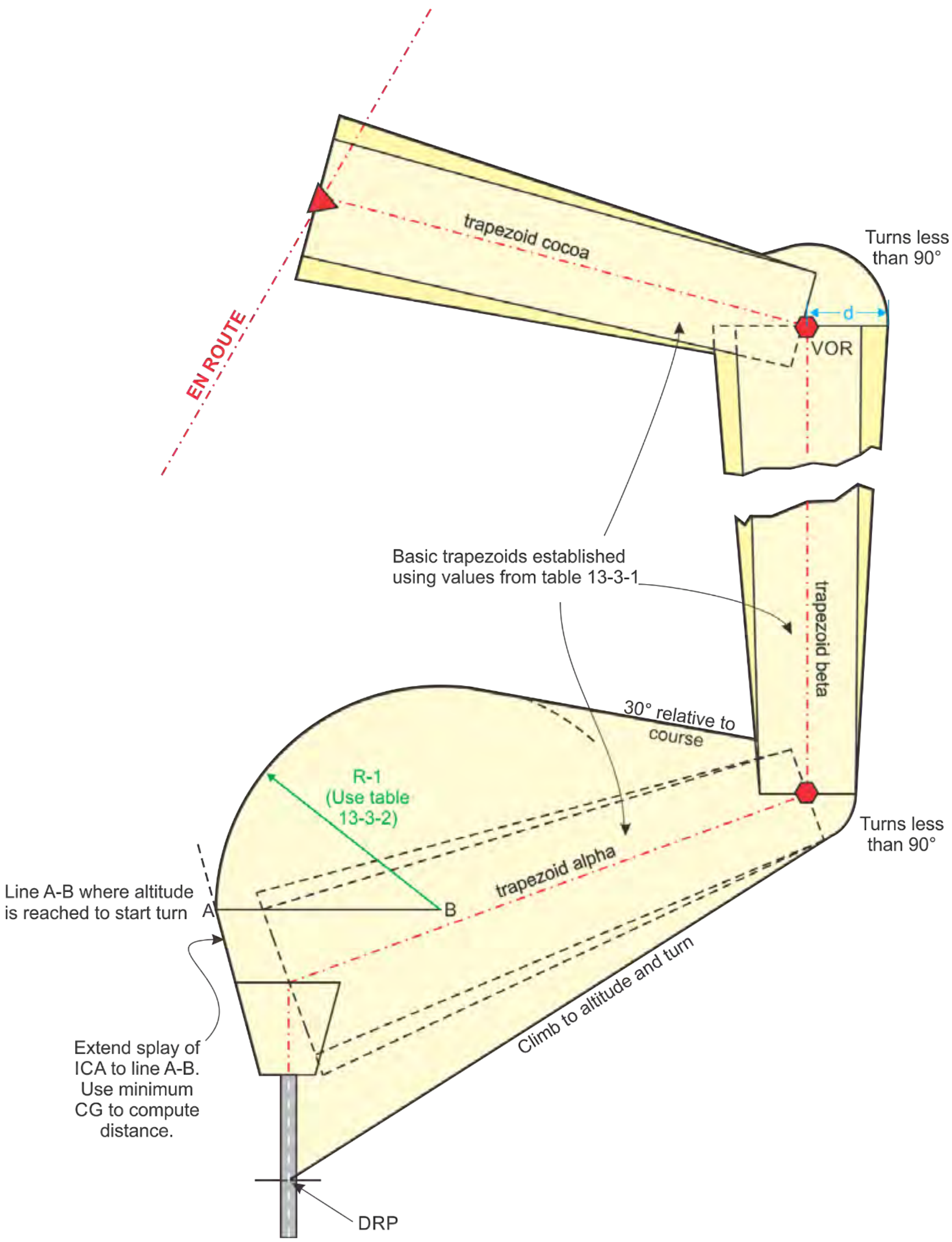
(1) Align the centerline of trapezoid alpha, through point C (end of ICA on runway centerline extended).

(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



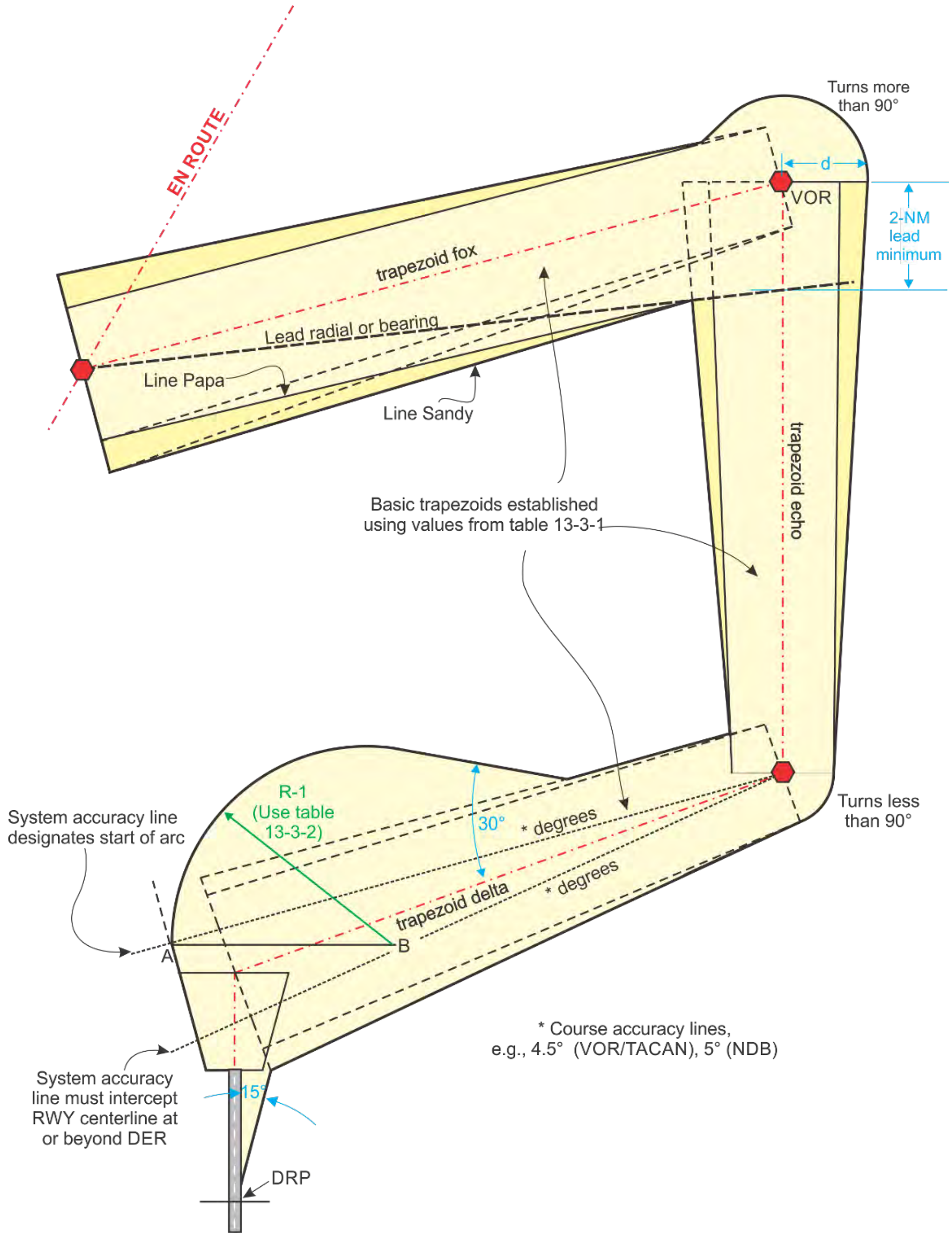
b. Climb to intercept a course (see Figure 13-3-9). Construct a 15-degree splay relative to runway centerline from the DRP to the secondary boundary of trapezoid delta (inside of turn) area. System accuracy line of delta must intercept runway centerline at or beyond DER.

(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.

(1) 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.

(2) 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."

d. 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

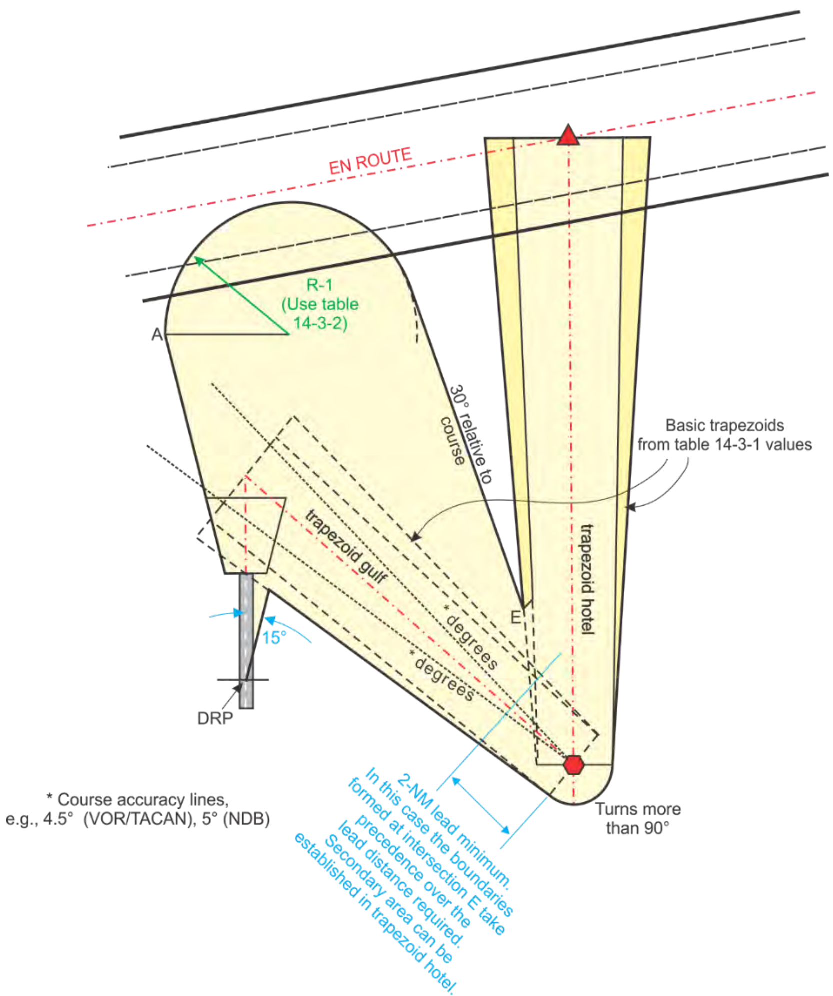


Figure 13-3-11. Multiple Turns

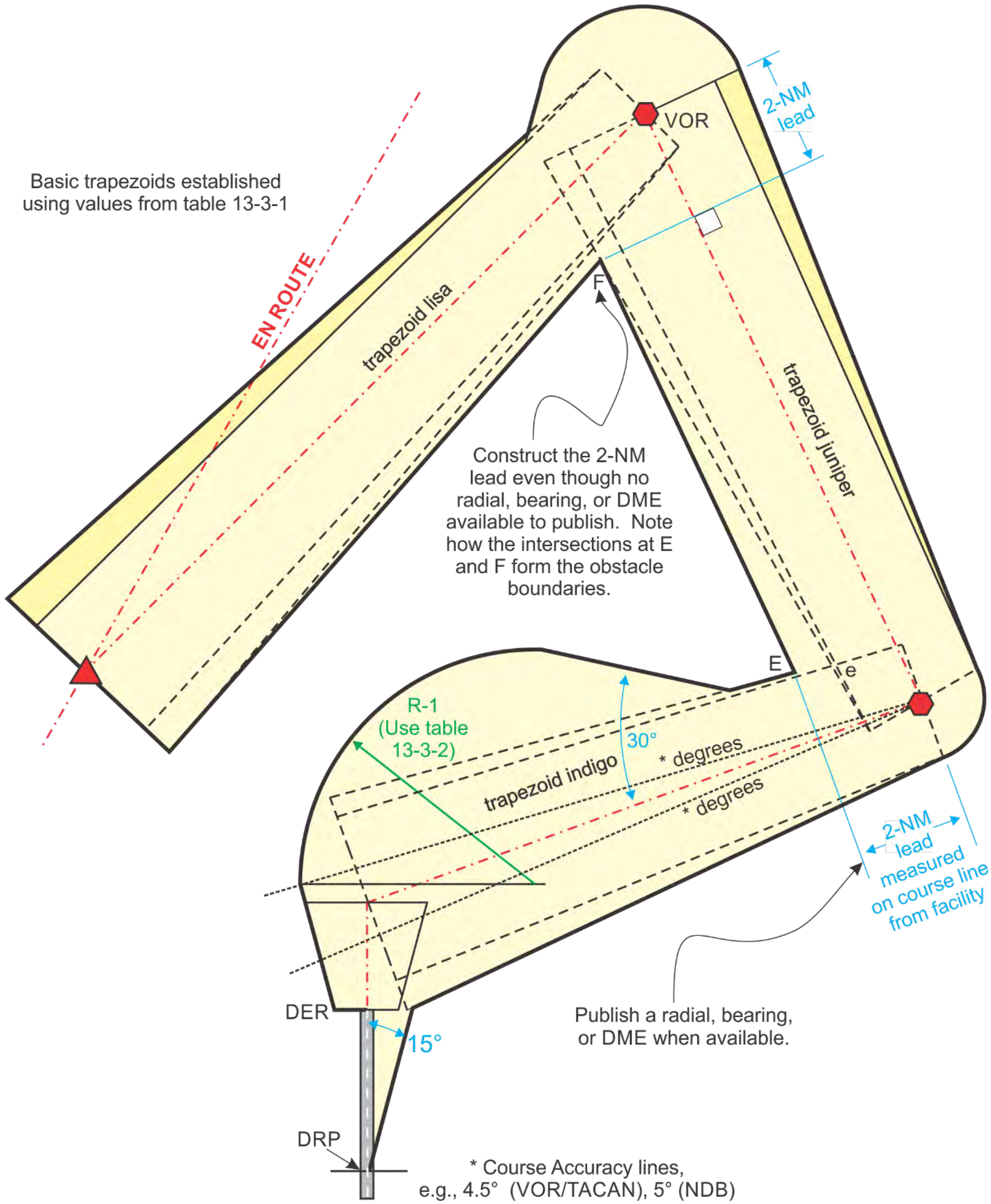
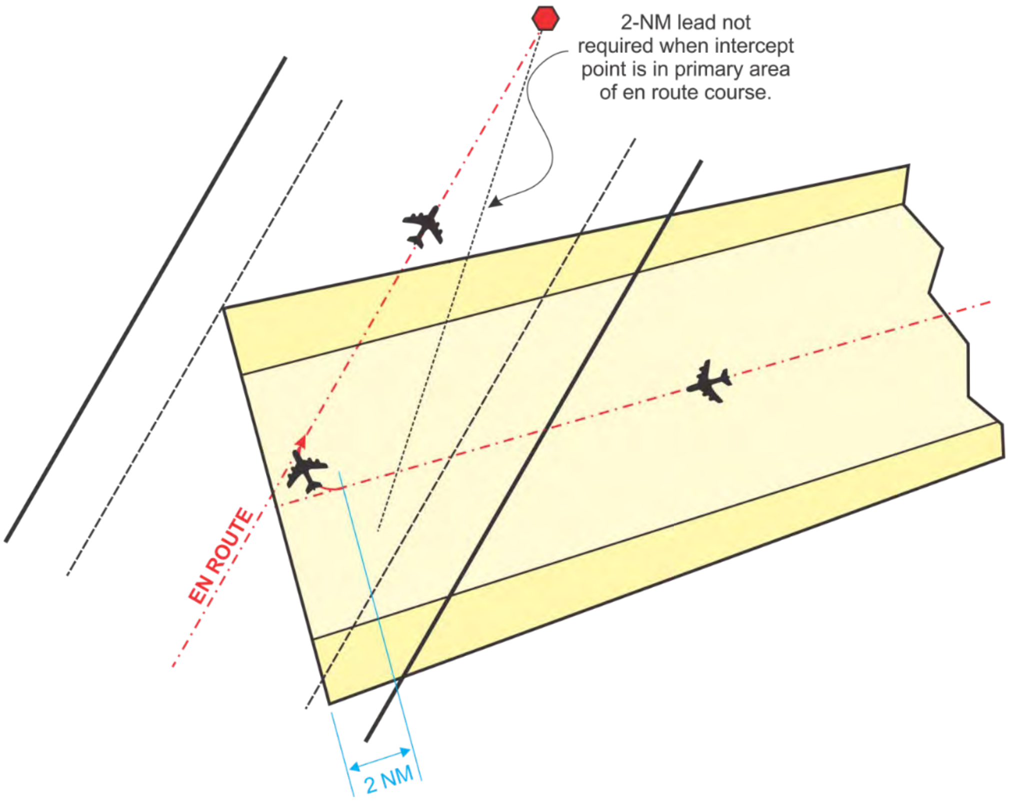


Figure 13-3-12. Turn onto En Route Course



13-3-7. 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

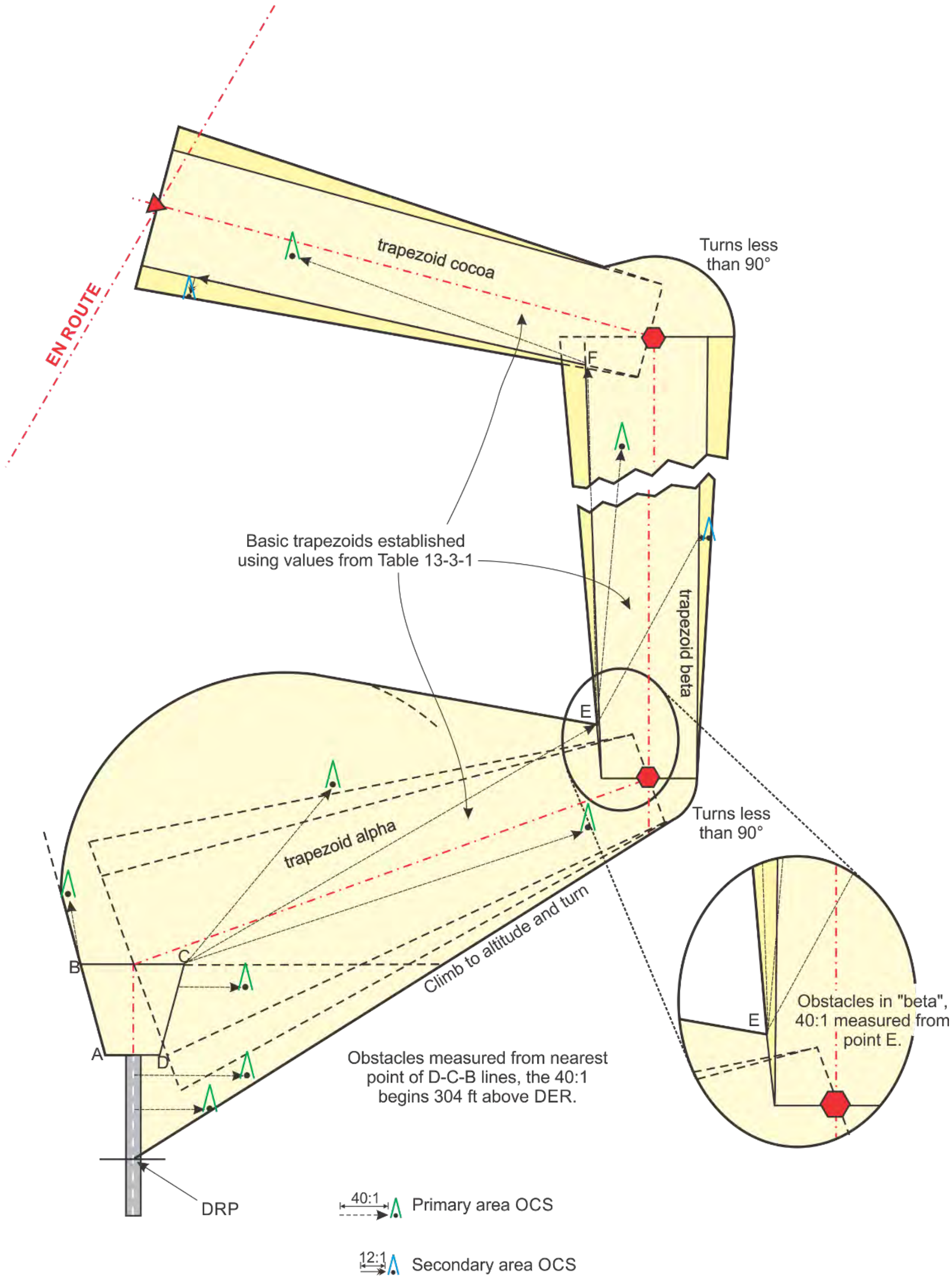
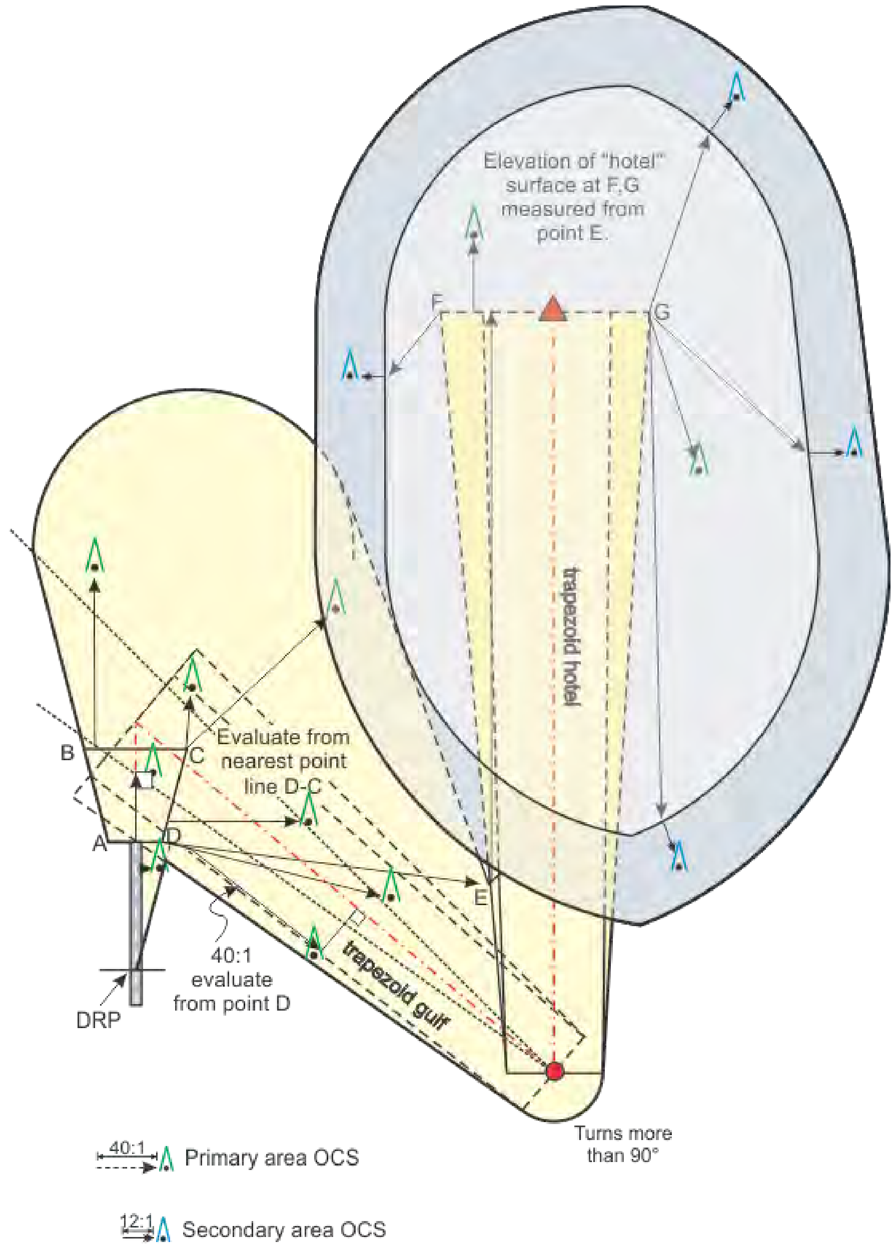


Figure 13-3-14. Climb in a Holding Pattern, Turns More Than 90 Degrees Evaluation



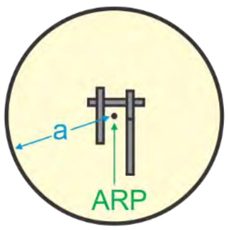
Section 13-4. Visual Climb Over Airport (VCOA)

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.

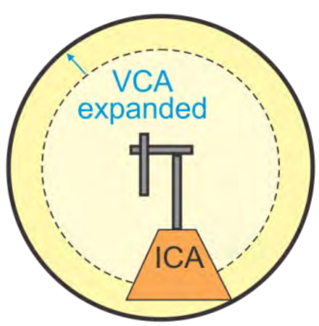
Figure 13-4-1. VCA



a=R1 (Table 13-4-1) plus the distance from ARP to most distant **DER**

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



The VCA must completely encompass the ICA.

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.

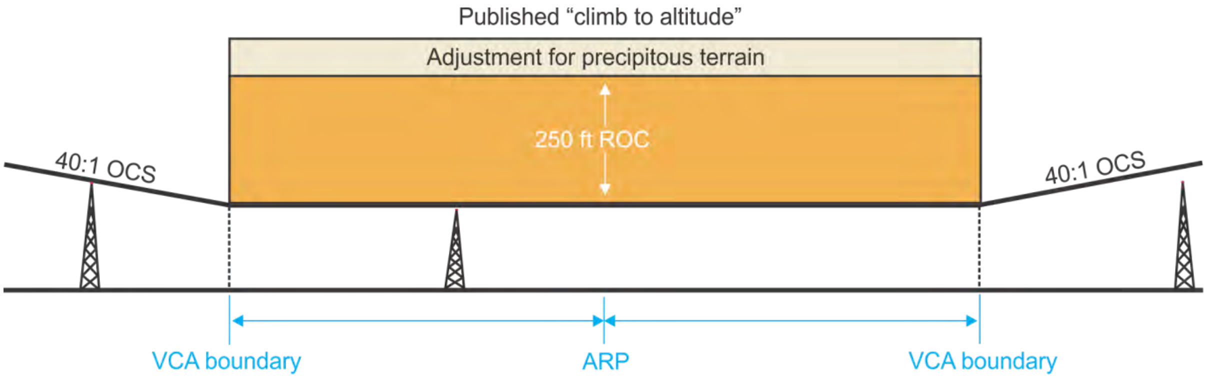
(2) Assess a 40:1 OCS outward from the VCA boundary using the preliminary height of the VCA level surface as the starting OCS height. The 40:1 surface must be evaluated to a minimum distance of 19 NM; expand the assessment to a distance of 40 NM if any part of the assessment area within 19 NM includes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



Example:

Highest obstacle within VCA :	151 ft
Precipitous terrain adjustment:	70 ft
ROC:	250 ft
Climb to altitude:	471 ft (rounds to 500)

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.

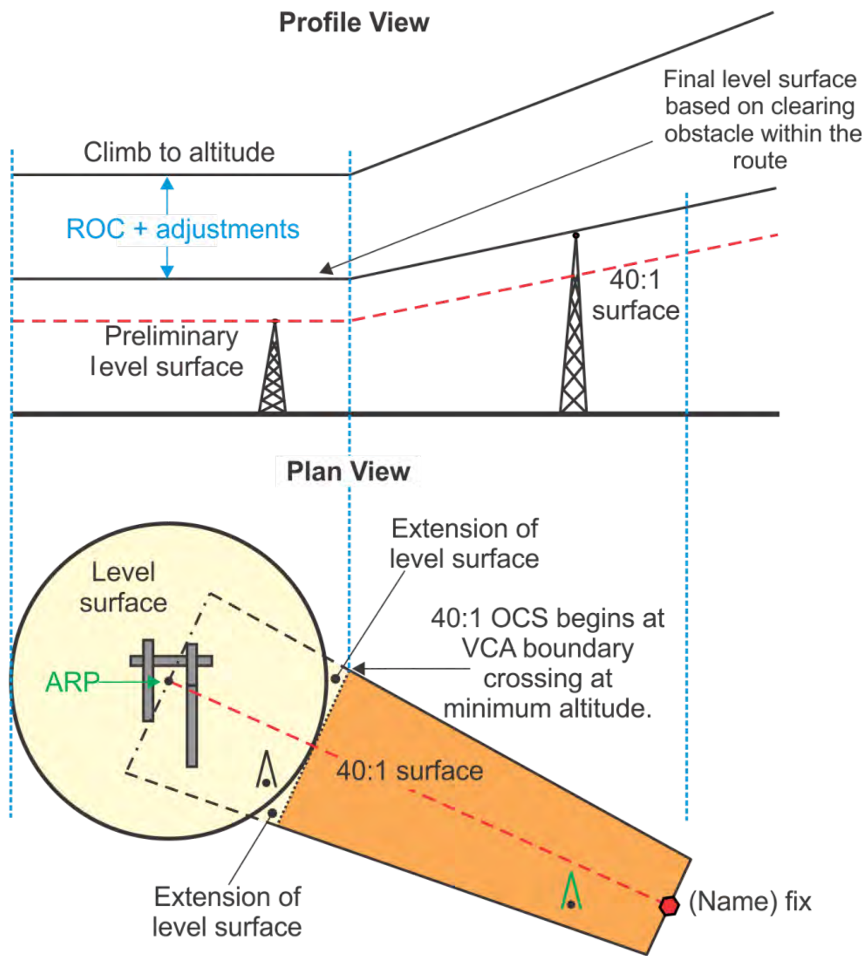
(2) Determine the preliminary level surface height by applying paragraph 13-4-3.a(1).

(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."

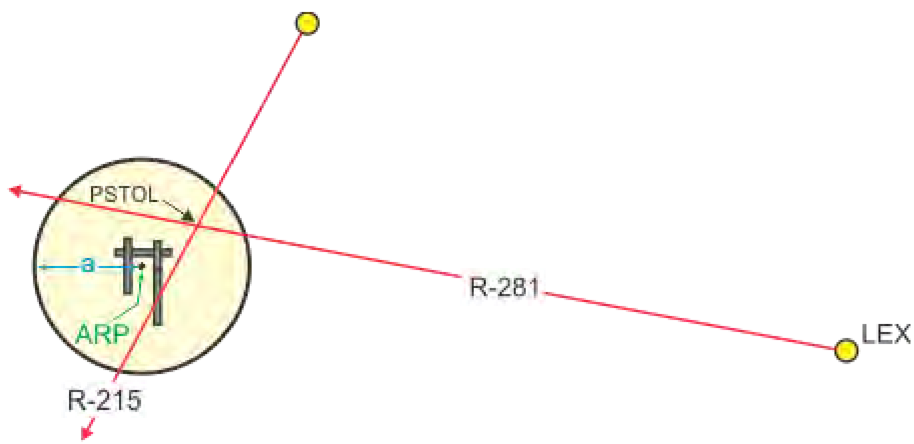
b. For a VCOA route departure, specify the intended direction of flight to cross the first fix of the route, followed by the climb to altitude, and then specify the route.

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).

<u>DoD Only</u>: 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.

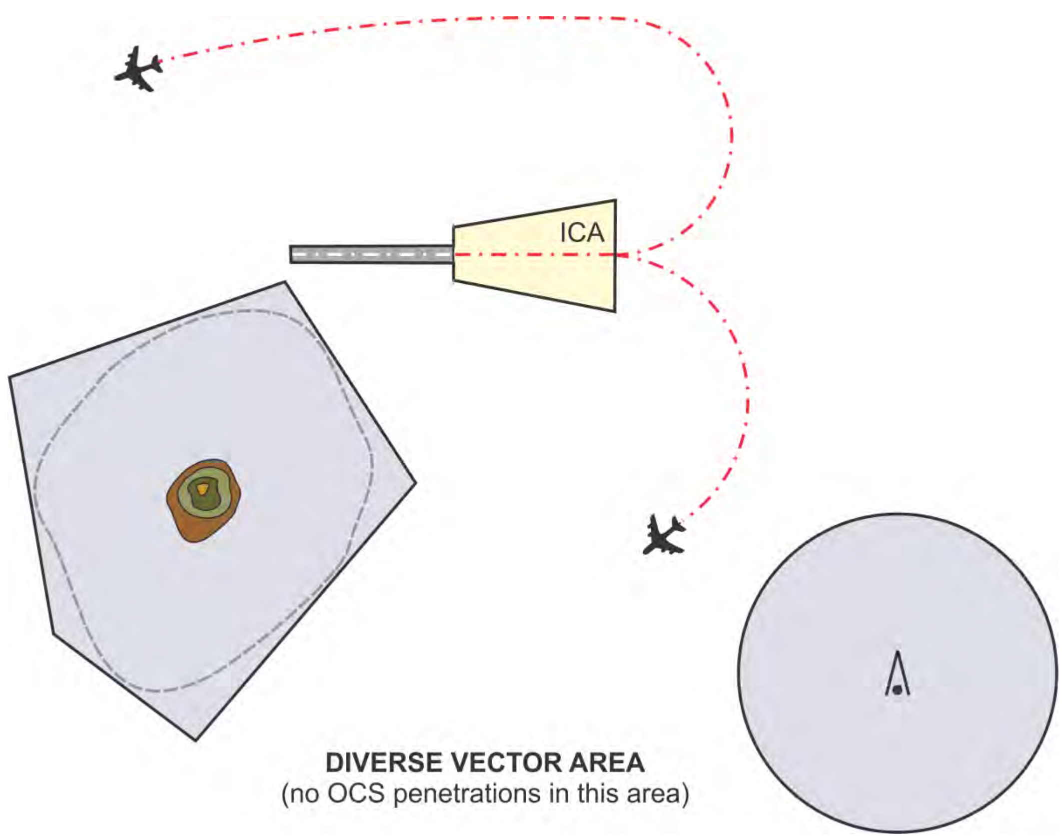
a. Isolate penetrating obstacles. This method is generally suitable for isolating single obstacles, or a group of obstacles in proximity to each other. Boundaries surrounding obstacles that penetrate a departure runway's OCS are established that define an area where vectors below the MVA/MIA are prohibited. 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.

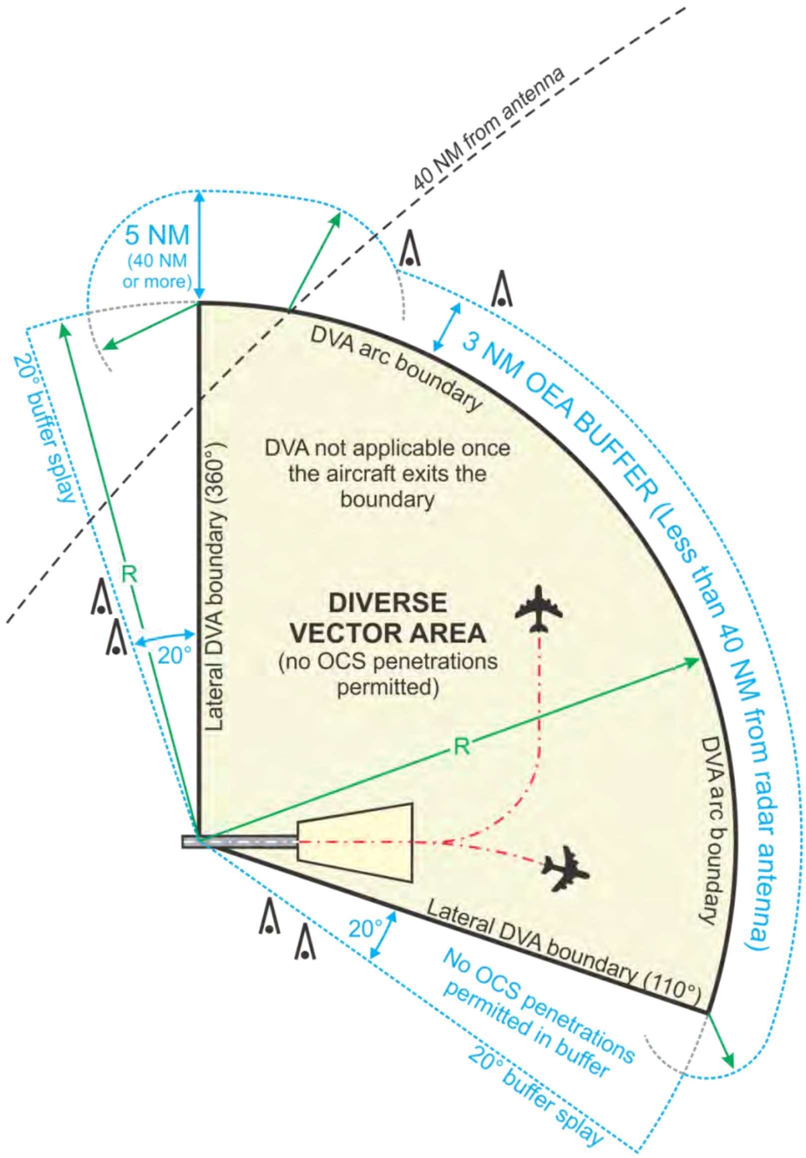
(3) Isolation areas must be located so that sufficient room to vector departing aircraft is provided which would allow ATC to issue vectors as necessary to avoid the areas. This determination must be made in collaboration with the air traffic facility.

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.

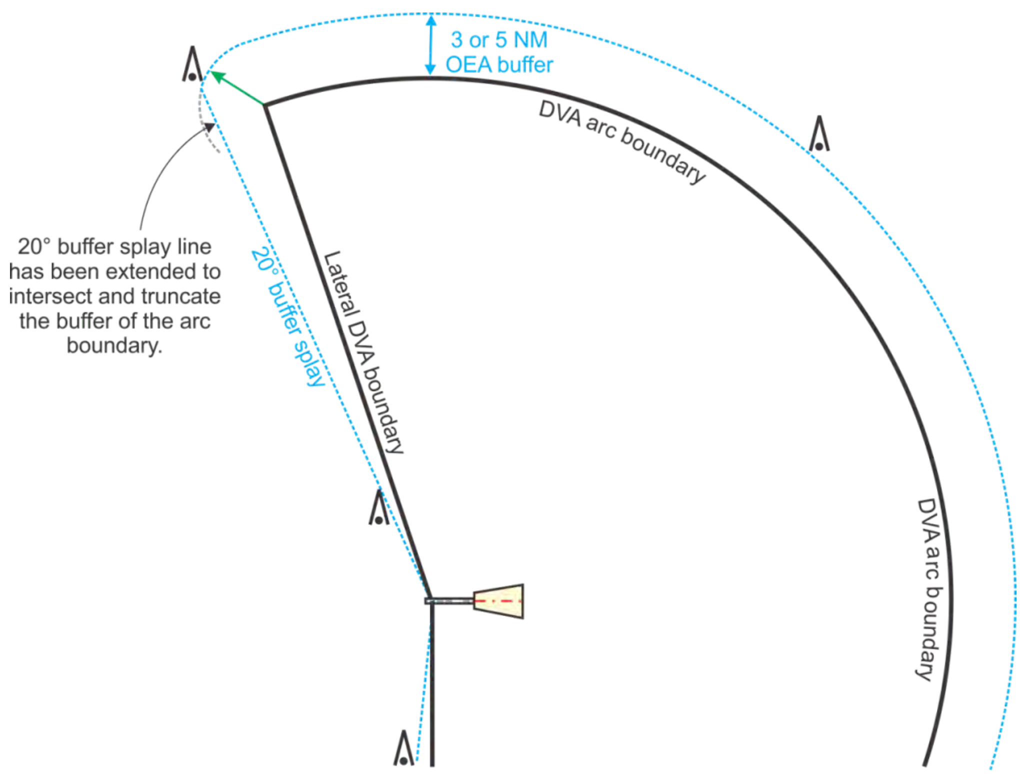
(3) An OEA buffer expands outward from the DVA boundaries. The buffer of the DVA arc boundary must meet the distance requirements of paragraph 11-3-2.a, except a 5 NM buffer always applies to a DVA that will be used by an ARTCC. The lateral buffers begin at DRP and splay outward from the lateral boundaries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

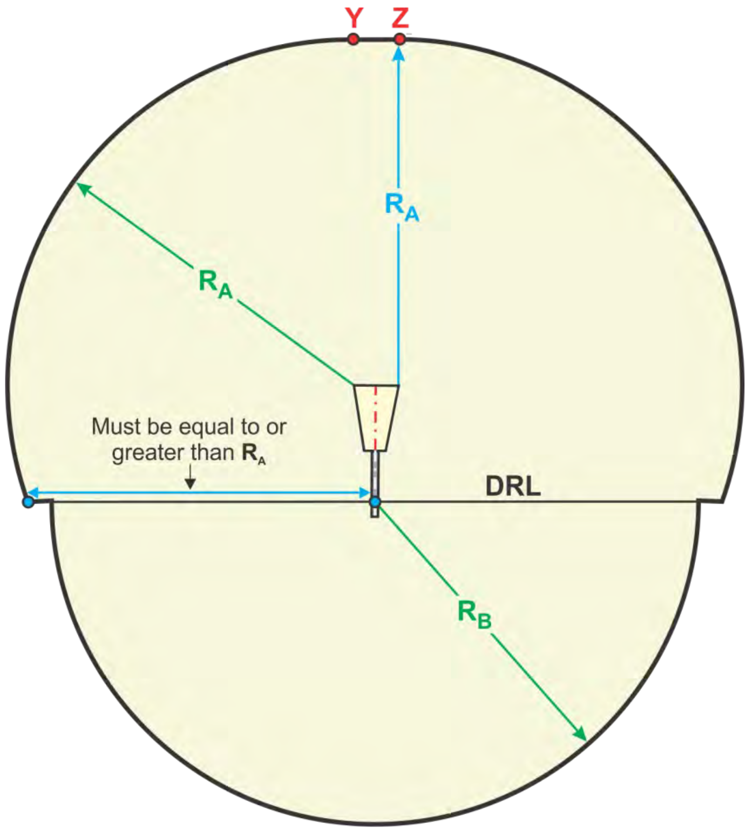
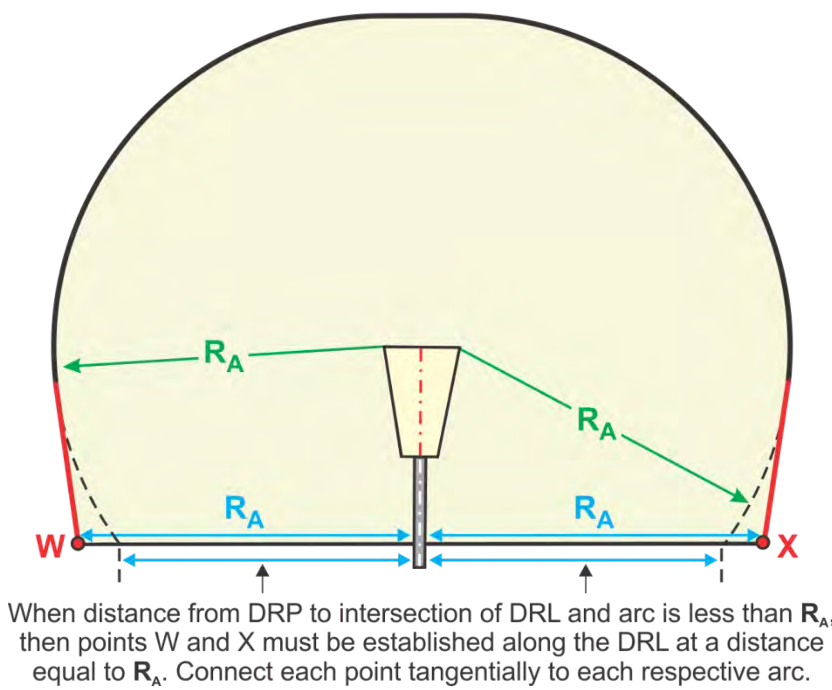


Figure 13-5-5. Construction with Points W and X



(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

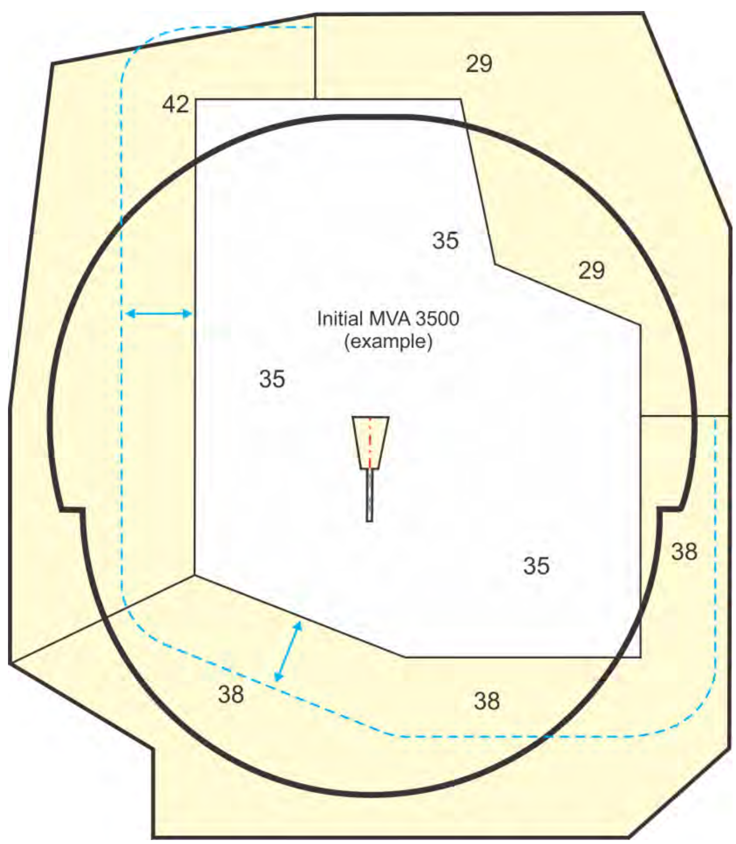


Figure 13-5-7. Obstacle Search Area

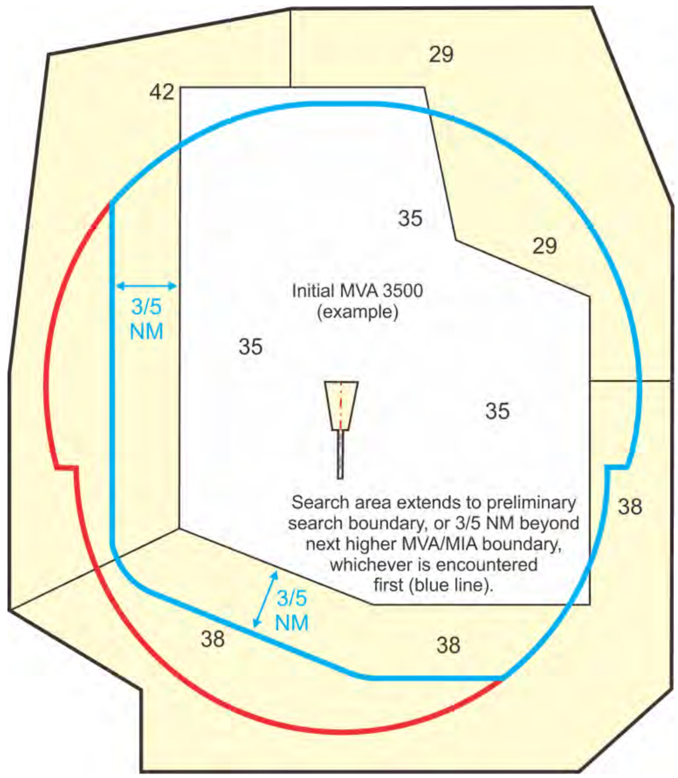
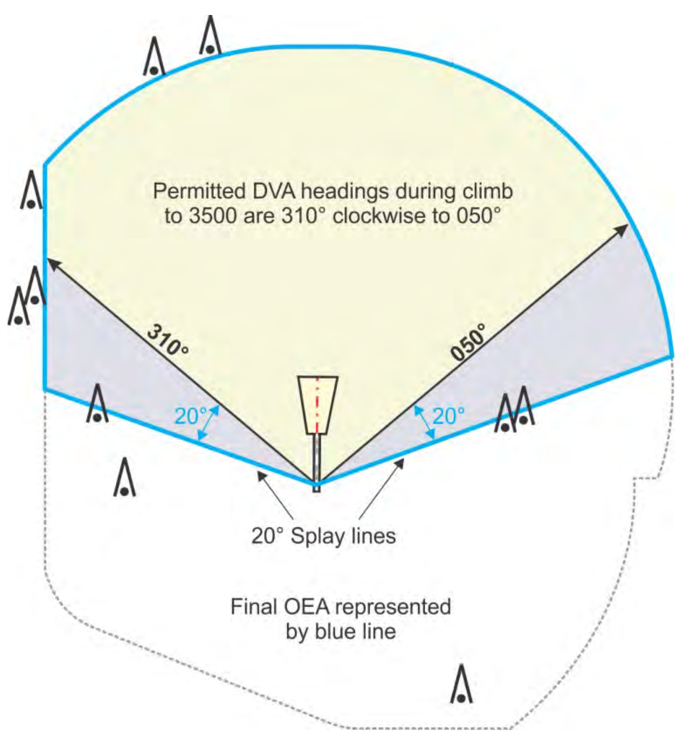


Figure 13-5-8. Permitted DVA Headings Based on Obstacles

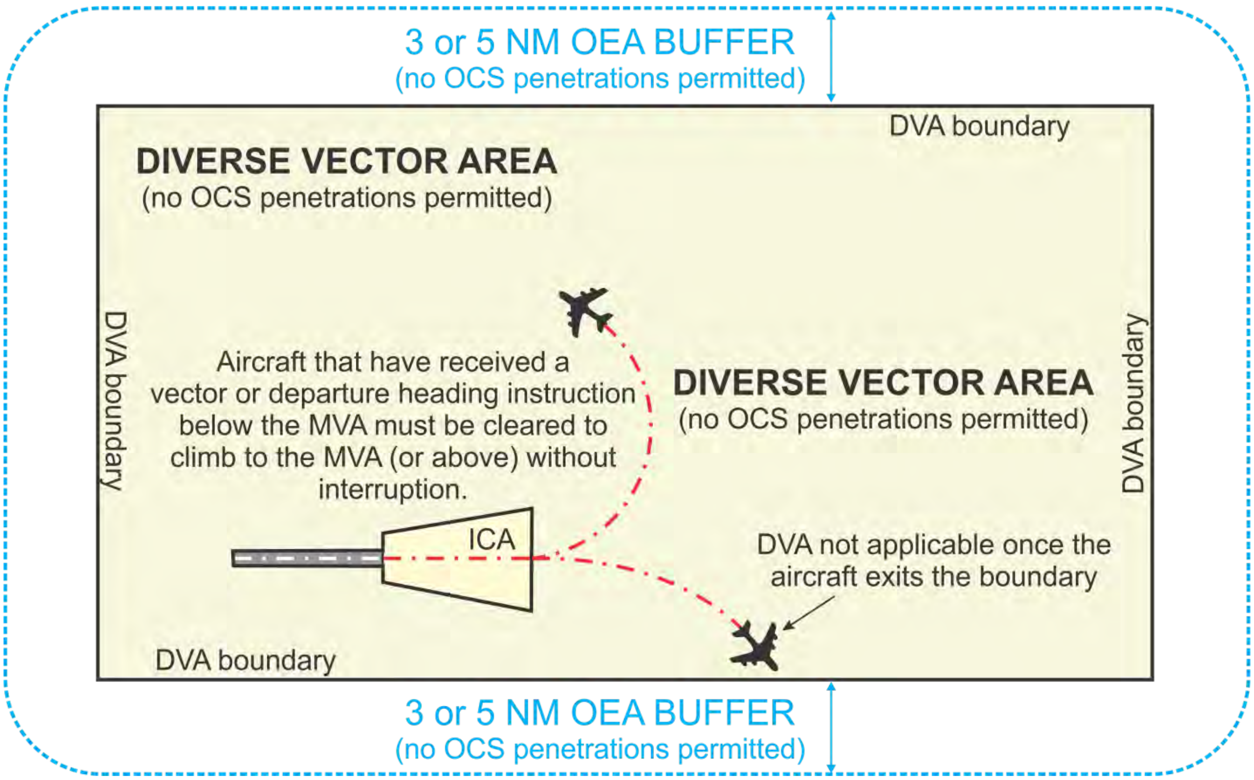


d. Define an area. An area may be defined which excludes all obstacles (low, close-in obstacles are permitted) that penetrate the departure OCS (see Figure 13-5-9).

(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.

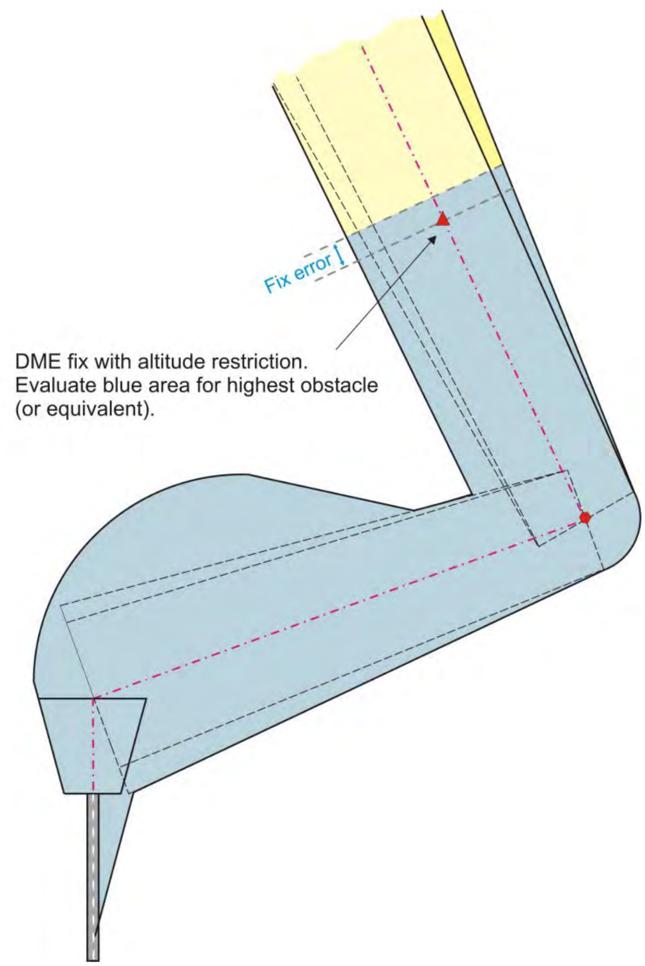
Section 13-6. Obstacle Clearance Requirements for SID Containing ATC Altitude Restrictions

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).

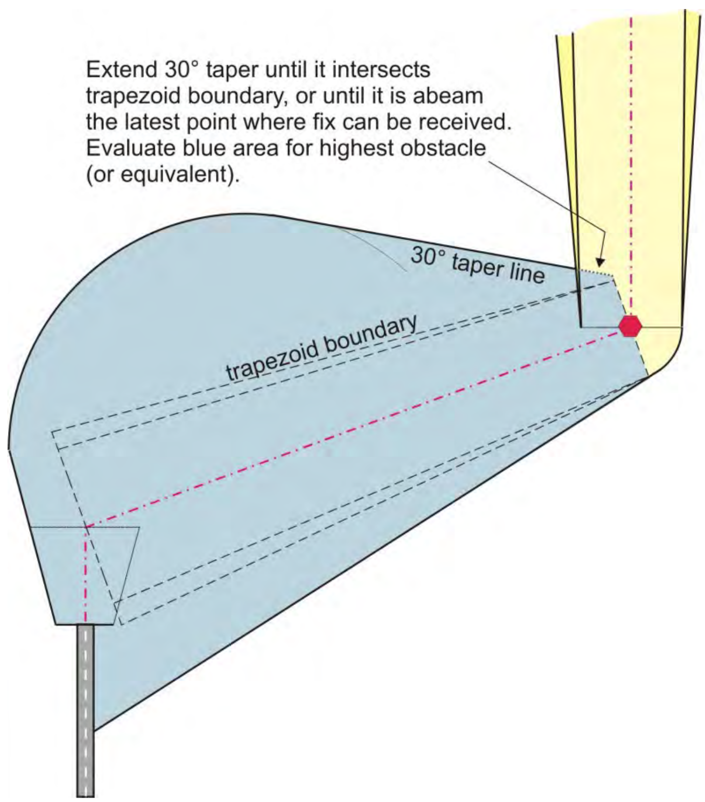
Figure 13-6-1. No Turn Required at Fix



(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).

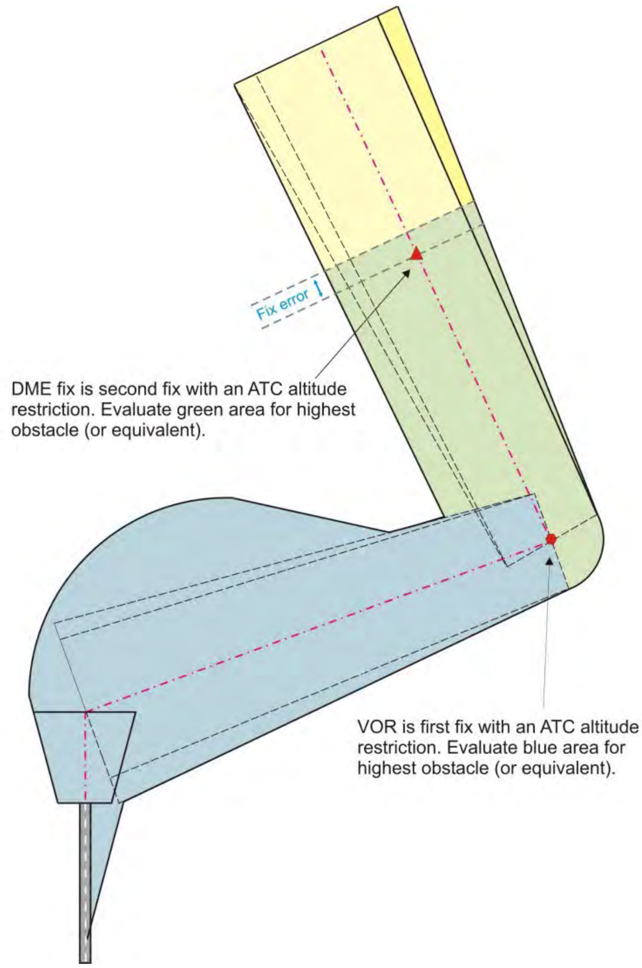
Figure 13-6-2. Turn Required at Fix with Incomplete Taper



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).

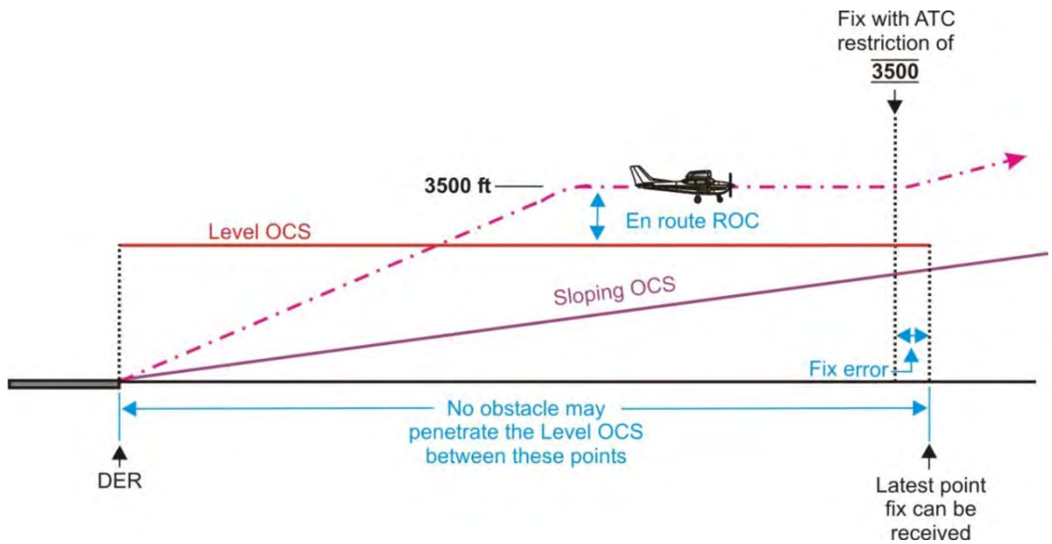
Figure 13-6-3. Multiple Altitude Restrictions



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.

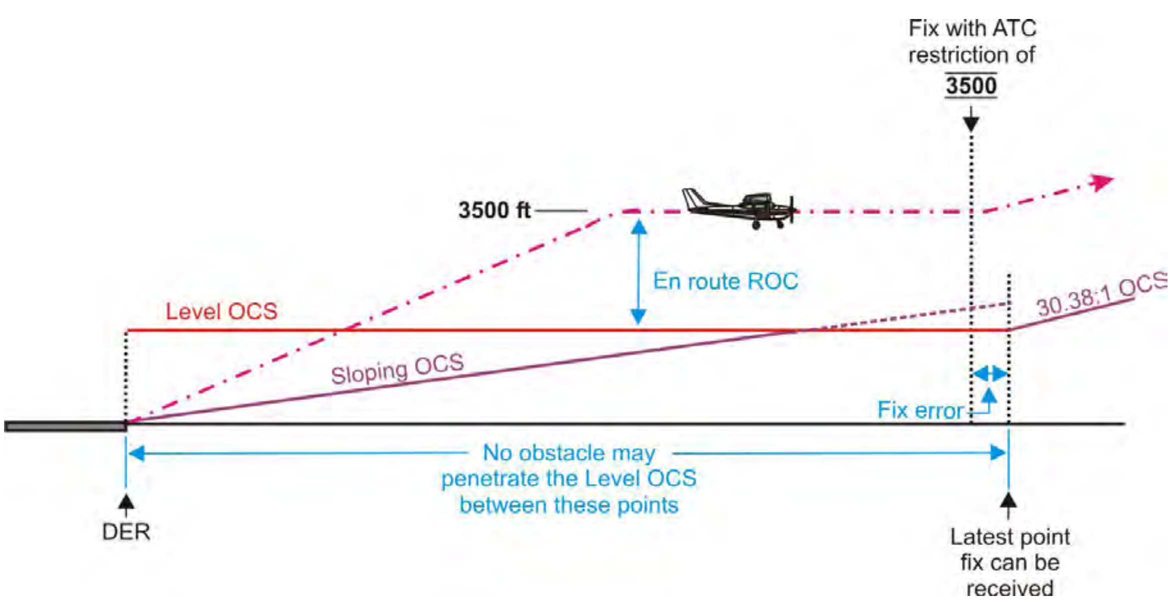
(1) Where the height of the level OCS is equal to or greater than the height of the sloping OCS, continue the sloping surface uninterrupted into the next segment of the departure (see Figure 13-6-4).

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.

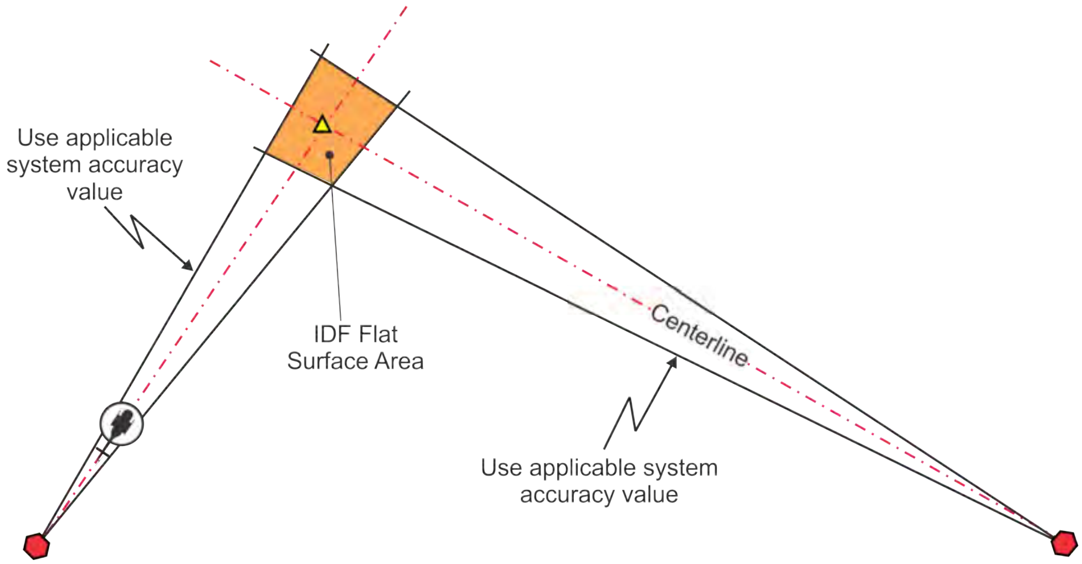
e. The DP must join the en route structure at an altitude that permits en route flight to include airspace and obstacle clearance. It is not mandatory that the DP join an airway, but the DP altitude must allow for continued level flight in all directions. If unable, raise the DP altitude or place restrictions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

Section 14-2. VHF Obstacle Clearance

14-2-1. Obstacle Clearance, Primary Area.

a. Nonmountainous areas. The minimum ROC over areas not designated as mountainous under 14 CFR part 95 is 1000 feet.

b. Mountainous areas. Owing to the action of Bernoulli Effect and of atmospheric eddies, vortices, waves, and other phenomena which occur in conjunction with the disturbed airflow attending the passage of strong winds over mountains, pressure deficiencies manifested as very steep horizontal pressure gradients develop over such regions. Since downdrafts and turbulence are prevalent under these conditions, the hazards to air navigation are multiplied. Except as set forth in paragraphs 14-2-1.b(1) and 14-2-1.b(2), the minimum ROC within areas designated in 14 CFR part 95 as "mountainous" is 2000 feet.

(1) ROC may be reduced to not less than 1500 feet above terrain and vegetation in the designated mountainous areas of the Eastern United States, Commonwealth of Puerto Rico, and the land areas of the State of Hawaii; and may be reduced to not less than 1700 feet above terrain and vegetation in the designated mountainous areas of the Western United States and the State of Alaska. Consideration must be given to the following points before any altitudes providing less than 2000 feet of terrain and vegetation clearance are authorized.

(a) Areas characterized by precipitous terrain.

(b) Weather phenomena peculiar to the area.

(c) Phenomena conducive to marked pressure differentials.

(d) Type of and distance between navigation facilities.

(e) Availability of weather services throughout the area.

(f) Availability and reliability of altimeter resetting points along airways/routes in the area.

(2) Where reduced ROC is applied as described in paragraph 14-2-1.b(1), altitudes providing at least 1000 feet of ROC over towers and/or other manmade obstacles/AAO are authorized.

14-2-2. Obstacle Clearance, Secondary Areas. In all areas, mountainous and nonmountainous, obstacles which are located in the secondary areas will be considered as obstacles to air navigation when they extend above the secondary obstacle clearance plane. This plane begins at a point 500 feet above the obstacles upon which the primary obstacle clearance area MOCA is based, and slants upward at an angle which will cause it to intersect the outer edge of the secondary area at a point 500 feet higher (see Figure 14-2-1). Where an obstacle extends above this plane, the normal MOCA must be increased by adding to the MSL height of the highest penetrating obstacle in the secondary area the required obstacle clearance, computed with Formula 14-2-1:

Formula 14-2-1. Secondary ROC

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

Where:

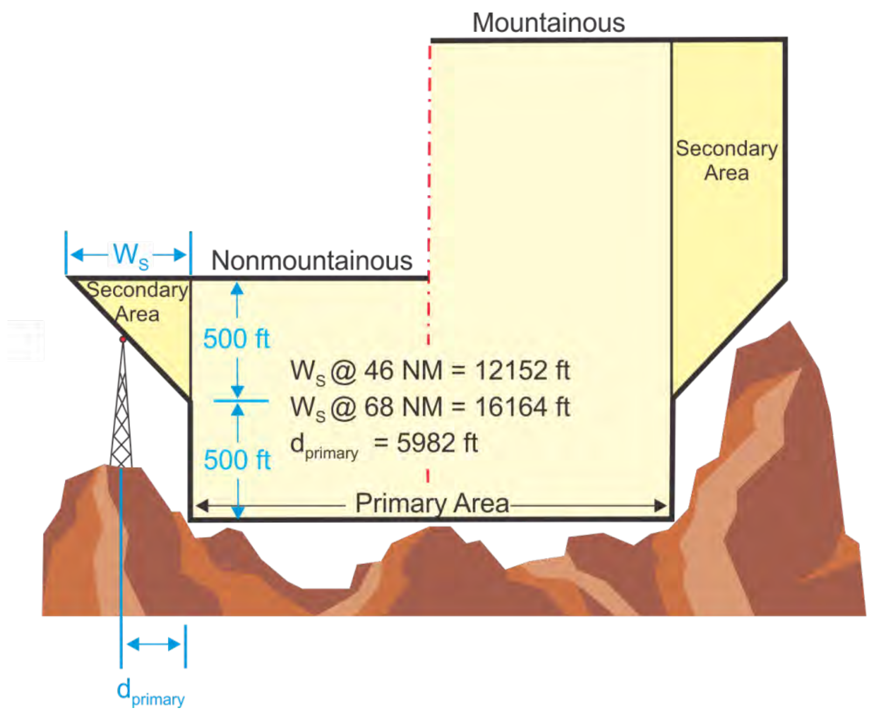
$d_{primary}$ = perpendicular distance(feet) from primary area edge

W_S = total width of the secondary area (feet)

Note 1: Add an extra 1000 feet in mountainous areas except where the primary area ROC has been reduced under the provisions of paragraph 14-2-1. In these cases, where the primary area ROC has been reduced to 1700 feet, add 700 feet to the secondary obstacle clearance, and where the primary area ROC has been reduced to 1500 feet, add 500 feet to the secondary area clearance value.

Note 2: W_S has a total width of 2 NM, or 12152 feet out to a distance of 51 NM from the en route facility, and then increases at a rate of 236 feet for each additional NM.

Figure 14-2-1. Cross Section, Secondary Area Obstacle Clearance



Section 15-2. Simultaneous Close Parallel (SCP) Approaches Spaced at Least 3000 Feet Apart but Less Than 4300 Feet Apart

15-2-1. Purpose. This section provides TERPS criteria for instrument approaches that are requested for SCP operations to parallel runways spaced less than 4300 feet but at least 3000 feet apart.

15-2-2. General Guidance. IAPs used for SCP operations must comply with the applicable design standards, except as stated in this chapter. For overview/background for SCP, see Appendix E.

15-2-3. Types of Approaches. The following types of approaches are authorized to support SCP operations (see Appendix E, Section 3, paragraph 4 for information on minimums):

a. ILS.

b. GLS.

c. RNAV (GPS) with LPV and/or LNAV/VNAV minimums.

Note: Pilot procedures and flight deck duties for RNP AR operations and PRM have not been evaluated for compatibility, therefore RNP AR is not authorized for these approaches.

15-2-4. Approach Design. Approaches requested to be authorized for simultaneous approach operation to runways spaced at least 3000 feet must have vertical guidance. For GLS and RNAV (GPS) approaches used for SCP, flight director or autopilot and GPS are required.

a. Feeder routes and initial approach segment. The initial approach is normally done by radar vectors, but when requested by ATC may also be made from a NAVAID, fix, or waypoint. SCP approaches are normally published without transition routes (unless requested by ATC). Procedure turn and high altitude teardrop turn procedures must not be included on an SCP approach procedure.

b. Intercept angle/point. If ATC requests a route, instead of or in addition to radar vectors, apply standard design guidance to the initial segment route except the maximum intercept angle between the FAC extended (LOC/RNAV/GLS course/track) and the initial segment (if used) must be limited to reduce the risk of overshooting the FAC extended. The maximum intercept angle for the route is the same (20 degrees or 30 degrees as stated in Order JO 7110.65) as would be used for radar vectors. Also, the intercept point with the FAC extended must be designed to be at or outside the intercept altitude/point (depicted as “Point S” in the figures in this chapter) beyond which ATC no longer provides a minimum of 1000 feet vertical or 3 NM radar separation. Coordinate with ATC if that information is not included in the procedure request.

c. Alignment. No course change between the intermediate segment and final approach segment is permitted at the PFAF except as allowed in Section 15-5. This applies to either a straight-in or offset FAC.

15-2-5. Final Approach Design.

a. Alignment of the FAC, for dual runway operations spaced at least 3600 feet. The alignment is recommended to be straight-in along the extended RCL; however, an offset FAC alignment may be used if requested by ATC or a user.

b. Alignment of the FAC, for runways spaced less than 3600 feet. When high update radar is not used, the alignment must have one FAC to be straight-in along the extended RCL and one offset FAC alignment for each runway pair to be authorized for simultaneous operations.

Note: If High Update Radar is used to monitor the no transgression zone (NTZ), the spacing for dual runway operations, the spacing needed for a straight-in FAC alignment and the width of the NTZ may be reduced based on the results of the current NAS-wide studies, or an airport specific study by the appropriate Flight Technologies and Procedures Division (AFS-400) Office.

c. Alignment of the FAC, for triple runway simultaneous operations. The center runway FAC must be straight-in along the extended RCL. The outside runway FAC, for runway pairs spaced at least 3900 feet is recommended to be straight-in along the extended RCL, but an offset FAC alignment may be used if requested by ATC or a user. The outside runway FAC, for runway pairs spaced less than 3900 feet, must have the FAC alignment to be offset in the direction away from the center runway FAC. The minimum runway spacing for triples is 3000 feet (the same as for dual runways).

d. Offset FAC. The offset FAC must be aligned at least 2-½ degrees divergent from the other FAC, but not more than 3.0 degrees.

Note: Autopilots with autoland are only used for localizers aligned with the RCL; therefore, Category II and III are not applicable to an offset FAC approach.

e. Obstacle assessment. An obstacle assessment must be performed for all runways using SCP procedures (see Section 15-4 and Appendix E).

15-2-6. Missed Approach Design. Missed approach procedures for SCP approaches should specify a turn as soon as practical (but not below 400 feet above TDZE, rounded to the nearest foot).

a. Divergence. Missed approach courses, for each pair of SCP procedures, must have a combined divergence of at least 45 degrees until other means of separation are provided.

b. Start of divergence. The 45-degree divergence must be established by 0.5 NM past the most distant DER.

Exception: A distance greater than 0.5 NM is allowed if the NTZ and the controller monitoring (which is established by ATC, not the procedure development specialist) is extended to the point where the 45-degree divergence is achieved (see Figure 15-2-1 and Figure 15-2-2). Coordinate with ATC, as necessary.

Section 15-4. Breakout Obstacle Assessment for Simultaneous Independent Parallel Instrument Approach Operations

15-4-1. Scope. A breakout obstacle assessment must be completed as part of the planning/evaluation for simultaneous independent approach operations to close parallel runways. For other simultaneous approach operations, this assessment may be used.

15-4-2. Assessment. The breakout obstacle assessment includes the following:

a. Refer to the most recent diverse departure assessment for the reciprocal runway. For example, if the simultaneous approach is to runway 17L, then refer to the diverse departure assessment for runway 35R.

b. Provide the results of the diverse departure assessment (all surfaces clear or a list of all penetrating obstacles) to the procedure requester (typically the SIT or ATC facility). The electronic output from the diverse departure assessment is an acceptable means of documenting the results.

c. The SIT or ATC facility has the option of using all of the obstacle penetrations identified by the diverse departure assessment. If all obstacles are to be used, proceed with paragraph 15-4-3 below, otherwise determine if any of the obstacle penetrations identified in paragraph 15-4-2.b also penetrate any of the parallel approach obstruction assessment surfaces described in Appendix E, Section 6, paragraph 2. Obstacles that do not penetrate any of the parallel approach obstruction assessment surfaces may be ignored. The remaining (penetrating) obstacles must be considered under paragraph 15-4-3.

15-4-3. Obstacle Penetration Mitigations. Penetrating obstacles must be mitigated by the ATC facility through accomplishment of one or more of the following actions. A safety risk analysis may be helpful in identifying the most appropriate action(s):

a. Remove or lower the obstacles (if practicable).

b. Establish local procedures for avoiding the penetrating obstacles when breakouts occur.

c. Display penetrating obstacles on the controller's radar display to aid in avoidance during breakouts.

15-4-4. Periodic Review. The breakout obstacle assessment is subject to the periodic review requirements specified within Section 2-8 of Order 8260.19.

Section 15-5. Simultaneous Independent Procedures Considered Established on a PBN Segment of a Published Instrument Approach

15-5-1. Purpose. This section provides design criteria for Performance Based Navigation (PBN) instrument approaches intended for simultaneous operations that allows ATC to discontinue 1000 feet or 3-NM separation once the aircraft is established on an approved PBN segment of an approach, in accordance with the Established on RNP (EoR) concept.

15-5-2. Approach Design. Apply Order 8260.58, and 8260.19 and Sections 15-1 and 15-2 of this order along with the following requirements.

a. Additional requirements:

(1) Only RNAV (GPS) and RNAV (RNP) procedures are authorized.

(2) Use of GPS is required.

(3) Use of flight director (FD) or auto pilot (AP) is required.

(4) When designing a procedure to an offset FAC or a procedure paired with and offset FAC, the final roll-out point on the offset FAC must be at least 3600 feet for dual operations or 3900 feet for triple operations from the final roll-out point to the FAC extended of the paired approach.

(5) When designing procedures from the same side of the FAC, the paired approach tracks must be no closer than 3 NM from each other until being monitored by a final monitor controller.

(6) Airspeed restrictions.

(a) TF legs. Establish an airspeed restriction not faster than 180 KIAS at or prior to the start fix of the FAC intercept leg.

(b) RF legs. Establish an airspeed restriction for the start waypoint of an RF leg that joins the FAC using along-track distance (see Table 15-5-1).

Table 15-5-1. RF Max Airspeed Restriction

RF leg length	Max KIAS
≥ 4NM	210
≤ 4NM ≥ 3NM	200
≤ 3NM ≥ 2NM	190
≤ 2NM	180

15-5-3. Track Separation. The approach design must provide for aircraft to become established on a unique initial or intermediate approach segment associated with the simultaneous approach procedure. A initial or intermediate approach segment is considered unique when separated by at least 0.5 NM from the track of any other RNAV (GPS) or RNAV (RNP) approach. In addition, an initial or intermediate approach segment is considered unique even if it does not have a

Section 16-7. Climb-in-Hold

16-7-1. Climb-in-Hold Evaluations. Applied when it is necessary for aircraft to utilize a holding pattern to reach the en route altitude prior to departing a designated holding fix as part of the departure procedure or missed approach procedure, or with climb-in-hold at the MAP missed approach procedures. Use of the higher airspeeds which may be required to accomplish the maneuver are only authorized when the holding pattern is charted as “Climb-in-Hold.” For example, “Proceed direct to XYZ VOR, and hold, continue climb-in-hold to 9000 feet before departing on course.” Aircrews must climb continuously until the specified altitude is reached. Where paragraph 16-7-2.a is applied, the holding speed icon must be charted (see Order 8260.19), otherwise 310 KIAS is assumed when the chart is annotated “climb in hold.”

16-7-2. Climb-in-Hold Airspeed Determination. Required climb speeds, often exceed the maximum level holding speeds in Table 16-2-1. Therefore, the following criteria must be used to provide for such operations.

a. The 200 KIAS pattern for altitudes 6000 feet and below and the 230 KIAS pattern for altitudes above 6000 feet must be used for holding patterns restricted to 175 KIAS.

b. Except as provided in paragraph 16-7-2.a, the 310-knot pattern must be used for climb-in-hold evaluations.

Example: Departing aircraft must climb to FL 180 in a holding pattern. The fix-to-NAVAID distance is 22 NM.

Solution: Refer to Table 16-7-1, pattern number 21 is indicated.

Table 16-7-1. Increased Holding Airspeed Holding Pattern Sizes (Altitude-Pattern Number) - Climb-in-Hold

Fix-to-NAVAID Distance		
0-14.9 NM	**15-29.9 NM and RNAV**	**30 NM and Over**
Altitude-Pattern No.	**Altitude-Pattern No.**	**Altitude-Pattern No.**
310 KIAS Climb-in-Hold		
2000 – 11	2000 – 12	2000 – 13
4000 – 12	4000 – 13	4000 – 14
6000 – 13	6000 – 14	6000 – 15
8000 – 14	8000 – 15	8000 – 16
10000 – 15	10000 – 16	10000 – 17
12000 – 17	12000 – 18	12000 – 19
14000 – 18	14000 – 19	14000 – 20
16000 – 19	16000 – 20	16000 – 21
FL18 – 20	FL 18 – 21	FL 18 – 22
FL 20 – 21	FL 20 – 22	FL 20 – 23
FL 22 – 22	FL 22 – 23	FL 22 – 24
FL 24 – 22	FL 24 – 23	FL 24 – 24
FL 26 – 24	FL 26 – 25	FL 26 – 26
FL 28 – 24	FL 28 – 25	FL 28 – 26
FL 30 – 25	FL 30 – 26	FL 30 – 27
FL 32 – 26	FL 32 – 27	FL 32 – 28
FL 34 – 27	FL 34 – 28	FL 34 – 29
FL 36 – 28	FL 36 – 29	FL 36 – 30
FL 38 – 29	FL 38 – 30	FL 38 – 31
FL 40 – 30	FL 40 – 31	

16-7-3. Climb-in-Hold Obstacle Evaluation. When a climb-in-hold is used, on a departure or missed approach due to the required ROC not being achieved at the holding fix, for a climb-in-hold at the MAP missed approach, or when more climb is required prior to departing the holding fix, no obstacle may penetrate the holding surface. This surface begins at the end of the segment leading to the plotted position of the holding fix. It rises at a 40:1 rate to the edge of the primary area, then at a 12:1 rate to the outer edge of the secondary area. The beginning height of the 40:1 surface varies with the ending height of the missed approach/departure OCS at a point on the end of the segment line nearest the obstacle being evaluated. Measurements to obstacles located in the climb-in-hold area (beyond the clearance limit) should be completed in two separate steps: (1) through the previous segment to the closest point to the obstacle on the end of the segment line, and (2) directly to the obstacle (see Figure 16-7-1). Precipitous terrain is not applied to the sloping surface of the climb in hold; however, the level holding surface must be evaluated for precipitous terrain.

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
DOT	Department of Transportation
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
FAA	Federal Aviation Administration
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 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/sector 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	obstacle 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
TODA	take-off distance available
TORA	take-off run available
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 77, Objects Affecting Navigable Airspace.

(2) 14 CFR part 91, General Operating and Flight Rules.

(3) 14 CFR part 95, IFR Altitudes.

(4) 14 CFR part 97, Standard Instrument Procedures.

(5) 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.

Appendix B. Definitions

In addition to the definitions common to procedure development contained in various 8260-series FAA orders, the following definitions apply:

1. 3-Dimensional. Approach procedures that provide longitudinal, lateral, and vertical path deviation information are 3D procedures. ILS, PAR, LNAV/VNAV, LPV, and RNP are examples of 3D procedures.

2. Air Traffic Service route. A generic term that includes VOR Federal airways, colored Federal airways, jet routes, and RNAV routes. The term "ATS route" does not replace these more familiar route names, but serves only as an overall title when listing the types of routes that comprise the United States route structure.

3. Airport reference point. The official horizontal geographic location of an airport. It is the approximate geometric center of all usable runways at an airport.

4. Along-track distance. A distance specified in nautical miles, with reference to the next WP.

5. Along-track tolerance. The amount of possible longitudinal fix positioning error on a specified track expressed as a ± value.

6. Angle of divergence (Minimum). The smaller of the angles formed by the intersection of two courses, radials, bearings, or combinations thereof.

7. APT waypoint. A WP located on the FAC at or abeam the first usable landing surface, which is used for construction of the final approach area for a circling-only approach.

8. Area navigation. A method of navigation which permits aircraft operation on any desired flight path within the coverage of ground or space-based navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

9. Authorization required. Aircraft may be equipped beyond the minimum standard for public RNP criteria and aircrews trained to achieve a higher level of instrument approach performance. AR criteria are based on a higher level of equipage and additional aircrew requirements. Procedures that utilize AR design criteria must be appropriately annotated.

10. Average coldest temperature. A value in Centigrade (°C) and/or Fahrenheit (°F) scale for the lowest temperature a Baro-VNAV (including RNP) procedure can be utilized. It is derived from historical weather data, or in the absence of historical data, a standardized temperature value below airport ISA is used.

11. Barometric altitude. A barometric altitude measured above MSL based on atmospheric pressure measured by an aneroid barometer. This is the most common method of determining aircraft altitude.

12. Baseline. Where a turn area expansion arc(s) may be centered, a line perpendicular to the inbound course after the leg termination fix ATT area. For CA, CI, VA or VI legs, the baseline is located at the leg termination point.

13. Circling approach area. The area in which aircraft circle to land under visual conditions after completing an instrument approach.

14. Clearway. A defined rectangular area beyond the end of a runway that is suitable for use in lieu of runway to satisfy take-off distance requirements (see also take-off distance available).

15. Climb gradient. A climb requirement expressed in feet/NM.

16. Common route. The segment(s) of a SID/STAR procedure that provides a single route serving an airport/runway or multiple airports/runways. The common route may consist of a single point.

17. Controlling obstacle. The obstacle on which the design of a procedure or establishment of a minimum altitude or angle is based (see also Order 8260.19).

18. Course. A specified track measured in degrees from magnetic north.

19. Course change. The mathematical difference between the inbound and outbound tracks at a single fix.

20. Course-to-a-fix. A defined, repeatable course (track over the ground) to a specific database fix.

21. Course-to-an-altitude. A defined, repeatable course to a specific altitude at an unspecified position.

22. Course-to-an-intercept. A defined, repeatable course to intercept the subsequent leg.

23. Cross-track tolerance. The amount of possible lateral positioning error expressed as a ± value.

24. Dead reckoning. The estimating or determining of position by advancing an earlier known position by the application of direction and speed data. For example, flight based on a heading from one VORTAC azimuth and distance fix to another is dead reckoning.

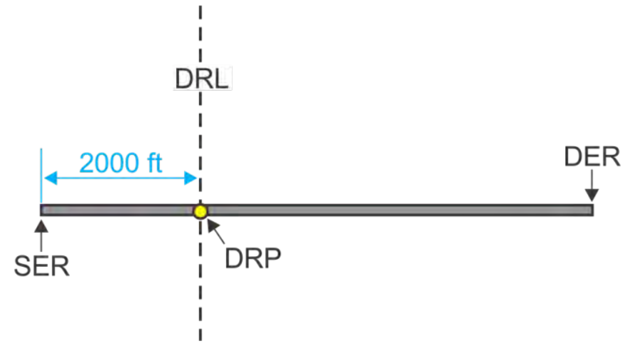
25. Decision altitude. A DA is a specified minimum altitude (feet MSL) in a PA or APV IAP at which the pilot must decide whether to initiate an immediate missed approach if they do not see the required visual references or to continue the approach.

26. Departure end of runway. The end of the runway opposite the landing threshold (see Figure B-1).

27. Departure reference line. An imaginary line of indefinite length perpendicular to runway centerline at the DRP (see Figure B-1).

28. Departure reference point. A point on the runway centerline 2000 feet from the SER (see Figure B-1).

Figure B-1. Runway Terms



29. Departure route. A specified course and altitude along a track defined by positive course guidance (PCG) to a clearance limit, fix, or altitude.

30. Departure sector. Airspace defined by a heading or a range of headings for aircraft departure operations.

31. Direct-to-a-fix. An unspecified non-repeatable track starting from an undefined position to a specific database fix.

32. Descent gradient. Description of aircraft descent profile specified in feet per nautical mile.

33. Distance of turn anticipation. The distance from (prior to) a fly-by fix at which an aircraft is expected to start a turn to intercept the course/track of the next segment.

34. Distance measuring equipment Arc. A course, indicated as a constant DME distance, around a navigation facility which provides distance information.

35. DME distance. The line of sight distance (slant range) from the source of the DME signal to the receiving antenna.

36. Diverse vector area. An area in which a prescribed departure route is not required. Radar vectors may be issued below the minimum vectoring or minimum IFR altitude. It can be established for diverse departure, departure sectors, and/or video map radar areas portraying obstacles and terrain.

37. Early turn point. Represents the earliest location where a flight track turn may commence.

38. En route transition. The segment(s) of a SID/STAR that connect to/from en route flight. Not all SIDs/STARs will contain an en route transition.

39. Fictitious helipoint. The equivalent of the helipoint when the final approach path is not based on the location and elevation of the helipoint.

40. Fictitious threshold point. The equivalent of the LTP when the final approach course is offset from runway centerline. It is not aligned through the LTP. It is located on the final approach course the same distance from the intersection of the final approach course and the runway centerline extended as the LTP. FTP elevation is the same as the LTP. For the purposes of this document, where LTP is used, FTP may apply when appropriate (see Figure B-2).

41. Final approach and takeoff area. A defined area over which the final phase of the approach to a hover, or a landing, is completed and from which the takeoff is initiated. A FATO is applicable only at a heliport; guidance for a FATO is published in AC 150/5390-2.

42. Final approach course. Magnetic and/or true heading definition of the final approach lateral path.

43. Final approach segment. The segment of an instrument approach procedure that begins at the PFAF and ends at the MAP or LTP/FTP, whichever is encountered last.

44. Fix. A generic term used to define a predetermined geographical position. A fix may be a ground-based NAVAID, WP or defined by reference to one or more radio NAVAIDs.

45. Fix displacement tolerance. FDT is a legacy term providing 2D quantification of positioning error. It is now defined as a circular area with a radius of ATT centered on an RNAV fix. The acronym ATT is now used in lieu of FDT.

46. Fix-to-NAVAID. Horizontal distance from the plotted position of the holding fix to the NAVAID.

47. Flight control computer. Aircraft computers which process information from various inputs to calculate flight path and flight guidance parameters.

48. Flight management system. An FMS is a specialized computer system that automates a wide variety of in-flight tasks, reducing the workload on the flight crew to the point that modern aircraft no longer carry flight engineers or navigators. A primary function is in-flight management of the flight plan. Using various sensors (such as GPS and INS often backed up by radio navigation) to determine the aircraft's position, the FMS can guide the aircraft along the flight plan. From the flight deck, the FMS is normally controlled through a CDU which incorporates a small screen and keyboard or touchscreen. The FMS sends the flight plan for display on the EFIS, ND or MFD.

49. Flight path alignment point. A point in the same lateral plane as the LTP/FTP that is used to establish the alignment of the FAS. For approaches aligned with the runway centerline, the FPAP is located at or beyond the opposite threshold of the runway. The delta length offset from the opposite threshold defines its location.

50. Flight path control point. The FPCP is a 3D point defined by the LTP geographic position, MSL elevation, and TCH value. The FPCP is in the vertical plane of the final approach course and is used to relate the glidepath angle of the final approach track to the landing runway. It is sometimes referred to as the TCH point or reference datum point (RDP).

51. Final roll-out point. A point in the final approach segment after which no turns are permitted. After the FROP, the FAC must comply with final approach course alignment requirements.

52. Fly-by fix. Fly-by fixes/waypoints are used when an aircraft should begin a turn to the next course prior to reaching the waypoint separating the two route segments.

53. Fly-over fix. Fly-over fixes/waypoints are used when the aircraft must fly over the point prior to starting a turn.

54. Glidepath angle. The GPA is the angle of the specified final approach descent path relative to a horizontal line tangent to the surface of the earth at the runway threshold.

55. Global azimuth reference point. GNSS Azimuth Reference Point. A calculated point 1000 feet beyond the FPAP lying on an extension of a geodesic line from the LTP/FTP through the FPAP. It may be considered the location of an imaginary localizer antenna.

56. Global Navigation Satellite System. A worldwide position and time determination system that includes one or more satellite constellations, aircraft receivers, and system integrity monitoring. GNSS is augmented as necessary to support the required navigation performance for the actual phase of operation.

57. Gradient. A slope expressed in feet per mile, or as a ratio of the horizontal to the vertical distance. For example, 40:1 means 40 feet horizontally to one foot vertically.

58. Ground point of intercept. A point in the vertical plane on the runway centerline at which it is assumed that the straight line extension of the glide slope intercepts the runway approach surface baseline.

59. Heading-to-an-altitude. A specified heading to a specific altitude at an unspecified position. The resulting track is not wind corrected.

60. Heading-to-an-intercept. A specified heading to intercept the subsequent leg at an unspecified position. The resulting track is not wind corrected.

61. Height above landing. The height above the landing area elevation.

62. Height above surface. The height of the MDA above the highest terrain/surface within a 5200-foot radius of the MAP in a PinS procedure.

63. Height above touchdown. The height of the DA above TDZE.

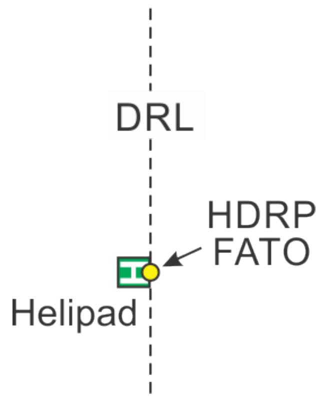
64. Helipoint. For approaches, it is the aiming point for the final approach course. The helipoint is normally centered in the TLOF with an elevation equivalent to the TLOF elevation.

65. Helipoint crossing height. For approaches, it is the height of the vertical path above the helipoint. For departures, it is the hover height above the helipoint.

66. Heliport. An area of land, water, or structure used or intended to be used for helicopter landings and takeoffs and includes associated buildings and facilities.

67. Heliport departure reference point. The intersection of the FATO and departure course.

Figure B-2. Heliport Departure Reference Point



68. Heliport elevation. The highest elevation of all landing areas within the heliport, expressed as the distance above mean sea level.

69. Heliport reference point. The official horizontal geographic location of a heliport located at the center of the FATO, or the centroid of multiple FATOs.

70. Initial climb area. A segment variable in length starting at the DER which allows the aircraft sufficient distance to reach an altitude of at least 400 feet above the DER.

71. ICA baseline. A line at DER, perpendicular to runway centerline, denoting the beginning of the ICA.

72. ICA end-line. A line at end of ICA perpendicular to the departure course.

73. Initial approach fix. A fix that identifies the beginning of an initial approach segment.

74. Initial departure fix. The first fix/waypoint used for the departure. The IDF denotes the beginning portion of the SID.

75. Instrument Landing System. A precision instrument approach system which normally consists of a localizer, glide slope, outer marker (or suitable substitute), inner marker for Category II operations (if RA minimums are not authorized), and an approach lighting system.

76. Intermediate fix. The fix that identifies the beginning of the intermediate approach segment of an instrument approach procedure. The fix is normally identified on the instrument approach chart as an IF.

77. International standard atmosphere. A model of standard variation of pressure and temperature.

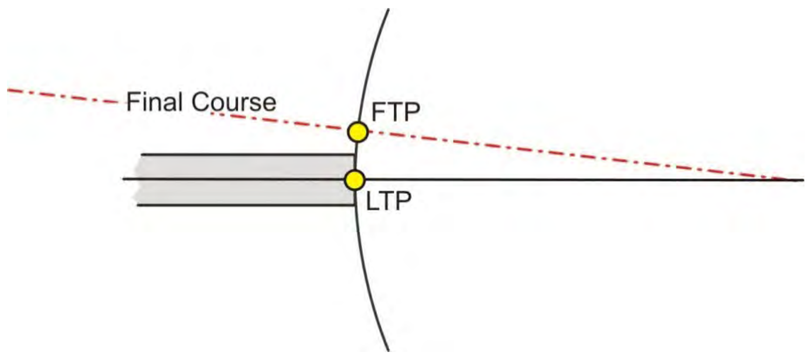
78. Knots indicated airspeed. The speed shown on the aircraft airspeed indicator.

79. 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.

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

81. 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



82. 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.

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

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

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

86. 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.

87. 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.

88. 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.

89. Minimum en route 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.

90. 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.

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

92. 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.

93. 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.

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

95. 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.

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

97. 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.

98. 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.

99. Operational advantage. An improvement which benefits the users of an instrument procedure. Achievement of lower minimums or authorization for a straight-in approach with no derogation of safety is an example of an operational advantage. Many of the options in TERPS are specified for this purpose. For instance, the flexible final approach course alignment criteria may permit the ALS to be used for reduced visibility credit by selection of the proper optional course.

100. Point-in-space approach. A PinS approach is an instrument approach procedure to a point in space, identified as a missed approach point, which is not associated with a specific airport or a specific landing area within 2600 feet of the MAP.

101. Positive course guidance. A continuous display of navigational data which enable an aircraft to be flown along a specific course line.

102. Precipitous terrain. Terrain characterized by steep or abrupt slopes.

103. Precise final approach fix. The PFAF is a calculated WGS84 geographic position located on the final approach course where the designed vertical path (NPA procedures) or glidepath (APV and PA procedures) intercepts the intermediate segment altitude (glidepath intercept altitude). The PFAF marks the beginning of the FAS. The calculation of the distance from LTP to PFAF includes the earth curvature.

104. Proceed VFR. Point-in-space procedure which allows an aircraft to fly an IFR approach to a point in which a transition to VFR is conducted. Aircraft are expected to continue from the MAP/IDF under VMC while maintaining VFR minimums. The aircraft is allowed to fly from/to the MAP/IDF to/from the landing area by any route desired by the pilot which will afford obstacle and terrain avoidance. An IFR recovery procedure is not provided between the MAP/IDF and landing area.

105. Proceed Visual. Point-in-space procedure which allows an aircraft to fly an IFR approach to a helipad under IFR conditions. The aircraft is required to be VMC at the MAP/IDF and maintain VMC during flight from/to the landing area. Obstacle evaluation is conducted as part of the procedure evaluation from/to the MAP/IDF to/from the landing area. Aircraft are required to fly the published slope to ensure obstacle avoidance is maintained.

106. Primary area. The area within a segment in which full obstacle clearance is applied.

107. Radio altimeter height. An indication of the vertical distance between a point on the nominal glidepath at DA and the terrain directly beneath this point.

108. Radius to fix leg. An RF leg is a constant radius circular repeatable path about a defined turn center that begins and terminates at a fix.

109. Reduced takeoff runway length. An alternative to a published climb gradient established to mitigate an obstacle that penetrates the departure 40:1 OCS by 35 feet or less. An RTRL establishes a distance prior to DER where takeoff must occur by.

110. Reference datum point. The RDP is a 3D point defined by the LTP or FTP latitude/longitude position, MSL elevation, and a TCH value. The RDP is in the vertical plane associated with the FAC and is used to relate the GPA of the final approach track to the landing runway. It is also referred to as the TCH point or FPCP.

111. Reference facility. A VOR/DME, VORTAC or TACAN facility used for the identification and establishment of an RNAV route, WP, or instrument approach procedure.

112. Reference fix. A point of known location used to geodetically compute the location of another fix.

113. Reference line. For fix turns less than 90 degrees, a line parallel to the course line after the turn fix where an additional set(s) of turn area expansion arcs are centered.

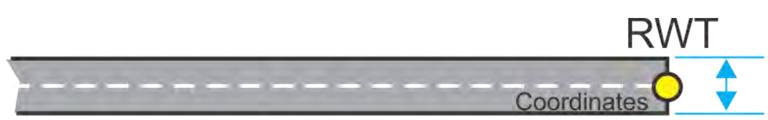
114. Reference navigational aid. A navigational facility required for various leg construction (CF for example) to assign a magnetic variation to the course.

115. Required navigation performance. RNP is a statement of the 95 percent navigation accuracy performance that meets a specified value for a particular phase of flight or flight segment and incorporates associated on-board performance monitoring and alerting features to notify the pilot when the RNP for a particular phase or segment of a flight is not being met.

116. Required obstacle clearance. The minimum vertical clearance (in feet) that must exist between aircraft and the highest obstacle within the OEA of instrument procedure segments.

117. Runway threshold. The RWT marks the beginning of that part of the runway usable for landing (see Figure B-3). It extends the full width of the runway. Threshold elevation is equal to the highest MSL point along the RWT line (see Figure B-4).

Figure B-4. Runway Threshold



118. Runway transition. The segment(s) of a SID/STAR between the common route/point and the runway(s). Not all SIDs/STARs will contain a runway transition.

119. Runway WP. A WP located at the runway threshold and used for construction of the final approach area when the FAC meets straight-in alignment criteria.

120. Secondary area. The area within a segment in which ROC is reduced as distance from the prescribed course is increased.

121. Segment. The basic functional division of an instrument approach procedure. The segment is oriented with respect to the course to be flown. Specific values for determining course alignment, obstacle clearance areas, descent gradients, and obstacle clearance requirements are associated with each segment according to its functional purpose.

122. 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.

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

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

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

126. 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.

127. 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.

128. 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.

129. Take-off distance available. The TORA plus the length of any remaining runway or clearway beyond the far end of the TORA.

130. Take-off run available. The runway length declared available and suitable for the ground run of an aircraft taking off.

131. 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.

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

133. 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.

134. 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.

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

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

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

138. 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.

139. 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.

140. 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.

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

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

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

144. 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.

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

146. 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.

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

148. 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.

149. 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.

150. 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.

151. 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.

152. Visual segment. The visual segment is the portion of the FAS OEA between the DA and the LTP.

153. WP. A predetermined geographical position used for route definition and progress reporting purposes that is defined by latitude/longitude.

154. WP displacement area. The rectangular area formed around and centered on the plotted position of a WP.

155. Wide Area Augmentation System. The WAAS is a navigation system based on the GPS. Ground correction stations transmit position corrections that enhance system accuracy and add satellite based VNAV features.

d. Meters to feet:

$feet = meters \times \frac{1\,ft}{.3048\,m}$ Example: $123.456\,ft = 37.6294m \times \frac{1\,ft}{.3048\,m}$

e. Feet to Nautical Miles (NM):

$NM = feet \times \frac{.3048\,NM}{1852\,ft}$ Example: $1.38707\,NM = 8420\,ft \times \frac{.3048\,NM}{1852\,ft}$

f. NM to feet:

$feet = NM \times \frac{1852\,ft}{.3048\,NM}$ Example: $8428\,ft = 1.38707\,NM \times \frac{1852\,ft}{.3048\,NM}$

g. NM to meters:

$meters = NM \times \frac{1852\,m}{NM}$ Example: $2689.66m = 1.4523\,NM \times \frac{1852\,m}{NM}$

h. Meters to NM:

$NM = meters \times \frac{NM}{1852\,m}$ Example: $1.4523\,NM = 2689.66m \times \frac{NM}{1852\,m}$

i. Temperature Degrees Celsius (°C) to Degrees Fahrenheit (°F):

$T_{Fahrenheit} = 1.8 \times T_{Celcius} + 32$ Example: $68°F = 1.8 \times 20°C + 32$

j. Temperature Degrees Fahrenheit (°F) to Degrees Celsius (°C):

$T_{Celcius} = \frac{T_{Fahrenheit} - 32}{1.8}$ Example: $20°C = \frac{68°F - 32}{1.8}$

4. Other Conversions.

a. Degrees to a gradient (feet per NM).

$gradient = \tan(degrees) \times \frac{1852\,ft}{.3048\,NM}$

Example: $318.4351719\,ft/NM = \tan(3) \times \frac{1852\,ft}{.3048\,NM}$

b. Gradient (feet per NM) to degrees.

$degrees = \mathrm{atan}(\mathrm{gradient} \div \frac{1852\,ft}{.3048\,NM})$

Example: $3° = a\mathrm{tan}(318.4351719\,ft/NM \div \frac{1852\,ft}{.3048\,NM})$

c. Slope (run over rise) to degrees.

$degrees = \mathrm{atan}\left(\frac{rise}{run}\right)$ Example: $2.86° = a\mathrm{tan}\left(\frac{1}{20}\right)$

d. Degrees to slope.

$$slope = \frac{1}{\tan(degrees)} \qquad \underline{\text{Example}}:\ 20{:}1 = \frac{1}{\tan(2.862405)}$$

5. Common Equation Terms. These terms/variables are common to all calculations.

Table D-1. Common Equation Terms

Equation Acronym	Equation Terminology
MSL	above mean sea level
ϕ	bank angle
β	Magnitude of heading change in degrees
θ	vertical angle in degrees
DA	decision altitude in feet MSL
alt	altitude in feet MSL
apt_{elev}	published airport elevation in feet MSL
LTP_{elev}	published threshold elevation in feet MSL
TCH	threshold crossing height in feet above threshold
$PFAF_{alt}$	minimum intermediate segment altitude in feet MSL
O_{MSL}	obstacle elevation in feet MSL
OBS_X	along-track distance in feet from LTP to obstacle
HAT	difference between touchdown zone elevation (rounded to the nearest foot) and DA/MDA
HAL	difference between helipoint elevation (rounded to the nearest foot) and DA/MDA

Figure E-4. Final Approach Courses. No Transgression Zones and Normal Operating Zones (Dual Approach, Non-PRM, Spacing at least 4300 feet)

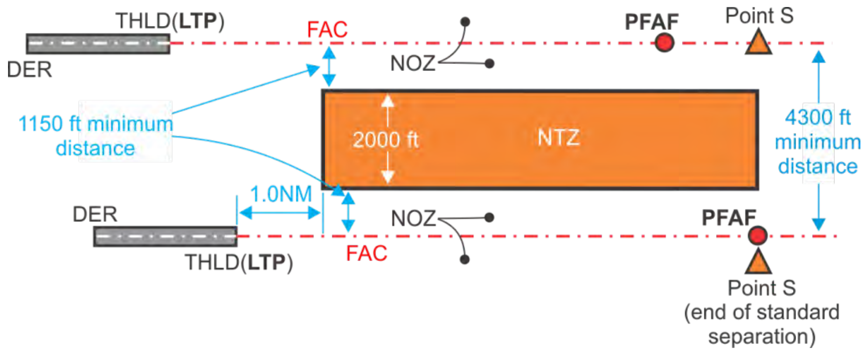
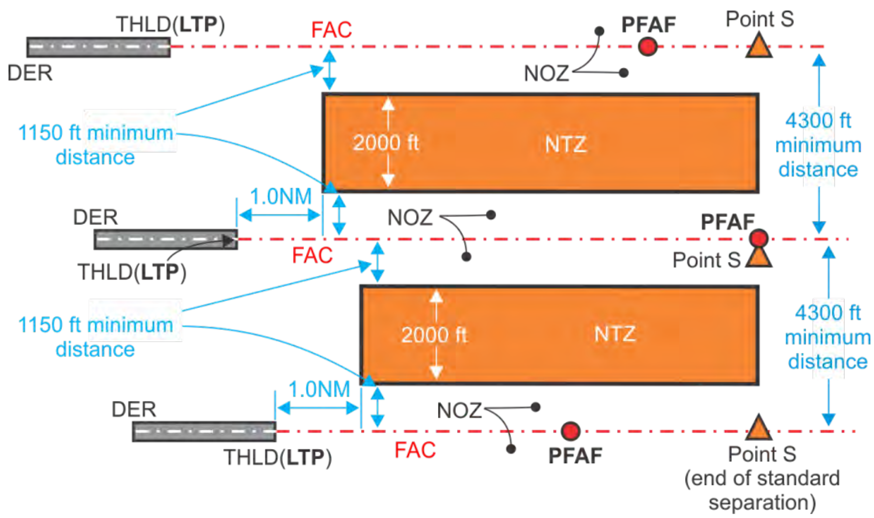


Figure E-5. Final Approach Courses. No Transgression and Normal Operating Zones (Triple Approach, Non-PRM, Spacing at least 4300 feet)



Note: For triple approaches, the highest glide slope intercept altitude should be associated with the approach to the center runway and that intercept point establishes were point S is located for the other two runways.

6. Design Guidelines The following guidelines, based on safety studies, are to be used:

a. On GLS, RNAV (GPS), and RNAV (RNP) approaches use of flight director (FD) or auto pilot (AP) is required to provide course/track guidance.

b. On ILS approaches, the chart note for FD or AP is required in the situation where RNAV, including RNAV (RNP) is used for a route to transition aircraft to ILS. It would not apply to a procedure that uses only radar vectors to transition aircraft to the ILS (no RNAV routes leading to the localizer course).

c. Results of safety studies indicate that a 10-degree intercept to the final approach course will decrease the probability of overshoots and to minimize FMA and TCAS alerts especially for runways spaced less than 4800 feet apart.

d. GPS is required to be available and included in the aircraft navigation solution for RNAV (GPS), RNAV (RNP), and GLS approaches and where an RNAV route is used to join an ILS or LOC final.

Note: When there are some routes that do not qualify for simultaneous operation, the local ATC procedures authorizing the simultaneous operation must specifically exclude those routes/IAFs (also see Section 1, paragraph 4 of this appendix).

less), a ceiling of approximately 375 feet above the DA, for the offset course approach, is considered adequate. The aircraft in the highest approach category authorized to conduct the approach will determine the approach geometry. Clear-of-clouds time values may be refined with operational experience and scientific analysis.

c. Straight flight segment. The SOIA design program includes a minimum straight flight segment of 1000 feet between the turn at the offset course approach DA and the turn to intercept the extended runway centerline at the stabilized approach point.

7. NTZ. SOIA incorporates a conventional NTZ design that terminates at the location of the DA for the offset FAC approach to protect aircraft on both FACs prior to the extended visual segment.

8. Ceiling for SOIA Operations. The optimum design, when runway centerlines are less than 2500 feet apart, is to have the ceiling value high enough to not require ATC wake turbulence spacing within the pairs.

a. Determine a preliminary ceiling for the offset approach that is at least 450 feet above the procedure's decision altitude. For example, if the DA is 3130 feet MSL and the airport elevation is 2090 feet MSL, then the preliminary ceiling would be 1500 feet (3130 + 450 – 2090 = 1490; rounds to 1500).

b. The preliminary ceiling value will be used during flight simulator operational evaluations and/or considered during an operational safety assessment.

c. Based on those results and any inputs received from others (such as ATC), the SOIA SIT may choose to increase the ceiling value as necessary. The final ceiling value is submitted as part of the AAUP for each approach.

9. Wake Turbulence Requirements and Considerations. Wake turbulence mitigation techniques employed will be based on each airport's specific runway geometry and meteorological conditions. Established pilot wake turbulence avoidance procedures will also be considered. A specific wake turbulence simulator evaluation and/or operational safety assessment must be performed by Flight Technologies and Procedures Division (AFS-400) for each airport where SOIA implementation is requested. Additionally, if future runway construction changes the relationship of the runways previously approved for SOIA operations, Flight Technologies and Procedures Division (AFS-400) must conduct a supplemental wake analysis. For SOIA runway centerlines less than 2500 feet apart, the wake turbulence spacing as described in Order JO 7110.65, paragraph 5-5-4, MINIMA, need not be applied within the pairs, if the ceiling for SOIA operations is at least 450 feet above the DA and if the Flight Technologies and Procedures Division (AFS-400) flight simulator operational evaluation and/or operational safety assessment is acceptable. Otherwise, the wake turbulence spacing as described in Order JO 7110.65, paragraph 5-5-4, MINIMA, must be applied within the pairs. ATC must issue all wake turbulence advisories when applicable. Separation between the pairs, normally applied between the trailing aircraft on the offset course approach (for example LDA) in the leading pair and the leading aircraft on the straight-in approach (for example ILS) in the subsequent pair, must meet the requirements for standard radar separation unless other approved methods of separation can be applied. Additionally, separation minima in paragraph 5-5-4 of Order JO 7110.65 regarding wake turbulence must be applied as follows: (1) between the straight-in approach (for example ILS) aircraft in the leading SOIA pair and either aircraft in the subsequent SOIA pair as required by paragraph 5-5-4 and (2) between the offset course approach (for example LDA) aircraft in the leading SOIA pair and either aircraft in the subsequent SOIA pair, as required by paragraph 5-5-4 and the SOIA paragraph (currently paragraph 5-9-9).

Note 1: When SOIA runway centerlines are at least 2500 feet apart, there are no wake turbulence requirements between aircraft on adjacent FACs (see Order JO 7100.65).

Note 2: The height of 450 feet above the DA provides at least 30 seconds clear of cloud time for all aircraft through category D. Thirty seconds has been shown to be sufficient for pilots to visually acquire the preceding (straight-in) aircraft prior to reaching the offset course approach DA and prepare to implement a wake avoidance strategy if deemed necessary. The 450 feet height may be reduced, after review by Flight Operations Group (AFS-410), to a height that provides 30 seconds clear of clouds time based on the categories of aircraft authorized for the SOIA procedure (see paragraph 6b).

Note 3: The ceiling may be less than 450 feet above the DA without applying wake turbulence spacing within the pairs, if acceptable mitigating techniques and operational procedures can be documented or developed and verified by a safety management process that involves a safety risk assessment, stakeholder participation, and monitoring the implemented procedures to ensure the mitigations are effective. This requires approval (see paragraph 1-4-2), which will be based on a flight simulator operational evaluation, review by Flight Technologies and Procedures Division (AFS-400) Aviation Safety Inspector Pilots and/or an operational safety assessment, and/or review by the Procedure Review Board. Also, air traffic authorization is required as stated in Order JO 7110.65.

10. Crosswind Limits for SOIA. The limiting steady state, direct crosswind component of the reported airport surface wind is 10 knots for runways spaced 750 feet apart, increasing by one knot for each additional 75 feet of centerline separation to a maximum of 15 knots (when centerline spacing is at least 1125 feet). These requirements may be refined based on operational experience and scientific analysis. In addition, these values and their application may be further modified by the FAA wake turbulence study required for each SOIA location.

11. ATC/Flight Crew Coordination. When an aircraft is conducting an offset approach, for example LDA PRM, simultaneously with the adjacent straight-in approach, for example ILS PRM, the offset course approach flight crews must be advised of traffic on the adjacent (straight-in) approach course if pairing with the straight-in aircraft is anticipated. Prior to reaching the DA for the offset course approach, the flight crew must: Visually acquire the leading straight-in approach aircraft, broadcast this acquisition to ATC, and establish and maintain visual contact with the landing runway environment. If visual contact of the straight-in approach aircraft or runway environment is lost, a missed approach must be executed. Broadcasting by the offset course approach aircraft that the straight-in approach traffic is in sight indicates that the offset course approach flight crew has visually acquired the traffic and accepts responsibility for separation and wake turbulence avoidance as applicable. ATC is not required to (and normally does not) respond to this transmission.

a. Pilot responsibility. Pilots accepting a clearance for an offset course approach, for example LDA PRM approach, will remain on the offset course until passing the DA for the offset course approach.

b. Aircraft sequence. During SOIA operations, the offset course approach aircraft should be the trailing aircraft prior to exiting the overcast, and must be in the trailing position prior to reaching the DA for the offset course approach. Aircraft may pass each other as necessary prior to this point as instructed by ATC to achieve the required spacing.

c. AAUP. Pilot responsibilities must be specified on the AAUP (see Order 8260.19).

Note: For additional information regarding SOIA operations, refer to the AIM.

12. SOIA Implementation. The implementation process must include:

a. A national effort by Flight Technologies and Procedures Division (AFS-400). An effort must be made to monitor the operational integrity of SOIA procedures at each site, evaluate PRM-SOIA requirements to ensure consistency with existing standards (including this order and Orders 8260.19 and 8900.1), and oversight and review of issues raised by local SITs.

b. An established local implementation process. The leadership is the responsibility of the SOIA SIT or the air traffic facility at each SOIA site. Tasks include: to assist throughout the SOIA development process, to evaluate and provide support to Flight Technologies and Procedures Division (AFS-400), ATC and Air Operator Training issues, to monitor local operational integrity issues, a blunder data collection effort (if required by the current air traffic guidance) and to report/refer issues for national consideration as appropriate. Consult Order 8260.43 for core membership and other aviation participants who should be included in this process.

Section 5. Simultaneous Independent Procedures Considered Established on a PBN Segment of a Published Instrument Approach

1. Roles/Responsibilities and Approval Process.

a. Requesting ATC facility will follow PBN implementation process outlined in Order JO 7100.41, Performance Based Navigation Implementation Process.

b. Procedures that meet design requirements are annotated on FAA Form 8260-9 as compliant with Section 15-5 in accordance with Order 8260.19.

2. Conclusions. These operations meet the FAA acceptable level of collision risk for dual parallel runway configurations spaced 3600 feet or greater and for triple parallel runway configurations spaced 3900 feet or greater. Operations to runways spaced 9000 feet or less require an FMA with NTZ, while operations to runways spaced more than 9000 feet do not require an FMA. Operations to dual parallel runway configurations based on RNAV (GPS) procedures require a 10-degree intercept of the extended final approach course, and may also be performed adjacent to a straight-in procedure to one of the runways. Triple parallel runway configurations require the 10-degree intercept on either or both outside runways, and a straight-in approach to the center runway. Use GPS based RNAV and RNP procedures with or without vertical guidance using TF fly-by turn procedure design, and may be combined with ILS or GLS straight-in approaches.

3. Key Findings. Consider the following when designing procedures:

a. A 10-degree intercept of the final approach course and an at-or-below 210 KIAS restriction on the downwind leg are required to prevent consistent overshooting of the extended runway centerline.

b. Extending the length of the 10-degree intercept leg, decreasing the angle of the turn prior to the 10-degree intercept leg or increasing the runway spacing are effective methods to further reduce collision risk.

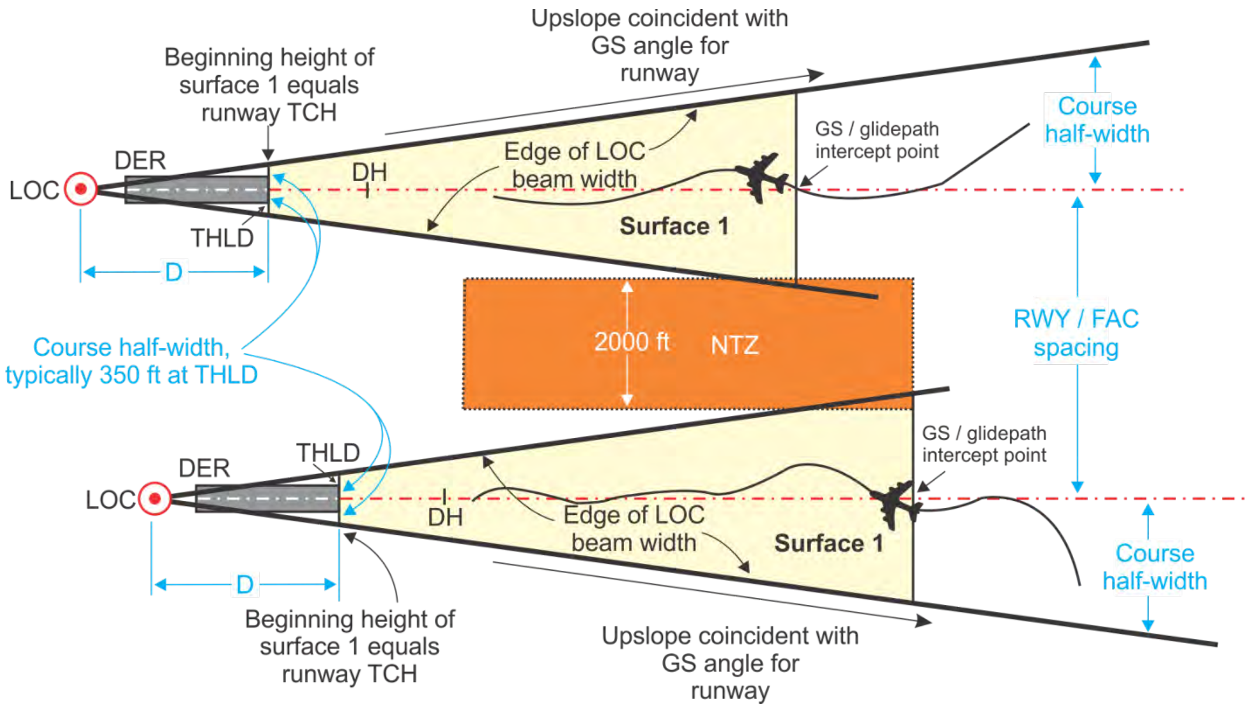
c. An aircraft should not be considered established on an approach unless the procedure is designed such that the controller can verify that the flight crew is flying the approach for with they were cleared.

d. RNP of 1 NM is acceptable for the turn to the final approach segment, provided GPS and autopilot or flight director are required.

e. VNAV capability may reduce crew workload.

f. Publishing an “at” altitude restriction near the apex of the established on approach turn can improve operational performance and slightly reduce collision risk if this simulates a descent angle between two and three degrees. Compatibility with aircraft automation may impact the suitability of altitude restrictions.

Figure E-12. Final Approach Descent Surface 1



(1) Length. Surface 1 begins over the runway threshold at a height equal to the TCH for the runway, and continues outward and upward at a slope that is coincident with the glide slope/glidepath, to its ending at the GS/vertical path intercept point.

(2) Width. Surface 1 has a width equal to the lateral dimensions of the LOC course width. The surface 1 half-width (see Figure E-12) is calculated using Formula E-2 or Formula E-3.

Formula E-2. Surface 1 Half-width, Part One

$$\frac{1}{2}W = A \times Tan\left(\frac{B}{2}\right) + 350$$

Where:

W = Width of surface 1
A = Distance from RWT measured parallel to course
B = Course Width Beam Angle

OR

Formula E-3. Surface 1 Half-width, Part Two

$$\frac{1}{2}W = L \times Tan\left(\frac{B}{2}\right)$$

Where:
W = Width of surface 1
L = Distance from Azimuth antenna (in feet)
B = Course Width Beam Angle

(3) Height. Surface 1 height at any given centerline distance (d), may be determined in respect to threshold elevation, by adding the TCH to the product of centerline distance in feet from threshold times the tangent of the glide slope/glidepath angle (see Formula E-4).

Formula E-4. Surface 1 Height Above LTP Elevation

$$h1 = [d \times Tan(GPA)] + TCH$$

Where:
h1 = Surface 1 height above LTP Elevation

b. Surface 2.

(1) Length [same as paragraph 2a(1)].

(2) Width and height. Surface 2 shares a common boundary with the outer edge of surface 1 on the side opposite the NTZ. Surface 2 begins at the height of surface 1 and slopes upward and outward for 800 feet from the edge of the surface 1 at a slope of 11:1, measured perpendicular to the FAC. After 800 feet, surface 2A uses a slope of 40:1. Further application is not required when the 11:1 or 40:1 surface reaches a height of 1000 feet below the MOCA, MSA, or MVA, whichever is applicable (see Figure E-13).

Note 1: If more than one is applicable, use 1000 feet below the lowest applicable MOCA, MSA, or MVA. If an airport is in a designated mountainous area, instead of 1000 feet, use the applicable ROC. This note applies to the use of MOCA, MSA, or MVA throughout Section 6 of this appendix.

Note 2: The 40:1 surface provides evaluation for breakout in any direction and is recommended. For locations that limit the amount of turn on the breakout, a higher surface may be used instead of the 40:1 surface with a site specific review by Flight Technologies and Procedures Division (AFS-400).

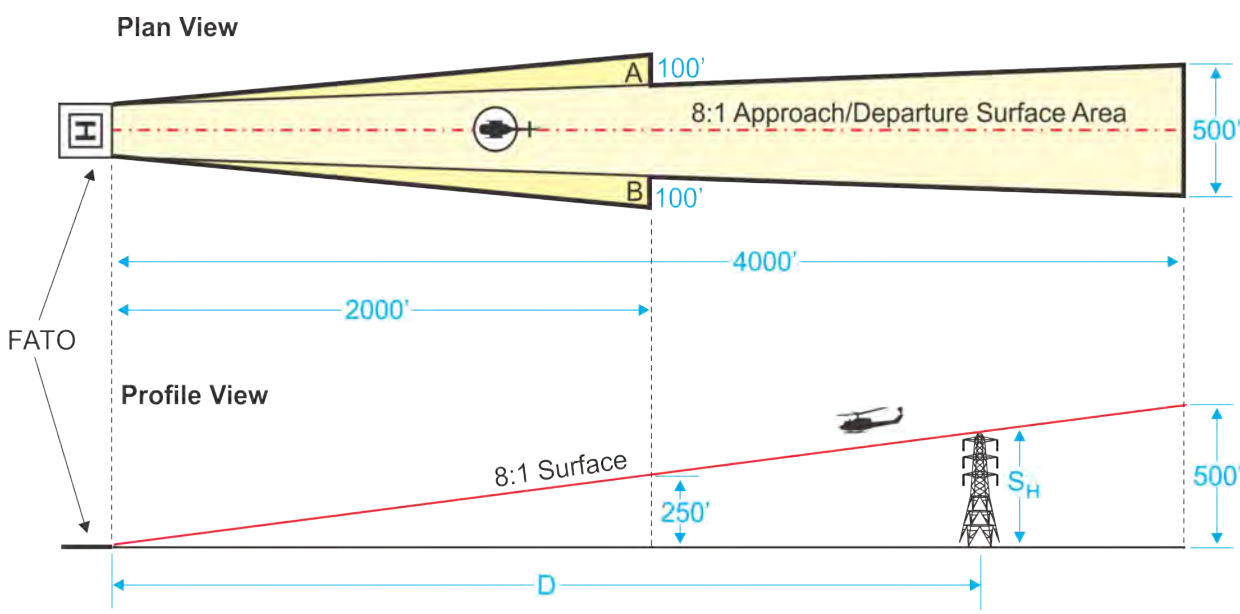
Appendix G. Conditions and Assumptions for IFR to VFR Heliport (IVH) (Proceed Visual) Approach Procedures

Before designing an RNAV (GPS) IVH approach procedure, ensure the heliport meets the following criteria:

1. FAA Form 7480-1, Notice for Construction, Alteration and Deactivation of Airports, has been filed under part 157.

2. No penetration of the 8:1 surface in AC 150/5390-2 is permitted (see Figure G-1). Penetrations of either A or B areas but not penetrations of both areas are allowed if the obstructions are charted, and marked or lighted and if not considered a hazard. Use Figure G-1 to determine height of the 8:1 surface.

Figure G-1. AC 150-5390-2 8:1 Surface



Formula G-1. 8:1 OCS Height (S_H)

$$S_H = (r + HE) \times e^{\frac{D}{8r}} - r$$

Where:

D = Distance from the FATO edge to obstacle, measured along centerline (feet)

HE = Heliport elevation

3. An acceptable onsite evaluation of the heliport for VFR use is required. Order 8900.1, Flight Standards Information Management System (FSIMIS), Volume 8, Chapter 3, Section 3 is to be used for evaluation of the heliport. Based on the FAA determination, a procedure can be developed under the following conditions:

a. No objection.

b. Conditional. Conditions that have been resolved by the proponent (e.g., obstacle penetrations of the 8:1 approach area, transitional and lateral extension areas, or those that pertain to the minimum size of the FATO, TLOF, and safety area). Recommendations made by the inspector when there are no operational safety concerns may not require resolution.

c. Objection. If an objection determination is issued, an IVH approach procedure is not authorized to be developed. A PinS (Proceed VFR) approach procedure may be developed in accordance with paragraph 12-2-2.

4. An acceptable evaluation of the visual segment for flyability, obstacles, and visual references must be completed in both day and night flight conditions. The heliport or heliport visual references must be in clear view at the MAP (e.g., it cannot be completely obscured behind a building). A heliport is the area of land, water or a structure used or intended to be used for the landing and takeoff of helicopters, together with appurtenant buildings and facilities. Buildings and facilities associated with the heliport such as hangers, administration buildings, AWOS equipment, windsock, beacon, etc. located within 500 feet are acceptable visual references. Surrounding buildings and land marks are not allowable visual references, unless approved by Flight Standards. At least one of the following visual references must be visible or identifiable before the pilot may proceed visually:

a. FATO or FATO lights.

b. TLOF or TLOF lights.

c. Lead-in lights.

d. VGSI.

e. Windsock or windsock light(s).*

f. Heliport beacon.*

g. Other facilities or systems approved by Flight Standards (AFS-400).

***Note:** Windsock lights and heliport beacons should be located within 500 feet of the TLOF.

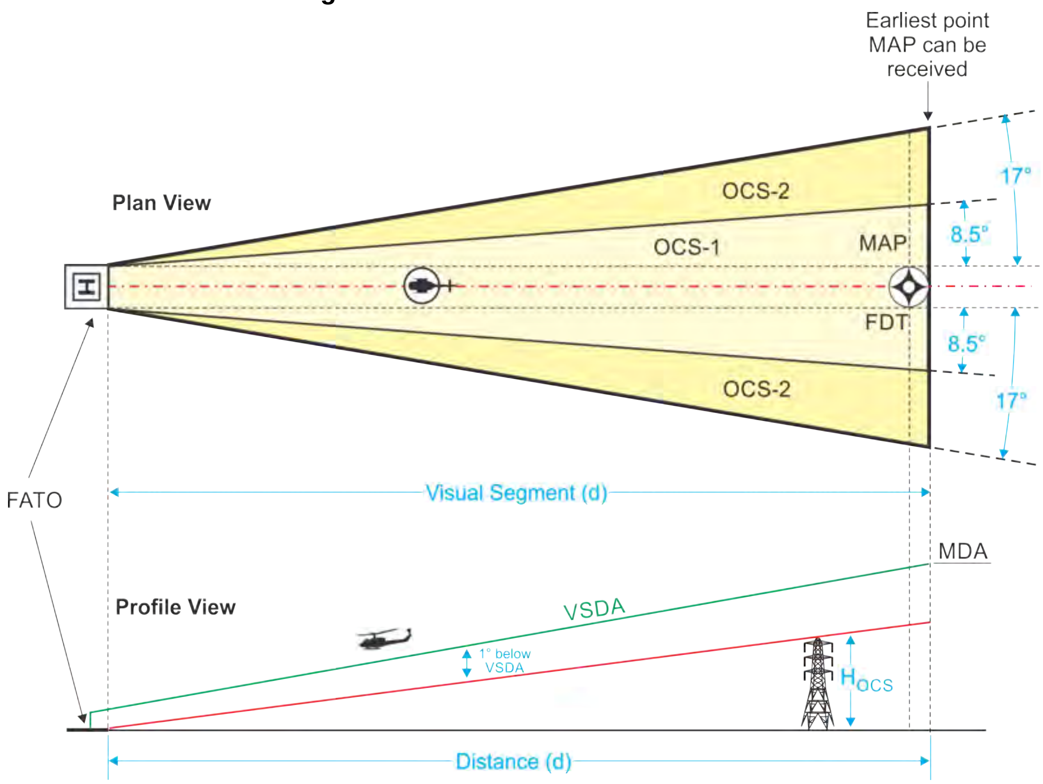
5. IVH Analysis. The following analysis must be performed for authorizing an IVH procedure (see Figure G-3). Obstacle clearance surface (OCS) areas are applied using concepts from paragraph 3-3-2.c with the following exceptions:

a. Alignment is always centered on the visual segment centerline

b. Length OCS-1 and OCS-2. The length of OCS-1 and OCS-2 begin from the edge of the FATO and extend to abeam the earliest point the MAP can be received (see Figure G-2).

c. Area Width OCS-1 and OCS-2. OCS-1 splays outward 8.5 degrees from the outer edges of the FATO. OCS-2 splays outward 17 degrees from the outer edges of the FATO (see Figure G-2).

Figure G-2. OCS for IVH Procedures



(1) Step 1: Calculate OCS-1 width (W_{OCS-1}) at distance (d) from the FATO edge using Formula G-2.

Formula G-2. OCS-1 Width (W_{OCS-1})

$$W_{OCS-1} = [\tan(8.5) \times d] + 0.5 \times F_w$$

Where:

W_{OCS-1} = Perpendicular distance from the flight path to the edge of OCS-1 (feet)

d = Distance from the FATO edge measured along the flight path (feet)

F_w = FATO width (feet)

(2) Step 2: Calculate the OCS-2 width (W_{OCS-2}) at distance (d) from the FATO edge using Formula G-3.

Formula G-3. OCS-2 Width (W_{OCS-2})

$$\boldsymbol{W_{OCS-2} = [\tan(17) \times d] + 0.5 \times F_w}$$

Where:
W_{OCS-2} = Perpendicular distance from the flight path to the edge of OCS-2 (feet)
d = Distance from the FATO edge measured along the flight path (feet)
F_w = FATO width (feet)

(3) The slope of OCS-1 and OCS-2 is equal to the VSDA minus one (1) degree measured from the FATO edge elevation. Use Formula G-4 to determine the MSL elevation of OCS-1 and OCS-2 at distance (D) from the FATO edge.

Formula G-4.OCS-1 and OCS-2 Slope (H_{OCS})

$$\boldsymbol{H_{OCS} = (r + HE) \times e^{\frac{D \times [\tan(VSDA-1)]}{r}} - r}$$

Where:
$VSDA$ = Visual segment descent angle (degrees)
D = Distance from the FATO edge to obstacle (feet)
HE = FATO edge elevation (feet)

d. If an unlighted obstacle penetrates OCS-1, a VGSI is required to be installed at the heliport.

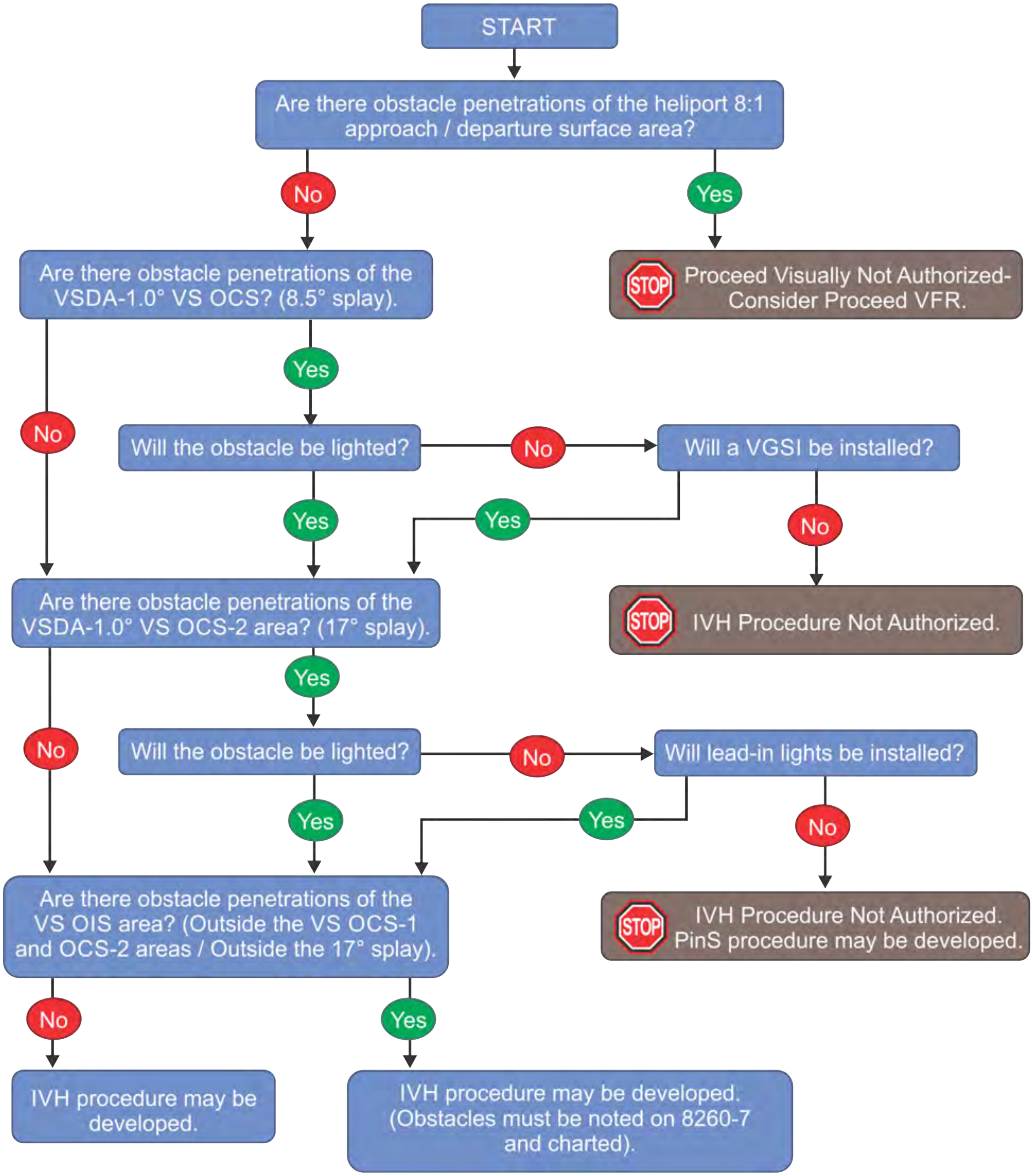
e. If an unlighted obstacle penetration is outside of OCS-1 but within OCS-2, the heliport must have lead-in lights to provide the pilot the visual cues to remain within the IVH OCS area.

f. The operational suitability of the lead-in lights must be evaluated in accordance with Appendix G, paragraph 4 during the night evaluation.

g. If there are obstacle penetrations outside of the OCS-1 and OCS-2 areas but within the OES area, these obstacles must be noted on the appropriate 8260-series form and charted.

h. If any of these conditions are not met, a PinS (Proceed VFR) procedure may be developed.

Figure G-3. IVH Procedure Decision Process



Directive Feedback Information

Please submit any written comments or recommendation for improving this directive, or suggest new items or subjects to be added to it. Also, if you find an error, please tell us about it.

Subject:

To: Flight Technologies and Procedures Division, AFS-400 Coordination Mailbox (9-AWA-AFS400-COORD@faa.gov)

(Please check all appropriate line items)

☐ An error (procedural or typographical) has been noted in paragraph on page .

☐ Recommend paragraph on page be changed as follows: *(attach separate sheet if necessary)*

☐ In a future change to this order, please cover the following subject: *(briefly describe what you want added)*

☐ Other comments:

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