CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B
CHG 26

National Policy

Effective Date:
02/24/2014

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

1. Purpose. This change incorporates existing standards from various policy documents and revises/deletes obsolete area navigation (RNAV) standards.

2. Who this change affects. The audience for this change is the FAA organization responsible for instrument flight procedure (IFP) development. The secondary audience includes other IFP providers, Air Traffic Organization (ATO) Service Area offices, Flight Standards headquarters and Regional office Divisions/Branches, and the applicable elements in the Department of Defense (DoD) and Department of Homeland Security (DHS) [hereafter referred to as the U.S. Military or Military].

3. Where you can find this change. You can find this order on the Federal Aviation Administration's (FAA) Web site at http://www.faa.gov/regulations_policies/orders_notices.

4. What this change cancels.

a. TIL 99-003 dated January 15, 1999, "Taxiing Aircraft as Departure Obstructions."

b. TIL 01-025 dated June 19, 2001, "Turning Area Curve Radii at 10,000 Feet MSL."

c. TIL 02-043 dated December 4, 2002, "8260.3B United States Standard for Terminal Instrument Procedures (TERPS) Change 19, Correction #1."

d. TIL 03-048 dated July 7, 2003, "Interim Correction to Order 8260.3B, United States Standard for Terminal Instrument Procedures."

f. AFS-400 Memorandum dated December 7, 2001, "Minimum Segment Altitudes and Required Obstacle Clearance (ROC)."

g. AFS-400 Memorandum dated January 17, 2003, "Implementation of FAA order 8260.3B, United States Standard for Terminal Instrument Procedure (TERPS), Change 19."

h. AFS-400 Memorandum dated January 5, 2004, "Clarification of Precision Obstacle Free Area (POFA)."

i. AFS-400 Memorandum dated March 17, 2005, "Revised Policy for Application of Volume 4, Paragraph 1.3."

Distribution: Electronic Only

Initiated By: AFS-400

j. AFS-400 Memorandum dated December 6, 2005, "Clarification of TERPS Glidepath Angle Standard."

k. AFS-400 Memorandum dated April 24, 2007, "Category I Instrument Landing System (ILS) End Fire Glide Slope (EFGS) Antenna Obstacle Evaluation."

l. AFS-400 Memorandum dated December 28, 2007, "Implementation of Order 8260.3B, U.S. Standard for Terminal Instrument procedures (TERPS), Change 20."

m. AFS-400 Memorandum dated August 17, 2009, "Policy Clarifications Associated with FAA Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS), Change 21."

n. AFS-400 Memorandum dated June 22, 2010, "Clarification on Missed Approach Climb Gradient Application."

o. AFS-400 Memorandum dated September 4, 2013, "Proposed Change to FAA Order 8260.3B, United States Standard for Terminal Instrument procedures (TERPS), Volume 1, Chapter 1, Paragraph 289, Obstacles Close to a Final Approach Fix"."

p. AFS-400 Memorandum dated September 4, 2013, "Information on the Future Use of Touchdown Zone Elevation (TDZE) on Instrument Approach Procedure (IAP) Charts."

q. Order 8260.16, Airport Obstruction Surveys, dated July 7, 1969.

r. Order 8260.56, Diverse Vector Area (DVA) Evaluation, dated August 2, 2011.

5. Explanation of changes.

a. General. Deleted references to OPNAV Inst. 3722.16C per U.S. Navy request. Updated Cover, Foreword, and DoD Distribution and Requisition page to correlate with removing the references.

b. Volume 1.

(1) Chapter 1. Incorporated TIL 03-048. Revised section 1 text for clarity; deleted paragraph for existing procedures. In sections 2 through 5, revised text for clarity. In section 6, clarified procedure identification requirements and added a requirement to specify unique suffixes to differentiate public and special. In section 7, revised text for clarity; added directive feedback information.

(2) Chapter 2. Throughout chapter, figures have been updated on pages where the text was revised as part of this change. Throughout chapter, paragraphs related to altitude selection and obstacle clearance have been updated to clarify intent and to incorporate policy related to minimum required obstacle clearance (i.e., December 7, 2001 policy memorandum). Throughout

chapter, instances of “shall” have largely been replaced with “must” where other text on the same page has been revised.

(3) Paragraph 220. Updated paragraph 220 as resolution to Aeronautical Charting Forum issue 07-01-270.

(4) Paragraph 289. This paragraph has been revised to remove the word “existing” so that the paragraph is applicable to any obstacle. It has also been revised to incorporate a 3.5:1 slope (instead of a 7:1 slope) for helicopter only procedures. These changes incorporate policy contained in AFS-400 memorandums dated September 4, 2013 and December 28, 2007 respectively.

(5) Chapter 3. Throughout chapter, references to height above threshold (HATh) as used in the determination visibility have been replaced with height above touchdown (HAT), consistent with AFS-400 policy memorandum dated September 4, 2013. Definition/examples of HAT and height above airport (HAA) calculations have been added to paragraph 3.1. Paragraph 3.1.1a and the note have been revised for clarity; sentence related to consideration of the Airport Reference Code (ARC) in determining authorized approach categories has been removed. Paragraphs 3.2.2b and 3.2.2b(2)(a) have been revised to incorporate AFS-400 policy memorandum dated August 17, 2009.

(6) Chapter 9. Incorporates requirement for the missed approach point for a localizer (LOC) or localizer type directional aid (LDA) approach procedure to be at least 3000 feet from the LOC/LDA facility.

(7) Chapter 10. Section 1 revised to clarify policy relating procedure/chart development for single/multi-sensor radar.

(8) Chapter 11. Revised for clarity. Incorporated AFS-400 policy memorandum dated December 28, 2007.

(9) Chapter 15. Incorporated AFS-400 policy memorandum dated December 28, 2007.

(10) Chapter 17. Incorporated TIL 01-025 to clarify the turn radius used for construction of en route turning areas at 10000 feet MSL. Incorporated AFS-400 policy memorandum dated December 28, 2007. Removed requirement to coordinate high altitude holding with the “Aviation Systems Standards” office.

(11) Removed Appendix 6, Alphabetical Index.

c. Volume 3.

(1) Paragraph 1.1. Edited for clarity. Replaced references to microwave landing system (MLS) with mobile microwave landing system (MMLS). Removed references to transponder landing system (TLS), wide area augmentation system (WAAS), local area augmentation system (LAAS), and barometric vertical navigation (baro-VNAV).

(2) Paragraph 1.1. Edited for clarity. Replaced MLS with MMLS. Removed references to TLS, WAAS, and LAAS.

(3) Figure 1-1. Updated figure.

(4) Paragraph 1.2. Removed definitions for Barometric Altitude, Barometric Vertical Navigation, Departure End of Runway, Flight Path Alignment Point, Flight Path Control Point, Geoid Height, Ground Point of Intercept, Height Above Ellipsoid, Inner Approach Obstacle Free Zone, Inner-Transitional OFZ, Lateral Navigation, Object Free Area, Precision Approach, Precision Approach Radar, Pseudo Ground Point of Intercept, Required Navigation Performance, Three Dimensional (3D) Point/Waypoint, Two Dimensional (2D) Point/Waypoint, and Wide Area Augmentation System. Replaced definition of MLS with MMLS. Updated definitions for Fictitious Threshold Point, Glidepath Intercept Point, Landing Threshold Point, Precise Final Approach Fix, and Runway Threshold. Added new definition for “Legacy.” Updated figure 1-3 to accompany the revision to the definition of “Runway Threshold.”

(5) Chapter 2. This chapter has been completely revised for editorial clarity, references have been updated, obsolete criteria have been removed, figures have been updated, and criteria specific to RNAV have been removed.

(6) Chapter 3. Replaced all figures; no substantive changes.

(7) Paragraph 3.0. Revised for clarity.

(8) Figure 3-1. Updated figure; no substantive changes.

(9) Paragraph 3.1. Revised for clarity.

(10) Paragraph 3.2. Revised for clarity.

(11) Paragraph 3.2.1. Revised for clarity.

(12) Figure 3-3. Title of figure revised for clarity.

(13) Paragraph 3.2.2. Editorial changes.

(14) Paragraph 3.3. Revised title of paragraph and content of paragraph. In particular, specific requirements related to POFA (currently called the POFZ) have been removed. POFZ requirements are contained within AC 150/5300-13, Airport Design, and also within order 7110.65, Air Traffic Control.

(15) Figure 3-4. Deleted figure depicting “POFA.”

(16) Paragraph 3.6.2. Editorial changes.

(17) Paragraph 3.6.3. Revised so adjustment is always mandatory when “Y” surface is penetrated.

(18) Paragraph 3.7. Editorial changes.

(19) Paragraph 3.8. through 3.8.4. Editorial changes.

(20) Paragraph 3.8.5. Deleted.

(21) Paragraph 3.9 through 3.9.4. This paragraph has been significantly revised to remove references to RNAV. The ILS missed approach criteria have also been revised to allow harmonization with localizer performance with vertical guidance (LPV) missed approach criteria, while retaining the current standard as an optional method for evaluation.

(22) Chapter 4. Deleted.

(23) Revised appendix 2 to include global navigation satellite system landing system (GLS) approaches in simultaneous independent parallel instrument approaches (SIPIA) standard.

(24) Revised appendix 3 by changing the title to “Simultaneous Close Parallel (SCP) Approaches” and by adding guidance for authorizing RNAV and Ground Based Augmentation System Landing System (GLS) approaches for SCP approaches. Added requirement to obtain AFS-400 approval for triple and quadruple SCP operations. Removed high update radar requirement when runway spacing is at least 3600 feet. Removed references to MLS, updated definitions and figures, removed duplicative information, and provided additional clarifications and current references.

d. Volume 4.

(1) Removed unneeded definitions from paragraph 1.1.

(2) Paragraph 1.1.24. Deleted definition for “Takeoff Runway Available (TORA).” See also explanation of change for paragraph 1.4.5 below.

(3) Paragraph 1.3. Remove the option to adjust the origin height of the departure OCS per AFS-400 memorandum dated March 17 2005.

(4) Paragraph 1.4.5. Removed option to limit TORA and replaced it with option to reduce takeoff runway length per AFS-400 memorandum dated March 17 2005.

(5) Paragraph 2.3. Deleted paragraph and replaced with chapter 5, Diverse Vector Area Evaluation (DVA).

(6) Chapter 3. Revised to incorporate TIL 02-043.

(7) Figures 4-1 through 4-4. Replaced figures; no substantive changes.

(8) Paragraph 4.2.1. Updated paragraph reference within the "climb to altitude" formula.

(9) Paragraph 4.2.2.e(1). Updated paragraph reference within the "climb to altitude" formula.

(10) Chapter 5. New chapter added to replace paragraph 2.3 and to incorporate content from Order 8260.56, Diverse Vector Area (DVA) Evaluation. The only significant change in content from order 8260.56 is that climb gradients in excess of 200 ft/NM are no longer prohibited.

6. Effective Date. Implementation of all changes must be completed no later than 12 months from the published effective date. Previous editions may be used until implementation has commenced, not to exceed 12 months from the new effective date.

7. Distribution. We will distribute this change to Washington headquarters to the Group and Team level in the Air Traffic Organization (Safety, En Route and Oceanic Services, Terminal Services, System Operations Services, Technical Operations Services, and Mission Support Services), Offices of Airport Safety and Standards, and Offices of Air Traffic Oversight; to the branch level in Offices of Airport Safety and Standards; Flight Standards Service; to the Aeronautical Navigation Products Office (AeroNav Products, AJV-3), and to the Regulatory Standards Division (AMA-200), at the Mike Monroney Aeronautical Center; to the branch level in the regional Flight Standards and Airport Divisions; to all Flight Standards District Offices (FSDOs); to the Team level in the Air Traffic Organization Service Areas (En Route and Oceanic, Terminal, and Technical Operations); special mailing list ZVN-826; and Special Military and Public Addressees.

John S. Duncan
Director, Flight Standards Service

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
iii thru iv	11/15/83	iii thru iv	02/24/14
v thru vi	12/06/84	v thru vi	02/24/14
vii thru x	08/31/11	vii thru xxvi	02/24/14
Volume 1		**Volume 1**	
vii thru xvi	08/31/11		
1 thru 2	05/15/02	1 thru 2	02/24/14
3	11/12/99	3	02/24/14
4 thru 6-2	05/15/02	4 thru 6	02/24/14
9 thru 12	02/13/98	9 thru 12	02/24/14
12-1 thru 12-2	11/12/99	12-1 thru 12-2	02/24/14
15 thru 16-2	02/13/98	15 thru 16-2	02/24/14
17 thru 18	05/15/02	17 thru 18	02/24/14
21	02/13/98	21	02/13/98
22	06/05/09	22	02/24/14
23 thru 24	06/05/09	23	06/05/09
		24	02/24/14
26-1 thru 26-2	06/05/09	26-1	02/24/14
		26-2	06/05/09
27	02/13/98	27	02/24/14
28	05/12/02	28	05/12/02
36-1 thru 36-4	02/13/98	36-1 thru 36-4	02/24/14
3-1 thru 3-2	12/07/07	3-1	02/24/14
		3-2	12/07/07
3-5 thru 3-6	12/07/07	3-5	12/07/07
		3-6	02/24/14
3-7 thru 3-10	08/31/11	3-7 thru 3-9	02/24/14
		3-10	08/31/11
3-15 thru 3-16	08/17/11	3-15 thru 3-16	02/24/14
9-1 thru 9-2	05/15/02	9-1 thru 9-2	02/24/14
10-1 thru 10-2	06/05/09	10-1 thru 10-2	02/24/14

10-5 thru 10-6	06/05/09	10-5	02/24/14
		10-6	06/05/09
10-7 thru 10-8	06/05/09	10-7	06/05/09
		10-8	02/24/14
101	02/79	101	02/24/14
102 thru 104	03/12/93	102 thru 104	02/24/14
15-17 thru 15-20	02/13/98	15-17 thru 15-20	02/24/14
173	12/06/84	173	02/24/14
174	06/80	174	02/24/14
183	05/15/02	183	02/24/14
184	06/80	184	02/24/14
Appendix 6 Page 1 thru 22	7/26/90		
Volume 3		**Volume 3**	
i thru vi	05/15/02		
1-1 thru 1-8	5/15/02	1-1 thru 1-4	02/24/14
2-1 thru 2-10	5/15/02	2-1 thru 2-12	02/24/14
2-11 thru 2-18	06/05/2009		02/24/14
3-1 thru 3-4	5/15/02	3-1 thru 3-4	02/24/14
3-7 thru 3-18	5/15/02	3-7 thru 3-24	02/24/14
4-1 thru 4-14	5/15/02		
A2-1 thru A2-2	03/09/2012	A2-1 thru A2-2	02/24/14
Appendix 3 Page 1 thru 8	05/15/02	Appendix 3 Page A3-1 thru A3-12	02/24/14
Volume 4		**Volume 4**	
i thru iv	05/15/02		
1-3 thru 1-8	5/15/02	1-3 thru 1-8	02/24/14
2-5 thru 2-8	5/15/02	2-5 thru 2-6	02/24/14
3-1 thru 3-4	5/15/02	3-1 thru 3-4	02/24/14
4-1 thru 4-4	5/15/02	4-1 thru 4-4	02/24/14
		5-1 thru 5-8	02/24/14

FOREWORD

This publication prescribes standardized methods for designing instrument flight procedures (IFPs) in the United States and its territories. It is to be used by all personnel charged with the responsibility for the preparation, approval, and promulgation of terminal instrument procedures. These criteria are predicated on normal aircraft operation and performance.

These criteria are applicable to the Federal Aviation Administration and have been adopted by the United States Army, the United States Navy, the United States Air Force, and the United States Coast Guard.

Recommendations concerning changes or additions should be provided to one of the following approving authorities as appropriate:

OFFICE OF FLIGHT OPERATIONS, FAA, Washington, D.C. 20591 (Civil Procedures)

DIRECTOR, U.S. Army Air Traffic Control Activity, Aeronautical Services Office (USAATCAASO), Cameron Station, Alexandria, Va. 22314

HEADQUARTERS, U.S. Air Force XOORF, Washington, D.C. 20330

COMMANDANT, (G-OSR-2173) U.S. Coast Guard, Washington, D.C. 20590

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TABLE OF CONTENTS

Page

VOLUME 1. GENERAL CRITERIA

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

Page

Chapter 11 **Helicopter Procedures (Continued)**

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

Page

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 1. GENERAL CRITERIA (CONTINUED)

Page

Appendix 5 Approach Lighting Systems (7 Pages)

VOLUME 2. NONPRECISION APPROACH PROCEDURE (NPA) CONSTRUCTION

RESERVED

VOLUME 3. PRECISION APPROACH (PA) AND LOCALIZER DIRECTIONAL AID (LDA) WITH GLIDE SLOPE APPROACH PROCEDURE CONSTRUCTION

Chapter 1. General Information

Chapter 2. General Criteria

TABLE OF CONTENTS (Continued)

VOLUME 3. PRECISION APPROACH (PA) AND LOCALIZER DIRECTIONAL AID (LDA) WITH GLIDE SLOPE APPROACH PROCEDURE CONSTRUCTION (CONTINUED)

TABLE OF CONTENTS (Continued)

VOLUME 3. PRECISION APPROACH (PA) AND LOCALIZER DIRECTIONAL AID (LDA) WITH GLIDE SLOPE APPROACH PROCEDURE CONSTRUCTION (CONTINUED)

Page

TABLE OF CONTENTS (Continued)

VOLUME 3. PRECISION APPROACH (PA) AND LOCALIZER DIRECTIONAL AID (LDA) WITH GLIDE SLOPE APPROACH PROCEDURE CONSTRUCTION (CONTINUED)

VOLUME 4. DEPARTURE PROCEDURE CONSTRUCTION

TABLE OF CONTENTS (Continued)

VOLUME 4. DEPARTURE PROCEDURE CONSTRUCTION (CONTINUED)

VOLUME 5. HELICOPTER AND POWER LIFT INSTRUMENT PROCEDURE CONSTRUCTION

RESERVED

CHAPTER 1. ADMINISTRATIVE

SECTION 1. SCOPE

1. PURPOSE OF THIS ORDER. Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS), contains the criteria used to formulate, review, approve, and publish instrument flight procedures (IFPs) for operations to and from civil and military airports.

2. DISTRIBUTION. This order is distributed to selected Federal Aviation Administration (FAA) addresses in Washington headquarters to the Group and Team level in the Air Traffic Organization [Safety and Technical Training (AJI), Air Traffic Services (AJT), System Operations Services (AJR), Technical Operations Services (AJW), and Mission Support Services (AJV)]; to the Branch level in the Flight Standards Service; to the Operations Headquarters Directorate, AJT-2; to the National Aeronautical Navigation Products Office, AJV-3; to the National Flight Data Center, AJV-21; and to the Regulatory Standards Division, AMA-200, at the Mike Monroney Aeronautical Center; to the branch level in the regional Flight Standards Divisions; to the Team level in the ATO Service Area Operational Support Groups, and special mailing list ZVN-826. For distribution within the Department of Defense, see pages v.

3. WHERE CAN I FIND THIS ORDER. You can find this order on the Federal Aviation Administration's (FAA) Web site at http://www.faa.gov/regulations_policies/orders_notices.

4. WHAT THIS ORDER CANCELS. The United States Standard for Terminal Instrument Procedures (TERPS) 8260.3A, TM 11-2557-26, OPNAV Inst. 3722.16B, JAFM 55-9, and CG 318, dated 02/06/1970, are canceled.

5. TYPES OF PROCEDURES. Criteria are provided for the following types of authorized IFPs:

a. Precision Approach (PA). An instrument approach based on a navigation system that provides course and glidepath deviation information meeting the precision standards of International Civil Aviation Organization (ICAO) Annex 10 is considered a PA procedure. Precision Approach Radar (PAR) and Instrument Landing System (ILS) are examples of PA procedures.

b. Approach with Vertical Guidance (APV). An instrument approach based on a navigation system that is not required to meet the PA standards of ICAO Annex 10 but provides course and glidepath deviation information is considered an APV procedure. Localizer Performance with Vertical Guidance (LPV), lateral navigation/vertical navigation (LNAV/VNAV), and localizer type directional aid (LDA) with glidepath, are examples of APV procedures.

c. Nonprecision Approach (NPA). An instrument approach based on a navigation system that provides course deviation information, but no glidepath deviation information is considered an NPA procedure. Very high frequency omnidirectional range (VOR), tactical air navigation (TACAN), LNAV, localizer performance (LP), nondirectional radio beacon (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.

6. WORD MEANINGS. Word meanings as used in this order:

a. Shall or Must means that application of the criteria is mandatory.

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

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

7. - 119. RESERVED.

SECTION 2. ELIGIBILITY, APPROVAL, AND RETENTION

120. ELIGIBILITY.

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

b. Civil Airports. IFPs must be provided at civil airports open to the aviation public whenever a reasonable need is shown. No minimum number of potential instrument approaches is specified; however, the responsible FAA office must determine that a public procedure will be beneficial to more than a single user or interest. Private procedures, for the exclusive use of a single interest, may be provided on a reimbursable basis under Title 14 of the Code of Federal Regulations (14 CFR) Part 171, where applicable, if they do not unduly conflict with the public use of airspace. Reasonable need is deemed to exist when the IFP will be used by:

(1) A certificated air carrier, air taxi, or commercial operator; or

(2) Two or more aircraft operators whose activities are directly related to the commerce of the community.

(3) Military aircraft.

121. REQUESTS FOR PROCEDURES. Requests for military procedures are processed as described by the appropriate military service. Civil procedures may be requested by letter; therefore, no special form is required. Send requests to the appropriate Regional or Service Area Office. Requests are accepted from any aviation source, provided the request indicates the airport owner/operator has been notified of the request. (Such notification is necessary only when the request is for an original procedure to an airport not already served by an approach procedure.) The FAA will advise airport owners/operators of additional requests for procedures.

122. APPROVAL. Where a reasonable civil need has been established or a military requirement exists, a request for an IFP must be approved if the following minimum standards are met:

a. Airport. An airport airspace analysis conducted under Order JO 7400.2, Procedures for Handling Airspace Matters, or appropriate military directives, as applicable must find the airport acceptable for instrument flight rules (IFR) operations. The airport landing surfaces must be adequate to accommodate the aircraft expected to use the procedure. The airport infrastructure requirements of FAA Advisory Circular (AC) 150/5340-1, Standards for Airport Markings, and FAA AC 150/5300-13A, Airport Design, paragraph 317 must be met to achieve the lowest possible minimums. Only circling minimums may be approved to airports where the runways are not clearly defined. Runway lighting is required for approval of night instrument approach operations. Do NOT deny takeoff and departure procedures at night due solely to the absence of runway edge lights.

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

c. Obstacle Marking and Lighting. Obstacles that penetrate 14 CFR Part 77 imaginary surfaces are obstructions and; therefore, should be marked and lighted, insofar as is reasonably possible under FAA 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 that AC. Do NOT deny instrument approach procedures due to inability to mark and light or remove obstacles that violate Part 77 surfaces. **Exception:** See chapter 3, section 3.

NOTE: In military procedures, the appropriate military directives apply.

d. 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.

e. Communications. 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. Air-to-ground communication normally consists of ultra high frequency (UHF) or very high frequency (VHF) radio, but high frequency (HF) communication may be approved at locations that have a special need and capability. Other suitable means of point-to-point communication, such as commercial telephone, are also required to file and close flight plans.

123. RETENTION AND CANCELLATION. Civil instrument procedures must be canceled when a re-evaluation of the usefulness of an IAP indicates that the benefits derived are not commensurate with the costs of retaining the procedure. This determination will be based upon an individual evaluation of requirements peculiar to each specific location, and will consider airport complexity, military requirements, planned airport expansion, and the need for a backup or supplement to the primary instrument approach system. Certain special procedures exist, generally based on privately operated navigation facilities. When a procedure based on a public facility is published, special procedures for that airport must be canceled unless retention provides an operational advantage to the user. Before an instrument procedure is canceled, coordination with civil and military users must be effected. Care must be taken not to cancel procedures required by the military or required by air carrier operators at provisional or alternate airports. Retain or cancel military procedures as required by the appropriate military authority.

124. - 129. RESERVED.

SECTION 3. RESPONSIBILITY AND JURISDICTION

130. 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, Flight Procedures Management Program). 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 must establish and approve 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.

131. 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.

132. - 139. RESERVED.

SECTION 4. IFP ESTABLISHMENT

140. FORMULATION. Proposed IFPs are prepared under the applicable volume/chapter of this order as determined by the phase of flight and navigation source. To permit use by aircraft with limited navigational equipment, an IFP should be formulated using a single navigation source whenever possible. The use of multiple navigation sources of the same or different types may be permitted to gain an operational advantage.

141. NONSTANDARD IFPs. The standards contained in this manual are based on reasonable assessment of the factors which contribute to errors in aircraft navigation and maneuvering. They are designed primarily to assure that safe flight operations for all users result from their application. The dimensions of the obstacle clearance areas are influenced by the need to provide for a smooth progression to and from the en route system. Every effort must be made to formulate IFPs in accordance with these standards; however, terrain, navigation information, obstacles, or traffic congestion may require special consideration where justified by operational requirements. In such cases, nonstandard IFPs that deviate from these criteria may be approved, provided they are documented and an equivalent level of safety exists. A nonstandard IFP is not substandard; it has been approved after special study of the local problems has demonstrated that no derogation of safety is involved. The FAA Flight Technologies and Procedures Division (AFS-400), is the approving authority for nonstandard civil IFPs. Military IFPs that deviate from standards because of operational necessity, and in which an equivalent level of safety is not achieved, must be marked "**NOT FOR CIVIL USE.**"

142. AMENDMENTS. Process in accordance with Order 8260.19, Flight Procedures and Airspace.

143. - 149. RESERVED.

SECTION 5. COORDINATION

150. COORDINATION. It is necessary to coordinate IFPs to avoid conflicts and protect the rights of all airspace users.

a. Air Traffic Control (ATC) facilities. All new or revised IFPs must be coordinated with the affected military or civil ATC facilities and other related airspace users. See Order 8260.19.

b. Airspace. Where action to designate controlled airspace for an IFP is planned, the airspace action should be initiated sufficiently in advance so that effective dates of the IFP and the airspace action will coincide. See Order 8260.19.

c. Notice to Airmen (NOTAM). See Order 8260.19.

151. COORDINATION CONFLICTS. Coordination conflicts that cannot be resolved with the FAA organization responsible for IFP development will be submitted to the Regional Airspace and Procedures Team (RAPT) for resolution. Make every effort to thoroughly evaluate the comments/objections, determine the validity and scope of each issue, and if necessary, determine the appropriate course of action to resolve the conflict. The RAPT will provide a written response detailing the disposition and actions taken. The RAPT will forward conflicts that cannot be resolved to Flight Standards' Flight Procedure Implementation and Oversight Branch (AFS-460) for resolution, and provide an information copy to commenting agencies/ organizations. Take parallel actions through military channels if a problem involves a military procedure.

152. - 159. RESERVED.

SECTION 6. IDENTIFICATION OF INSTRUMENT FLIGHT PROCEDURES (IFP)

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

161. 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 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, e.g., ASR, PAR, NDB, VOR, TACAN, LOC, LDA, and 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) approach procedures with Authorization Required (AR) use "RNAV (RNP)."

(c) RNAV procedures based solely upon VOR/DME or VORTAC signals; use "RNAV (VOR/DME)".

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

Examples: RNAV (GPS) RWY 17, RNAV (RNP) RWY 17, RNAV (VOR/DME) RWY 17, GLS RWY 17.

b. Exception. High altitude approaches, prefix the navigation system with "HI-." The "HI-" prefix does not obviate the requirement to use suffixes when more than one procedure uses the same navigational guidance to the same runway (see paragraph 161d).

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

c. PRM Modifier. This element is applicable to IFPs authorized for closely spaced parallel approach operations and to procedures established under Order 8260.49, Simultaneous Offset Instrument Approach (SOIA). 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, RNAV (RNP) PRM RWY 31R, LDA PRM RWY 28R, GLS PRM RWY 17

d. Duplicate identification 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 [e.g., 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

(1) 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 and altitudes (landing minimums excluded) are not considered duplicates of each other and do not require separate 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, e.g., "ILS Y RWY 16R" and "ILS Y RWY 16R (SA CAT I)".

(2) 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."

(3) RNAV (GPS), RNAV (RNP), and RNAV (VOR/DME). Duplicate identification 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, RNAV (VOR/DME) W RWY 28L

(4) 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 to which the 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

162. 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 161.

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.

(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

163. COMBINED CHARTING OF APPROACH PROCEDURES. A VOR approach may be combined with a TACAN approach if they share common tracks, fixes, and fix altitudes. An ILS approach may be combined with either a LOC approach, or with an RNAV (GPS) approach if they share common tracks, fixes, and fix altitudes (final segment step down fixes/altitudes excluded). Identify as specified in paragraph 161, 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, ILS or RNAV (GPS) RWY 24R, VOR or TACAN-A

164. DEPARTURE PROCEDURE IDENTIFICATION. For named departures, see Order 8260.46, Departure Procedure (DP) Program.

165. EN ROUTE PROCEDURE IDENTIFICATION. For named ATS routes, see Order 7400.2.

166. - 169. RESERVED.

SECTION 7. IFP PUBLICATION

170. SUBMISSION. IFPs must be submitted by the approving authority on forms provided by the originating agency. A record of coordination must be maintained by the originating agency. IFPs must be routed under current orders or directives of the originating agency.

171. ISSUANCE. The FAA Administrator (or designee) is responsible for issuing civil instrument procedures. The military approving authorities are responsible for issuing military instrument procedures.

172. EFFECTIVE DATE. See Orders 8260.19 and 8260.26, or applicable military directive(s). FAA policy does not permit the issuance of complete civil instrument approach procedures by Notice to Airmen (NOTAM).

173. INFORMATION UPDATE. For your convenience, FAA Form 1320-19, Directive Feedback Information, is included at the end of this order to provide any comments on deficiencies found, clarifications needed, or suggested improvements regarding the contents to this order. When forwarding comments to the originating office for consideration, please provide a complete explanation of why the suggested change is necessary.

174. MATHEMATICS CONVENTION.

a. Definition of mathematical functions.

$a+b$ indicates addition

$a-b$ indicates subtraction

$a\times b$ indicates multiplication

$\frac{a}{b}$ or a/b indicates division

$(a\times b)$ indicates the result of the process within the parenthesis

$|a-b|$ indicates the result of $a-b$ is assigned a positive sign

$\approx$ indicates approximate equality

$\sqrt{a}$ indicates the square root of quantity "a"

a^2 indicates $a\times a$

$\tan(a)$ indicates the tangent of "a" degrees

$\tan^{-1}(a)$ indicates the arc tangent of "a"

$\sin(a)$ indicates the sine of "a" degrees

$\sin^{-1}(a)$ indicates the arc sine of "a"

$\cos(a)$ indicates the cosine of "a" degrees

$\cos^{-1}(a)$ indicates the arc cosine of "a"

b. Operational Precedence (Order of Operations).

First - Grouping symbols: parentheses, brackets, braces, fraction bars, etc.
Second - Functions: tangent, sine, cosine, arcsine and other defined functions.
Third - exponentiation: powers and roots
Fourth - multiplication and division: products and quotients
Fifth - addition and subtraction: sums and differences

$5-3\times 2=-1$ because multiplication takes precedence over subtraction

$(5-3)\times 2=4$ because parentheses take precedence over multiplication

$\frac{6^2}{3}=12$ because exponentiation takes precedence over division

$\sqrt{9+16}=5$ because the square root sign is a grouping symbol

$\sqrt{9}+\sqrt{16}=7$ because roots take precedence over addition

$\frac{\sin(30°)}{0.5}=1$ because functions take precedence over division

$\sin\left(\frac{30°}{0.5}\right)=0.8660254$ because parentheses take precedence over functions

Notes:
1. *Most hand-held calculators are pre-programmed to apply these rules of precedence.*

2. *When possible, let the calculator maintain all of the available digits of a number in memory rather than re-entering a rounded number. For highest accuracy, only round the final results.*

175. – 199. RESERVED.

215. CONTROLLING OBSTACLE(S). See Order 8260.19, Flight Procedures and Airspace, and Order 8260.46, Departure Procedure (DP) Program, for documentation and charting requirements.

216.-219. RESERVED.

SECTION 2. FEEDER ROUTES/EMERGENCY AREAS

220. FEEDER ROUTES. Non-radar feeder routes should be established when the IAF is not part of the en route structure and when preferred over other options (e.g., radar vectors, 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 length must not exceed the operational service volume of the facilities which provide navigational guidance, unless additional frequency protection is provided.

a. Alignment. When the feeder route or portion of the feeder route meets "no-procedure turn" (NoPT) initial segment descent/alignment standards and is suitable for terminal operations, consider developing as a NoPT initial segment instead. The area considered for obstacle evaluation is oriented along the feeder route at a width appropriate to the type of route; e.g., VOR, NDB, or RNAV. When connecting to a course reversal segment, the area terminates at a line perpendicular to the feeder course through the course reversal fix. For routes based on conventional ground-based NAVAIDs, the angle of intersection between the feeder route course and the en route structure must not exceed 120 degrees. The angle of intersection between a conventional 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 the current Performance-Based Navigation (PBN) standard (e.g., Order 8260.58, United States Standard for Performance Based Navigation (PBN) Instrument Procedure Design, or successor) for feeder segments.

b. Area. For routes based on conventional ground-based NAVAIDs, apply chapter 17. For RNAV routes, apply Order 8260.58 (or successor).

c. Obstacle Clearance. The minimum ROC over areas not designated as mountainous under Federal Aviation Regulation (FAR) 95 is 1000 feet. The minimum ROC within areas designated in FAR 95 as "mountainous" is 2000 feet. Paragraphs 1720b(1), 1720b(2), and 1721 apply. 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.

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 high altitude penetrations is 800 ft/NM. Where a higher descent gradient is necessary, the MAXIMUM gradient is 1000 ft/NM.

221. MINIMUM SAFE/EMERGENCY SAFE ALTITUDES (MSA/ESA). Establish to provide at least 1000 feet of obstacle clearance for emergency use, within a specified distance from the primary navigation facility upon which a non-RNAV procedure is predicated, and for an RNAV procedure, within a specified distance from an RNAV waypoint (WP). The minimum altitudes are identified as minimum safe altitudes or emergency safe altitudes, and are specified in 100-foot increments. When necessary, round to the next higher 100-foot increment (e.g., when obstacle elevation plus ROC equals 1501, round up to 1600).

a. MSA. Establish an MSA for all procedures within a 25 NM radius of the WP/facility, including the area 4 NM beyond the outer boundary (see figure 2-1). When the distance from the facility to the airport exceeds 25 NM, extend the radius to include the airport landing surfaces up to a maximum distance of 30 NM. When the procedure does not use an omni-directional facility; e.g., localizer back course (LOC BC) with a fix for the PFAF, use the primary omni-directional facility in the area. Establish a common safe altitude (no sectors) for the entire area around the facility or if necessary to offer relief from obstacles, establish sector divisions. Sectors must not be less than 90 degrees in spread. Sector altitudes should be raised and combined with adjacent higher sectors when the altitude difference does not exceed 300 feet. A sector altitude must also provide 1000 feet of obstacle clearance in any adjacent sector within 4 NM of the sector boundary line. For RNAV straight-in approach procedures, establish a common safe altitude within a specified radius of the runway threshold (preferred) or the MAP WP; for RNAV circling procedures use the airport waypoint (APT WP) (see figure 2-2).

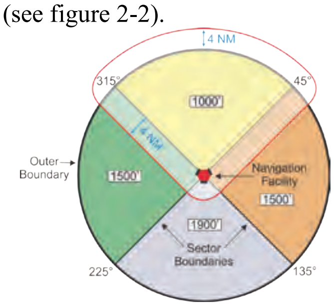


Figure 2-1. Non-RNAV MSA. Par 221.

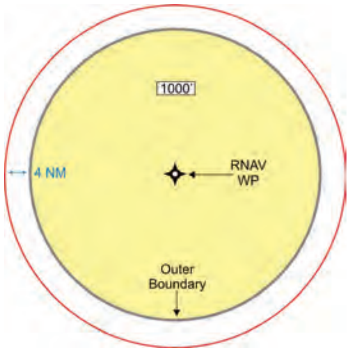


Figure 2-2. RNAV MSA. Par 221.

b. Emergency Safe Altitudes (ESA). ESAs are normally developed only for military procedures at the option of the approving authority. Establish ESA's within a 100-mile radius of the navigation facility or WP used as the ESA center, with a common altitude for the entire area. Where ESA's are located in designated mountainous areas, provide at least 2000 feet of obstacle clearance.

222.-229. RESERVED.

SECTION 3. INITIAL APPROACH

230. INITIAL APPROACH SEGMENT. The instrument approach commences at the IAF. In the initial approach, the aircraft has departed the en route phase of flight and is maneuvering to enter an intermediate segment. When the IF is part of the en route structure, it may not be necessary to designate an initial approach segment. In this case, the approach commences at the IF and intermediate segment criteria apply. An initial approach may be made along an arc, radial, course, heading, radar vector, or a combination thereof. Procedure turns, holding pattern descents, and high altitude penetrations are initial segments. Positive course guidance (PCG) is required except when dead reckoning (DR) courses can be established over limited distances. Although more than one initial approach may be established for a procedure, the number should be limited to that which is justified by traffic flow or other operational requirements. Where holding is required prior to entering the initial approach segment, the holding fix and IAF should coincide. When this is not possible, the IAF must be located within the holding pattern on the inbound holding course.

231. ALTITUDE SELECTION. Minimum altitudes in the initial approach segment must be established in 100-foot increments. The selected altitude must provide the minimum ROC (plus adjustments as specified by paragraph 3.2.2b of this volume); e.g., when obstacle elevation plus ROC equals 1501, round up to 1600. The altitude selected must not be below the procedure turn (PT) altitude where a PT is required. In addition, altitudes specified in the initial approach segment must not be lower than any altitude specified for any portion of the intermediate or final approach segment.

232. INITIAL APPROACH SEGMENTS BASED ON STRAIGHT COURSES AND ARCS WITH PCG.

a. Alignment.

(1) Courses. The angle of intersection between the initial approach course and the intermediate course must not exceed 120 degrees. When the angle exceeds 90 degrees, a radial or bearing which provides at least two miles of lead must be identified to assist in leading the turn onto the intermediate course (see figure 2-3).

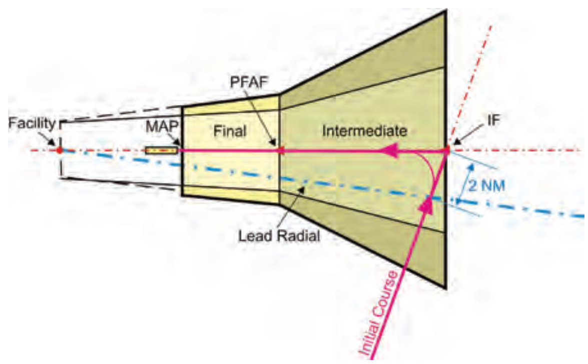


Figure 2-3. INITIAL APPROACH INTERCEPTION ANGLE GREATER THAN 90°. Par 232a(1).

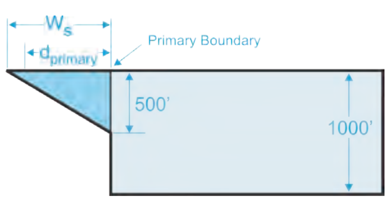
(2) Arcs. An arc may provide course guidance for all or a portion of an initial approach. The minimum arc radius must be seven miles, except for high altitude jet penetration procedures, in which the minimum radius should be at least 15 miles. When an arc of less than 15 miles is used in high altitude procedures, the descent gradient along the arc must not exceed the values in table 1. An arc may join a course at or before the IF. When joining a course at or before the IF, the angle of intersection of the arc and the course must not exceed 120 degrees. When the angle exceeds 90 degrees, a radial which provides at least two miles of lead must be identified to assist in leading the turn on to the intermediate course. DME arc courses must be predicated on DME collocated with a facility providing omni-directional course information.

Table 1. DESCENT GRADIENT ON AN ARC 15 NM AND LESS. Par 232a(2).

MILES	MAX FT. PER NM
15	**1,000**
14	**720**
13	**640**
12	**560**
11	**480**
10	**400**
9	**320**
8	**240**
7	**160**

b. Area. The initial approach segment has no standard length. The length must be sufficient to permit the altitude change required by the procedure and must not exceed 50 miles unless an operational requirement exists. The total width of the initial approach segment must be 6 miles on each side of the initial approach course. This width is divided into a primary area, which extends laterally four miles on each side of the course, and a secondary area, which extends laterally two miles on each side of the primary area. See volume 1, chapter 2, figure 10. When any portion of the initial approach is more than 50 miles from the navigation facility, the criteria for en route airways must apply to that portion.

c. Obstacle Clearance. The minimum ROC in the primary area is 1000 feet. The minimum ROC in the secondary area is 500 feet at the primary boundary, tapering uniformly to zero feet at the outer edge. Adjustments for precipitous terrain must be applied as specified in paragraph, 3.2.2b of this volume. See paragraph 231.



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

where
$d_{primary}$ = perpendicular dist (ft) from primary area
W_S = Total width of the secondary area (ft)

d. Descent Gradient. The OPTIMUM descent gradient in the initial approach is 250 ft/mile. Where a higher descent gradient is necessary, the MAXIMUM gradient is 500 ft/mile. The OPTIMUM descent gradient for high altitude penetrations is 800 ft/mile. Where a higher descent gradient is necessary, the MAXIMUM gradient is 1000 ft/mile.

233. INITIAL APPROACH SEGMENT BASED ON DR. See ILS chapter for special limitations.

a. Alignment. Each DR course must intercept the extended intermediate course. For LOW altitude procedures, the intercept point must be at least 1 mile from the IF for each two miles of DR flown. For HIGH altitude procedures, the intercept point may be one mile for each three miles of DR flown. The intercept angle must:

(1) Not exceed 90 degrees.

(2) Not be less than 45 degrees except when DME is used OR the DR distance is three miles or less.

b. Area. The MAXIMUM length of the DR portion of the initial segment is 10 miles (except paragraph 232b applies for HIGH altitude procedures where DME is available throughout the DR segment). Where the DR course begins, the width is six miles on each side of the course, expanding by 15 degrees outward until joining the points shown in figures 4-1, 4-2, 4-3, 4-4, and 4-5.

c. Obstacle Clearance. The minimum ROC in the DR initial approach segment is 1000 feet. There is no secondary area. Adjustments for precipitous terrain must be applied as specified in paragraph 3.2.2b of this volume. See paragraph 231.

d. Descent Gradient. The OPTIMUM descent gradient in the initial approach is 250 ft/mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 ft/mile. The OPTIMUM descent gradient for high altitude penetrations is 800 ft/mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 1000 ft/mile.

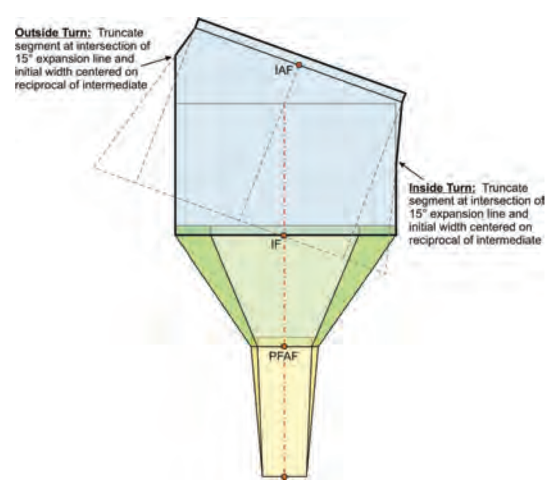


Figure 4-1. EXAMPLE DR SEGMENT. Par 233b.

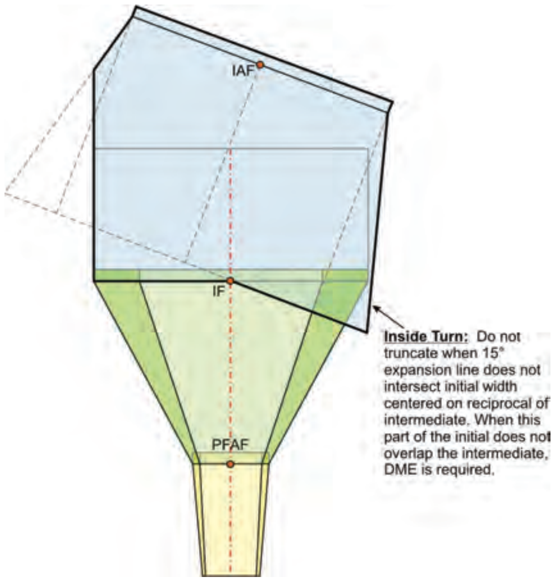


Figure 4-2. EXAMPLE DR SEGMENT. Par 233b.

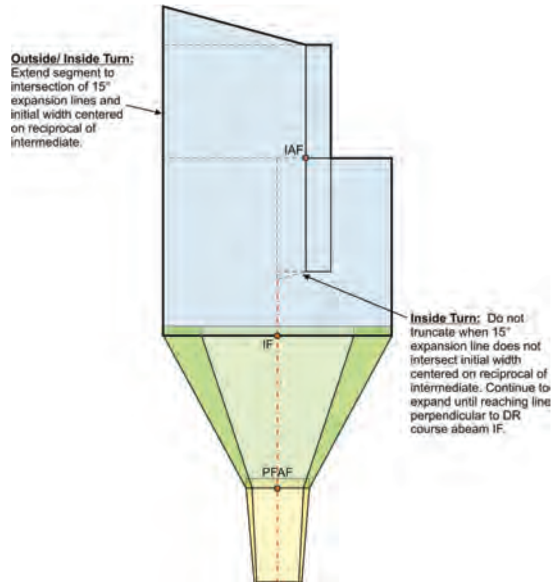


Figure 4-4. EXAMPLE DR SEGMENT. Par 233b.

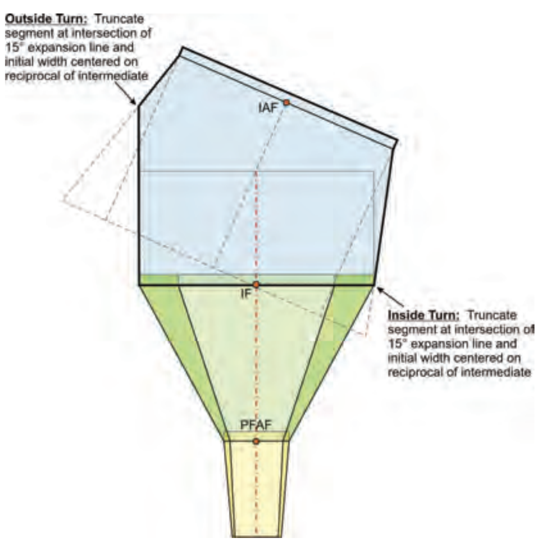


Figure 4-3. EXAMPLE DR SEGMENT. Par 233b.

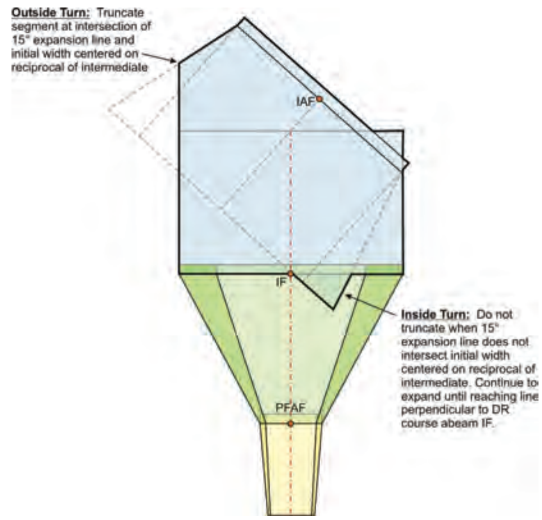


Figure 4-5. EXAMPLE DR SEGMENT. Par 233b.

234. INITIAL APPROACH SEGMENT BASED ON A PT. A PT must be specified when it is necessary to reverse direction to establish the aircraft on an intermediate or FAC, except as specified in paragraph 234e. A PT begins by overheading a facility or fix which meets the criteria for a holding fix (see paragraph 287b), or for a FAF (see paragraph 287c). The procedure must specify the PT fix, the outbound and inbound course, the distance within which the PT must be completed, and the direction of the PT. When a teardrop turn is used, the angle of divergence between the outbound courses and the reciprocal of the inbound course must be a MINIMUM of 15 degrees or a MAXIMUM of 30 degrees (see paragraph 235a for high altitude teardrop penetrations). When the beginning of the intermediate or final approach segment associated with the procedure turn is not marked by a fix, the segment is deemed to begin on the inbound procedure turn course at the maximum distance specified in the procedure. Where neither segment is marked by a fix, the final segment begins at the maximum distance specified in the procedure.

a. Alignment. When the inbound course of the PT becomes the intermediate course, it must meet the intermediate course alignment criteria (see paragraph 242a). When the inbound course becomes the FAC, it must meet the FAC alignment criteria (see paragraph 250). The wider side of the PT area must be oriented in the same direction as that prescribed for the PT.

b. Area. The PT areas are depicted in figure 5. The normal PT distance is 10 miles. See table 1A. Decrease this distance to five miles where only CAT A aircraft or helicopters are to be operating, and increase to 15 miles to accommodate operational requirements, or as specified in paragraph 234d. No extension of the PT is permitted without a FAF. When a PT is authorized for use by approach CAT E aircraft, use a 15-mile PT distance. The PT segment is made up of the entry and maneuvering zones. The entry zone terminates at the inner boundary which extends perpendicular to the PT inbound course at the PT fix. The remainder of the PT segment is the maneuvering zone. The entry and maneuvering zones are made up of primary and secondary areas. The PT primary area dimensions are based on the PT completion altitude or the highest feeder route altitude, whichever is greater. To allow additional maneuvering area as the true airspeed increases at higher altitudes, the dimensions of the PT primary area increase. The PT secondary area is 2 miles on the outside of the primary area.

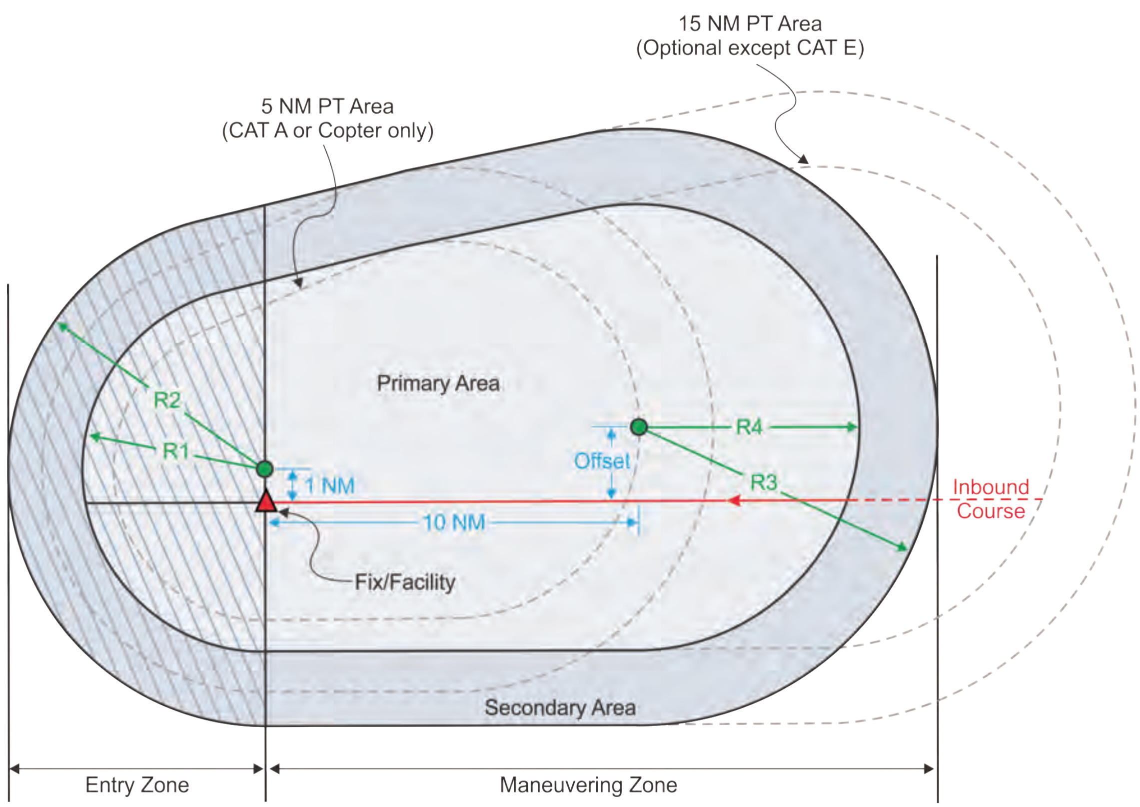


Figure 5. PROCEDURE TURN AREA, Par 234b.
(See Table 1A to determine radius values.)

Table 1A. PROCEDURE TURN VARIABLES ACCORDING TO ALTITUDE, Par 234b.

≤6,000

PT Length	Offset	R_1	R_2	R_3	R_4
5	2	4	6	5	7
>5-10	2	5	7	6	8
>10-15	β-4	5	7	β	β+2

$$\beta = 0.1 \times (d - 10) + 6$$

Where d = PT Length

>6,000 ≤10,000

PT Length	Offset	R_1	R_2	R_3	R_4
5	2	4	6	5	7
>5-10	2	6	8	7	9
>10-15	β-5	6	8	β	β+2

$$\beta = 0.1 \times (d - 10) + 7$$

Where d = PT Length

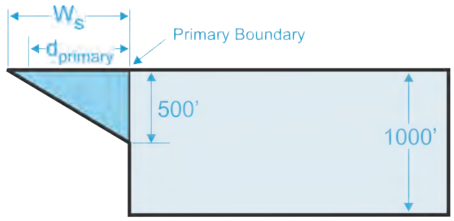
>10,000

PT Length	Offset	R_1	R_2	R_3	R_4
5	2	4	6	5	7
>5-10	2	7	9	8	10
>10-15	β-6	7	9	β	β+2

$$\beta = 0.1 \times (d - 10) + 8$$

Where d = PT Length

c. Obstacle Clearance. The minimum ROC in the primary area is 1000 feet. The minimum ROC in the secondary area is 500 feet at the primary boundary, tapering uniformly to zero feet at the outer edge (see figure 6). Adjustments for precipitous terrain must be applied as specified in paragraph 3.2.2b of this volume. The primary and secondary areas determine obstacle clearance in both the entry and maneuvering zones. The use of entry and maneuvering zones provides further relief from obstacles. The entry zone is established to control the obstacle clearance prior to proceeding outbound from the PT fix. The maneuvering zone is established to control obstacle clearance AFTER proceeding outbound from the PT fix (see figure 5). See paragraph 231.



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

where
$d_{primary}$ = perpendicular dist (ft) from primary area
W_S = Total width of the secondary area (ft)

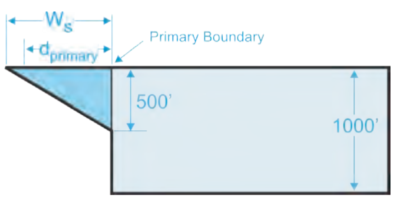
Figure 6. PT INITIAL OBSTACLE CLEARANCE.

d. Descent Gradient. The OPTIMUM descent gradient in the initial approach is 250 ft/mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 ft/mile. Where a PT is established over a FAF, the PT completion altitude should be as close as possible to the FAF altitude. The difference between the PT completion altitude and the altitude over the FAF must not be greater than those shown in table 1B. If greater differences are required for a 5- or 10-mile PT, the PT distance limits and maneuvering zone must be increased at the rate of 1 mile for each 200 feet of required altitude.

altitude loss outbound is required. It is assumed that the descent begins at the plotted position of fix. When the procedure requires a delay before descent of more than five miles, the distance in excess of five miles should be added to the distance the turn commences. The course divergence and penetration turn distance should then be adjusted to correspond to the adjusted turn distance. Extrapolations may be made from the table.

(3) Primary and Secondary Areas. All of the penetration turns area, except the outer two miles of the six-mile obstacle clearance area on the outer side of the penetration track, is primary area. See figure 7. The outer two miles is secondary area. The outer two miles on both sides of the inbound penetration course should be treated as secondary area.

c. Obstacle Clearance. The minimum ROC in the primary area is 1000 feet. The minimum ROC in the secondary area is 500 feet at the primary boundary, tapering uniformly to zero feet at the outer edge.



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

where
$d_{primary}$ = perpendicular dist (ft) from primary area
W_S = Total width of the secondary area (ft)

Where no IF is available, a 10 NM intermediate segment is assumed and intermediate ROC is applied. The controlling obstacle, as well as the minimum altitude selected for the intermediate segment, may depend on the availability of an IF. See figure 8. Adjustments for precipitous terrain must be applied in the penetration turn area as specified in paragraph 3.2.2b of this volume. See paragraph 231.

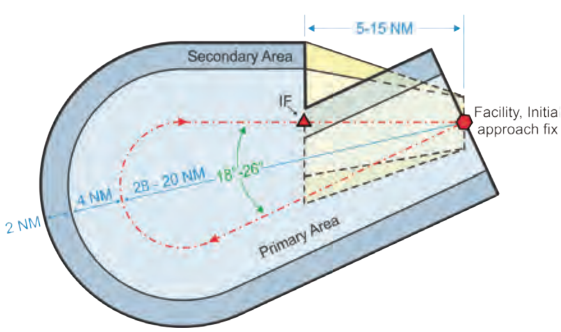


Figure 7. TYPICAL PENETRATION TURN INITIAL APPROACH AREA. Par 235.

d. Descent Gradient. The OPTIMUM descent gradient is 800 ft/mile. The MAXIMUM gradient is 1000 ft/mile.

e. Penetration Turn Altitude. When an IF is NOT provided, the penetration turn completion altitude must not be more than 4000 feet above the FAF altitude.

236. INITIAL APPROACH COURSE REVERSAL USING NONCOLLOCATED FACILITIES AND A TURN OF 120 DEGREES OR GREATER TO INTERCEPT THE INBOUND COURSE. See figures 9-1, 9-2, and 9-3.

a. Common Criteria.

(1) A turn point fix must be established as shown in the figures. The fix error must meet section 8 criteria and must not exceed ± 2 NM.

(2) A flightpath radius of 2.8 NM must be used for procedures where the altitude at the turn point fix is at or before 10000 feet, or 4 NM for procedures where the altitude at the turn point fix is above 10000 feet MSL.

(3) Descent Gradient. Paragraph 232d applies.

(4) Obstacle Clearance. Paragraph 235c applies.

(5) Initial Distance. When the course reversal turn intercepts the extended intermediate course, and when the course reversal turn intercepts a straight segment prior to intercepting the extended intermediate course, the minimum distance between the rollout point and the FAF is 10 NM.

(6) ROC Reduction. No reduction of secondary ROC is authorized in the course reversal area unless the turn point fix is DME.

b. Figures 9-1 and 9-2. The rollout point must be at or prior to the IF/point.

(1) Select the desired rollout point on the inbound course.

(2) Place the appropriate flightpath arc tangent to the rollout point.

(3) From the outbound facility, place the outbound course tangent to the flightpath arc. The point of tangency must be the turn point fix.

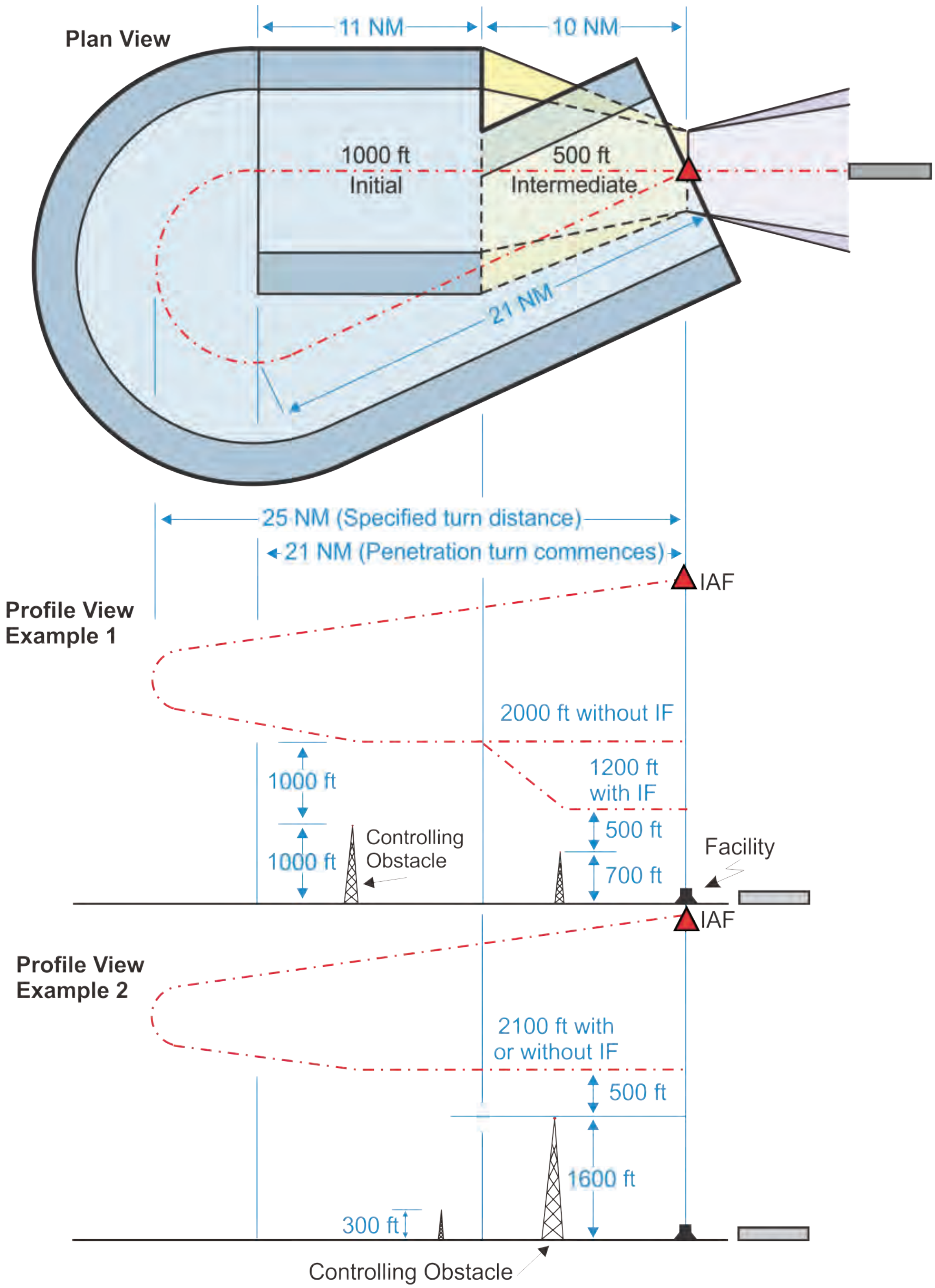
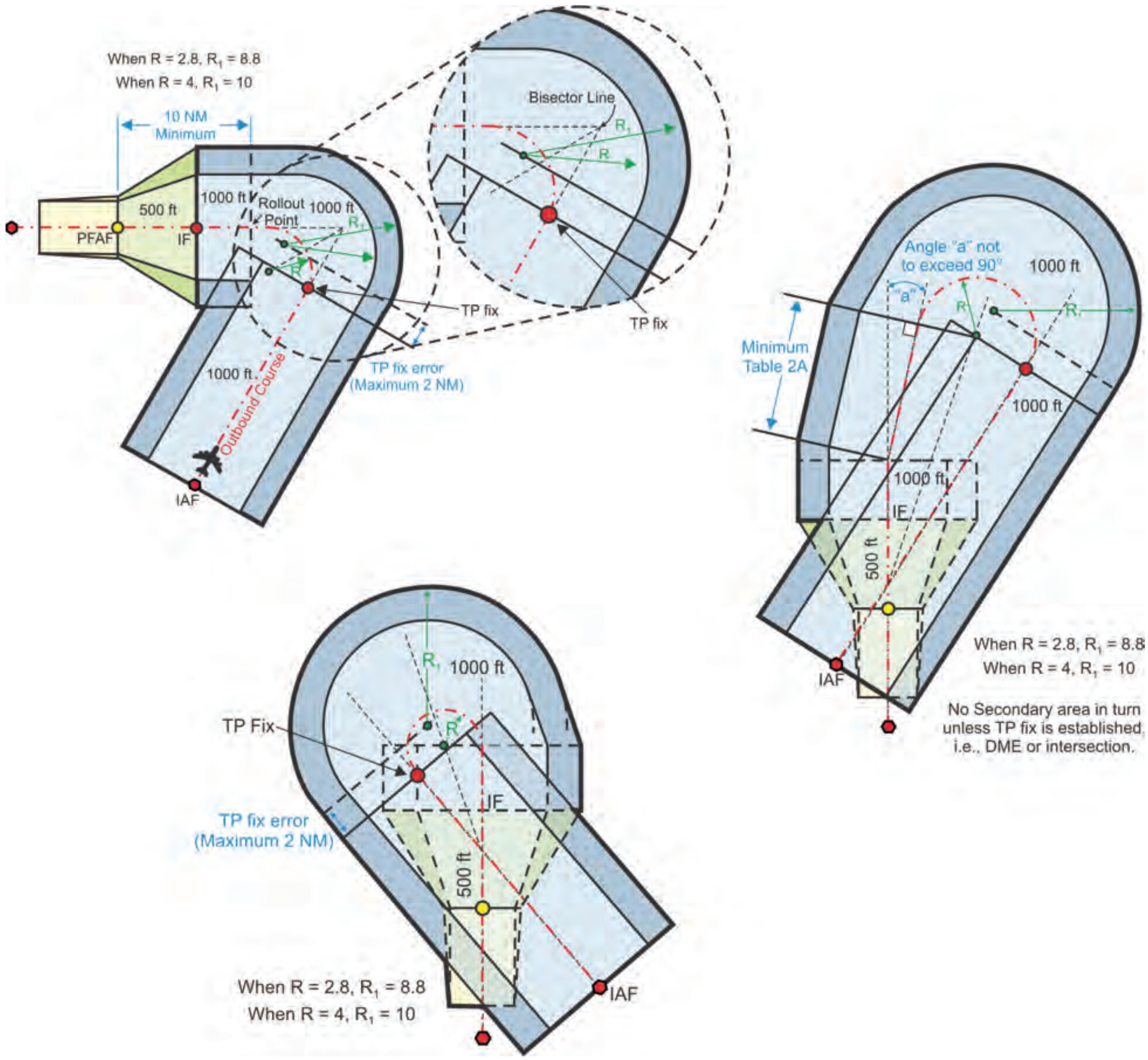


Figure 8. PENETRATION TURN INITIAL APPROACH OBSTACLE CLEARANCE. Par 235c.



Figures 9-1, 9-2, and 9-3. EXAMPLES OF INITIAL APPROACH COURSE REVERSAL. Par 236.

c. Figure 9-3

(1) The point of intersection must be at or prior to the IF/point (paragraph 242 applies). The angle must be 90 degrees or less.

(2) The distance between the roll-out point and the point of intersection must be no less than the distance shown in table 2A.

(3) Paragraph 235 and table 2A should be used for high altitude procedures up to the point of intersection of the two inbound courses.

Table 2A. MINIMUM DISTANCE FROM ROLL OUT POINT TO POINT OF INTERSECTION. Par. 236c(2).

ANGLE "a" (DEGREES)	NM
0 - 15	1
>15 - 30	2
>30 - 45	3
>45 - 60	4
>60 - 75	5
>75 - 90	6

(4) Select the desired point of intersection. From the outbound facility draw a line through the point of intersection.

(5) At the outbound facility, measure the required number of degrees course divergence (may be either side of the line through the point of intersection) and draw the outbound course out the required distance. Connect the outbound course and the line through the point of intersection with the appropriate arc.

(6) Determine the desired rollout point on the line through the point of intersection.

(a) Place the appropriate flightpath arc tangent to the rollout point.

(b) From the outbound facility draw the outbound course tangent to the flight path arc. The point of tangency is the turn point fix.

237.-239. RESERVED.

SECTION 4. INTERMEDIATE APPROACHES

240. INTERMEDIATE APPROACH SEGMENT. This is the segment which blends the initial approach segment into the final approach segment. It is the segment in which aircraft configuration, speed, and positioning adjustments are made for entry into the final approach segment. The intermediate segment begins at the IF, or point, and ends at the PFAF. There are two types of intermediate segments; the "radial" or "course" intermediate segment and the "arc" intermediate segment. In either case, PCG must be provided. See figure 10 for typical approach segments.

241. ALTITUDE SELECTION. Minimum altitudes in the intermediate approach segment must be established in 100-foot increments. The selected altitude must provide the minimum ROC (plus adjustments as specified by paragraph 3.2.2b of this volume); e.g., when obstacle elevation plus ROC equals 701, round up to 800. The altitude selected for arrival over the PFAF must be low enough to permit descent from the PFAF to the airport for a straight-in landing whenever possible. In addition, the altitude selected for the PFAF must not be lower than the highest straight-in or circling MDA (CMDA).

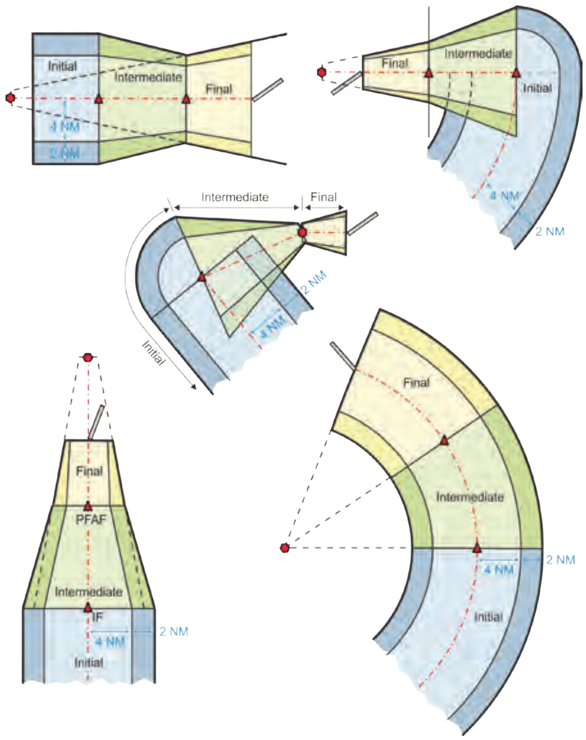


**Figure 10. TYPICAL APPROACH SEGMENTS.
Par 232b and 240.**

242. INTERMEDIATE APPROACH SEGMENT BASED ON STRAIGHT COURSES.

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

b. Area.

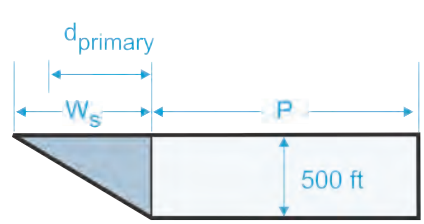
(1) Length. The length of the intermediate segment is measured along the course to be flown. Where the initial segment joins the intermediate segment at angles up to 90 degrees, the MINIMUM length is 5 NM for CAT A/B, and 6 NM for CAT C/D/E (except as specified in volume 1, chapters 9 and 10, and volume 3, chapter 2). Table 3 lists the minimum segment length where the initial approach course joins the intermediate course at an angle greater than 90 degrees (see figure 3). The MAXIMUM segment length is 15 NM. The OPTIMUM length is 10 NM. A distance greater than 10 NM should not be used unless an operational requirement justifies a greater distance.

(2) Width. The width of the intermediate segment is the same as the width of the segment it joins. When the intermediate segment is aligned with initial or final approach segments, the width of the intermediate segment is determined by joining the outer edges of the initial segment with the outer edges of the final segment. When the intermediate segment is not aligned with the initial or final approach segments, the resulting gap on the outside of the turn is a part of the preceding segment and is closed by the appropriate arc (See figure 10). For obstacle clearance purposes, the intermediate segment is divided into a primary and a secondary area.

Table 3. MINIMUM INTERMEDIATE COURSE LENGTH. Par 242b(1).

ANGLE (DEGREES)	MINIMUM LENGTH (MILES)	
	Cat A/B	C/D/E
>90 - 96	5	6
>96 - 102	6	7
>102 - 108	6	8
>108 - 114	6	9
>114 - 120	7	10

c. Obstacle Clearance. The minimum ROC in the primary area is 500 feet. The minimum ROC in the secondary area is 500 feet at the primary boundary, tapering uniformly to zero feet at the outer edge. Adjustments must be applied as specified in paragraph 3.2.2b and 3.2.2c of this volume. See paragraph 241.



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

where

$d_{primary}$ = perpendicular dist (ft) from primary area

W_s = Total width of the secondary area (ft)

d. Descent Gradients. Because the intermediate segment is used to prepare the aircraft speed and configuration for entry into the final approach segment, the gradient should be as flat as possible. The OPTIMUM descent gradient is 150 ft/mile. The MAXIMUM gradient is 318 ft/mile, except for a localizer approach published in conjunction with an ILS procedure. In this case, a higher descent gradient equal to the commissioned GS angle (provided it does not exceed three degrees) is permissible. Higher gradients resulting from arithmetic rounding are also permissible.

NOTE: When the descent gradient exceeds 318 ft/ mile, the procedure specialist should assure a segment is provided prior to the intermediate segment to prepare the aircraft speed and configuration for entry into the final segment. This segment should be a minimum length of five miles and its descent gradient should not exceed 318 ft/mile.

243. INTERMEDIATE APPROACH SEGMENT BASED ON AN ARC. Arcs with a radius of less than seven miles or more than 30 miles from the navigation facility must not be used. DME arc courses must be predicated on DME collocated with a facility providing omnidirectional course information.

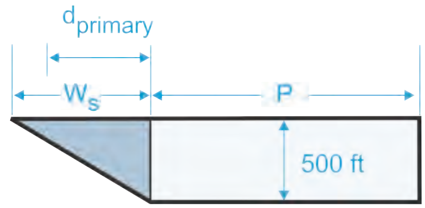
a. Alignment. The same arc must be used for the intermediate and the final approach segments. Turns are not permitted over the PFAF.

b. Area.

(1) Length. The intermediate segment must not be less than five miles nor more than 15 miles in length, measured along the arc. The OPTIMUM length is 10 miles. A distance greater than 10 miles should not be used unless an operational requirement justifies the greater distance.

(2) Width. The total width of an arc intermediate segment is 6 miles on each side of the arc. For obstacle clearance purposes, this width is divided into a primary and a secondary area. The primary area extends four miles laterally on each side of the arc segment. The secondary areas extend two miles laterally on each side of the primary area (see figure 10).

c. Obstacle Clearance. The minimum ROC in the primary area is 500 feet. The minimum ROC in the secondary area is 500 feet at the primary boundary, tapering uniformly to zero feet at the outer edge. Adjustments must be applied as specified in paragraph 3.2.2b and 3.2.2c of this volume. See paragraph 241.



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

where
$d_{primary}$ = perpendicular dist (ft) from primary area
W_S = Total width of the secondary area (ft)

d. Descent Gradients. Criteria specified in paragraph 242d apply.

244. INTERMEDIATE APPROACH SEGMENT WITHIN A PT.

a. PT Over a FAF. When the FAF is a facility (see figure 11).

(1) The MAXIMUM intermediate length is 15 NM, the OPTIMUM is 10 NM, and the MINIMUM is 5 NM. Its width is the same as the final segment at the facility and expanding uniformly to 6 NM on each side of the course at 15 NM from the facility.

(2) The intermediate segment considered for obstacle clearance must be the same length as the PT distance; e.g., if the procedure requires a PT to be completed within 5 NM, the intermediate segment must be only 5 NM long, and the intermediate approach must begin on the intermediate course 5 NM from the FAF.

(3) When establishing a stepdown fix within an intermediate/initial segment underlying a PT area:

(a) Table 1A must be applied.

(b) Only one stepdown fix is authorized within the intermediate segment that underlies the PT maneuvering area.

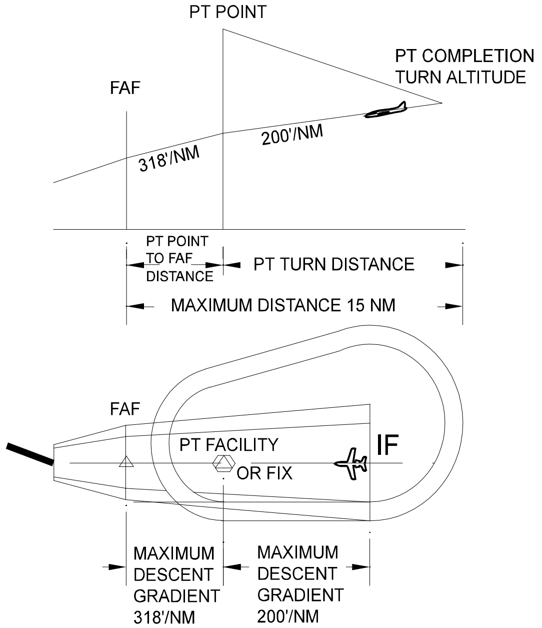
(c) The distance between the PT fix/facility and a stepdown fix underlying the PT area must not exceed 4 NM.

(d) The MAXIMUM descent gradient from the IF point to the stepdown fix is 200 ft/NM. The MAXIMUM descent gradient from the stepdown fix to the FAF is 318 ft/NM.

(3) Intermediate Segment Area.

(a) PT Over a Facility. The intermediate segment starts 15 NM from the facility at a width of 6 NM each side of the inbound course and connects to the width of the final segment at the FAF. The area considered for obstacle clearance is from the start of the PT distance to the FAF.

Figure 14-2. Intermediate Area Within PT Area. PT Facility/Fix Used as a Stepdown Fix [Par 244d(4)].



(b) PT Over a Fix (NOT a Facility). The intermediate segment starts at the PT distance at a width of 6 NM each side of the inbound course and connects to the width of the final segment at the FAF. The area considered for obstacle clearance is from the start of the PT distance to the FAF.

(4) The MAXIMUM descent gradient is 200 ft/NM. If the PT facility/fix is a stepdown fix, the descent gradient from the stepdown fix to the FAF may be increased to a maximum of 318 ft/NM (*see figure 14-2*). The PT distance may be increased in 1 NM increments up to 15 NM to meet descent limitations.

(5) When establishing a step-down fix within an intermediate/initial segment underlying a PT area:

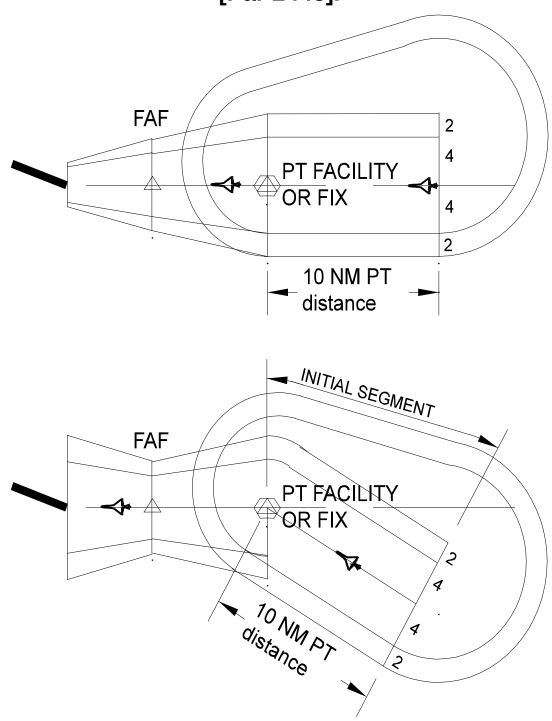
(a) When the PT fix is over a facility/fix prior to the FAF, the facility/fix is the stepdown fix in the intermediate/initial area, and another stepdown fix within this segment is not authorized.

(b) The MAXIMUM descent gradient from the IF point to the stepdown fix is 200 ft/NM. The MAXIMUM descent gradient from the stepdown fix to the FAF is 318 ft/NM.

e. PT Facility Fix Used as an IF. *See figure 14-3.*

(1) When the PT inbound course is the same as the intermediate course, either paragraph 244d may be used, or a straight initial segment may be used from the start of the PT distance to the PT fix.

Figure 14-3. Use of PT Fix or IF [Par 244e].



(2) When the PT inbound course is NOT the same as the intermediate course, an intermediate segment within the PT area is NOT authorized; ONLY a straight initial segment must be used from the start of the PT distance to the PT fix.

(3) When a straight initial segment is used, the MAXIMUM descent gradient within the PT distance is 318 ft/NM; the PT distance may be increased in 1 NM increments up to 15 NM to meet descent limitations.

(4) When establishing a stepdown fix within an intermediate/initial segment underlying a PT area:

(a) Only one stepdown fix is authorized within the initial segment that underlies the PT maneuvering area.

(b) The distance from the PT facility/fix and a stepdown fix underlying the PT area must not exceed 4 NM.

(c) The MAXIMUM descent gradient from the PT completion point (turn distance) to the stepdown fix, and from the stepdown fix to the IF, is 318 ft/NM.

f. When a PT from a facility is required to intercept a localizer course, the PT facility is considered on the localizer course when it is located within the commissioned localizer course width.

245.-249. RESERVED.

SECTION 5. FINAL APPROACH

250. 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 Final Approach Fix (FAF)/precise final approach fix (PFAF) and ends at the missed approach point (MAP) and/or Decision Altitude (DA). Criteria for alignment, length, obstacle evaluation area (OEA), and obstacle clearance surface/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 volume 1, chapter 3, paragraph 3.3.2d).

251. RESERVED.

252. VERTICAL DESCENT ANGLE (VDA). Determine the VDA for all NPA procedures except those published in conjunction with vertically-guided minima or no-FAF procedures w/out stepdown fix(es). Optimum VDA is 3.00 degrees. The VDA must be within the standard VDA range (see below). Flight Standards approval is required if the VDA is less than the angle of a commissioned visual glide slope indicator (VGSI) installed to the same runway. If the final is circling aligned, or if no VGSI is installed, then design procedures at the optimum VDA when possible or within the following range:

<u>STANDARD VDA RANGE</u>

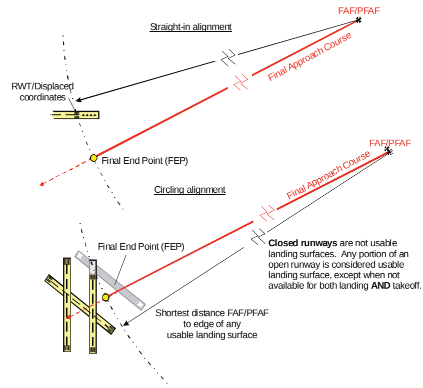
FAA	2.75°-3.77°	(IAPS w/ ≤ CAT C mins)
	2.75°-3.50°	(IAPS w/ CAT D/E mins)
USAF	2.50°-3.50°	(All IAPS)
USN	2.50°-3.77°	(All IAPS)

Note 1: Minimum VDA N/A to circling only procedures.

Note 2: CAT D/E VDA above 3.50 degrees must be annotated "Not for Civil Use."

Calculate VDA based on the distance from the plotted position of the FAF/PFAF or stepdown fix to the plotted position of the final end point (FEP). The FEP is a point on the FAC equal to the distance from the FAF/PFAF to runway threshold (RWT) coordinates (or displaced threshold coordinates when applicable) or from FAF/PFAF to the edge of first usable landing surface for circling only aligned procedures. See figure 14-4.

Figure 14-4. Final End Point [Par 252].



a. Calculating Descent Angle (procedures meeting straight-in alignment). Calculate the VDA from the FAF/PFAF altitude (or stepdown fix altitude per volume 1, 1, chapter 2, paragraphs 252c(1) or 252d) to threshold crossing height (TCH) using the following formula (radian calculations):

$$\theta_{DESCENT} = \mathrm{atan}\left(\ln\left(\frac{r + alt}{r + THRe + TCH}\right) \cdot \frac{r}{D_{FIX}}\right) \cdot \frac{180}{\pi}$$

Where:

atan = arc tangent
ln = Natural logarithm
alt = FAF/PFAF alt. or 252c(1) / 252d stepdown alt.
THRe = Threshold elevation
r = 20890537
TCH = Use volume 3, table 2-3 value that meets minimum and maximum TCH requirements
D_{FIX} = Dist. (ft) FAF/PFAF or stepdown fix to FEP

EXAMPLE

alt = 2,600 ft MSL
THRe = 1,012 ft MSL
TCH = 46 ft
D_{FIX} = 29,420.537 ft or 4.84 NM

$\theta_{DESCENT}$ = 3.00 degrees (round to ***nearest*** 0.01 degrees)

When the maximum VDA calculated in accordance with volume 1, chapter 2, paragraph 252a 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 **IF** less than or equal to maximum VDA calculated in accordance with volume 1, chapter 2, paragraph 252b. In this case, when VDA is published, specify the VDA calculated in accordance with volume 1, chapter 2, paragraph 252a (published angle MAY exceed the maximum).

(1) Determining straight-in FAF/PFAF or step down fix location to achieve a specified design angle. Use where fix location is flexible; e.g., FAF/PFAF or stepdown fix may be defined by an area navigation (RNAV), distance measuring equipment (DME), or intersection fix. 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 (e.g., 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. Determine the FAF/PFAF or stepdown fix location (distance from threshold to fix) using the formula in figure 14-5 (radian calculations).

Figure 14-5. Straight-In FAF/PFAF or Stepdown Fix Distance Based on Altitude and Angle [Par 252a].

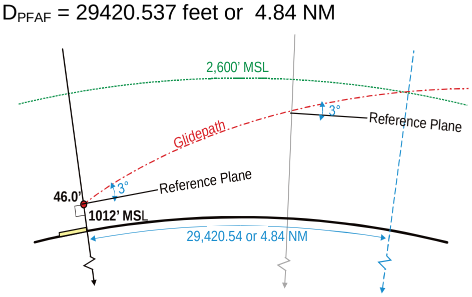
$$D_{PFAF} = \frac{\ln\left(\frac{r + alt}{r + THRe + TCH}\right) \cdot r}{\tan\left(\theta \cdot \frac{\pi}{180°}\right)}$$

Where:

ln = Natural logarithm
alt = Minimum FAF/PFAF or stepdown fix altitude
THRe = Threshold elevation
TCH = VGSI or Design TCH
r = 20890537
θ = VGSI or specified VDA

EXAMPLE

alt = 2600 feet MSL
THRe = 1012 feet MSL
TCH = 46.0
θ = 3.00 degrees
D_{PFAF} = 29420.537 feet or 4.84 NM



b. Calculating VDAs (procedures not meeting straight-in alignment or straight-in aligned procedures not authorized straight-in minimums). Calculate the VDA from the FAF/PFAF or stepdown fix altitude (volume 1, chapter 2, paragraphs 252c(2) or 252d) to the lowest CMDA using the following formula (radian calculations).

$$\theta_{CIRCLEDESCENT} = a\tan\left(\ln\left(\frac{r + alt}{r + CMDA}\right) \cdot \frac{r}{D_{FIX}}\right) \cdot \frac{180°}{\pi}$$

Where:

ln = Natural logarithm
r = 20890537
alt = FAF/PFAF or volume 1, chapter 2, para. 252c(2) / 252d stepdown fix altitude
CMDA = Lowest Published CMDA
D_{FIX} = Dist. (ft) FAF/PFAF or stepdown fix to FEP

EXAMPLE

alt = 2900 feet MSL
CMDA = 1320 feet MSL
D_{FIX} = 29043.83 feet or 4.78 NM
$\theta_{CIRCLEDESCENT}$ = 3.11354 degrees
(round to _nearest_ 0.01 degrees)

When the MAXIMUM VDA is exceeded, relocate the PFAF/stepdown fix and/or raise the CMDA until the angle is compliant.

(1) Determining Circling FAF/PFAF location to achieve a specified design angle. Procedures designed to circling alignment standards are not normally flown using a stabilized descent from the FAF/PFAF to landing. Therefore, the FAF/PFAF location is not ***predicated*** on VDA; however, the achieved angle must not exceed the maximum VDA. Establish the FAF/PFAF location in accordance with the alignment and segment length criteria applicable to the final approach navigational aid (NAVAID) or system and calculate the circling VDA.

c. Stepdown Fixes (with FAF procedures and/or procedures published w/out PA/APV minima). Establish stepdown fixes at the lowest altitude possible that also provides obstacle clearance. When minimum fix altitudes are above the vertical profile of a VDA calculated in accordance with volume 1, chapter 2, paragraph 252a or 252b, adjust the stepdown fix location(s) if feasible. Determine the altitude of the vertical path at a stepdown fix using the following formula (radian calculations).

$$Z_{vertpath} = e^{\frac{D_Z \times \tan\left(\theta \times \frac{\pi}{180°}\right)}{r}} \times (r + base_{alt}) - r$$

Where:

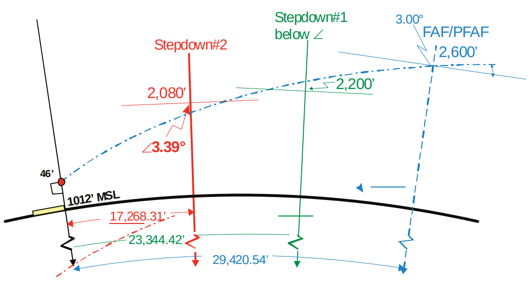
e = base of natural log. (Napier's constant)
D_Z = dist (ft) from FEP to fix
θ = angle calculated in accordance with Vol. 1, chapter 2, paragraph 252a/252b
r = 20890537
$base_{alt}$ = THRe + TCH (Vol. 1, chapter 2, paragraph 252a)
$base_{alt}$ = CMDA (Vol. 1, chapter 2, paragraph 252b)

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).

(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 volume 1, chapter 2, paragraph 252a). Publish the greatest VDA and associate it with the applicable stepdown fix. *See figure 14-6.*

(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 252b) and ensure each angle is less than or equal to the maximum angle.

Figure 14-6. VDA with Stepdown Fixes [Par 252c].



(3) DO NOT raise stepdown fix altitudes higher than needed for obstacle clearance solely to achieve coincidence with the VDA vertical path (USN N/A).

(4) DO NOT establish maximum, mandatory, or mandatory block altitudes at any final segment fix except where operationally required and approved by AFS-400 or appropriate military authority. Flight Standards approval will include a check of the final sub-segment descent rates and will specify necessary restrictions (e.g., do not publish VDA, etc.).

d. Stepdown Fixes (no-FAF procedures). Apply volume 1, chapter 2, paragraph 252a or 252b to calculate the VDA from the stepdown fix. When there are multiple stepdown fixes, also apply volume 1, chapter 2, paragraph 252c, except the vertical path is calculated from the first stepdown fix (farthest from RWT coordinates) instead of from the FAF/PFAF.

253. 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. **ESTABLISH A VDP FOR ALL STRAIGHT-IN NPA PROCEDURES** (to include those combined with a PA/APV procedure), with the following exceptions/limitations:

- Do not publish a VDP when the ***primary*** altimeter setting comes from a remote source.
- Do not publish a VDP located prior to a stepdown fix.
- If the VDP is between the MAP and the runway, do not publish a VDP.
- Do not publish a VDP when the 20:1 surface is penetrated (volume 1, chapter 3, paragraph 3.3.2d).
- When feasible, the VDP **should** be ≥ 1NM from any other final segment fix (e.g., 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.

a. Determine VDP distance. When dual or multiple lines of NPA minimums are published, use the lowest minimum descent altitude (MDA) from any CAT to calculate the VDP distance. Use the following formula to determine VDP distance from RWT coordinates (radian calculations):

$$D_{VDP} = r \cdot \left(\frac{\pi}{2} - \theta \cdot \frac{\pi}{180°} - \operatorname{asin}\left(\frac{\cos\left(\theta \cdot \frac{\pi}{180°}\right) \cdot (r + THRe + TCH)}{r + MDA} \right) \right)$$

Where:
MDA = Lowest Minimum Descent Altitude
THRe = Threshold elevation
TCH = VGSI or Design TCH
r = 20890537
θ = VGSI or specified VDA

(1) For runways served by a VGSI (regardless of coincidence with final VDA), using the VGSI TCH, establish the distance from RWT coordinates 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 volume 3, chapter 2, table 2-3, establish the distance from RWT coordinates to a point where the greater of a three degree or the final segment VDA reaches the appropriate MDA.

b. Marking VDP Location.

(1) For Non-RNAV Standard Instrument Approach Procedures (SIAPs), 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 DME is not available, do not establish a VDP. Maximum fix error is ± 0.5 NM.

Figure 15-2d. Restricted Circling Area (Complex < 180°, Intersecting runways) [Par 261b].

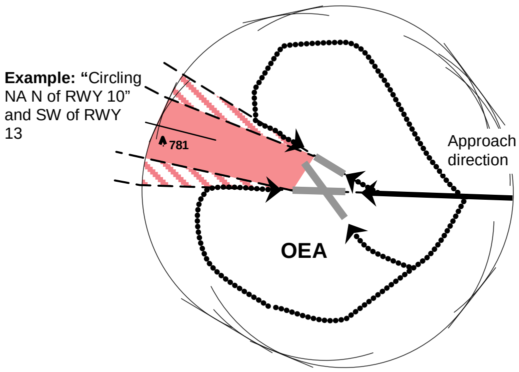


Figure 15-2e. Restricted Circling Area (Complex < 180°, Parallel runways) [Par 261b].

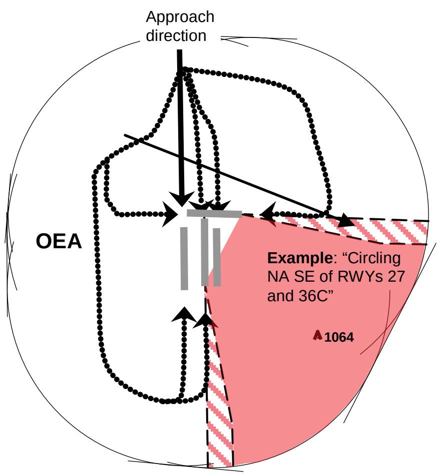
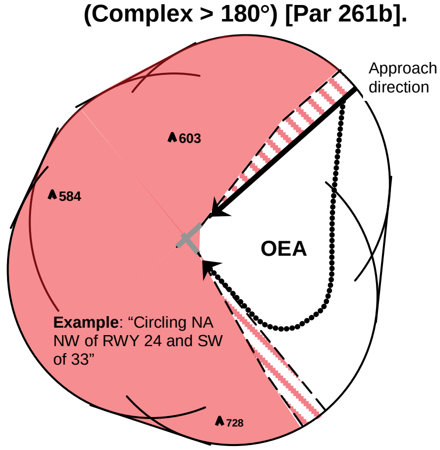


Figure 15-2f. Restricted Circling Area (Complex > 180°) [Par 261b].



262.-269. RESERVED.

SECTION 7. MISSED APPROACH.

270. MISSED APPROACH SEGMENT. A missed approach procedure must be established for each instrument approach procedure (IAP). The missed approach must be initiated at the decision altitude (DA) or MAP in nonprecision approaches. The missed approach procedure must be simple, specify a charted missed approach altitude (altitude at clearance limit), and a clearance limit fix/facility. When required by obstacles or deemed operationally advantageous, the missed approach may also specify an interim "climb-to" altitude to identify a turn point. The charted missed approach altitude must not be lower than the highest DA/MDA (including adjustments) and be sufficient to permit holding or en route flight. Design alternate missed approach procedures using the criteria in this section. The area considered for obstacles has a width equal to that of the final approach area at the MAP or DA point and expands uniformly to the width of the initial approach

(Continued on Page 27)

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segment at a point 15 flying miles from the MAP. When PCG is available, a secondary area for the reduction of obstacle clearance is identified within the missed approach area which has the same width as the final approach secondary area at the MAP, and which expands uniformly to a width of two miles at a point 15 miles from the MAP (see figure 16). Where PCG is not available beyond this point, expansion of the area continues until PCG is achieved or segment terminates. Where PCG is available beyond this point, the area tapers at a rate of 30 degrees inward relative to the course until it reaches initial segment width.

NOTE: Only the primary missed approach procedure may be included on the published chart.

271. MISSED APPROACH ALIGNMENT. Wherever practical, the missed approach course should be a continuation of the FAC. Turns are permitted, but should be minimized in the interest of safety and simplicity.

272. MAP. The MAP specified in the procedure may be the point of intersection of an electronic glidepath with a DA, a navigation facility, a fix, or a specified distance from the FAF. The specified distance may not be more than the distance from the FAF to the usable landing surface. The MAP must **NOT** be located prior to the VDP. Specified criteria for the MAP are contained in the appropriate facility chapters.

273. STRAIGHT MISSED APPROACH AREA. When the missed approach course is within 15 degrees of the final approach course, it is considered a straight missed approach (see figure 16). The area considered for obstacle evaluation is specified in paragraph 270.

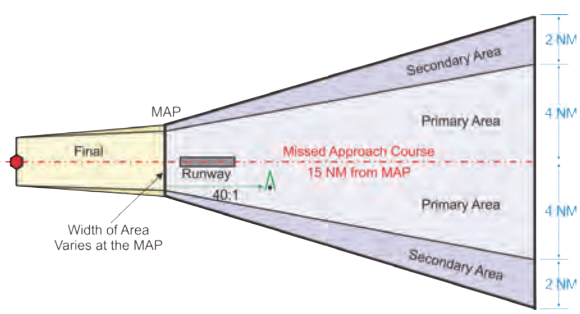


Figure 16. STRAIGHT MISSED APPROACH AREA. Par 270 and 273.

274. STRAIGHT MISSED APPROACH OBSTACLE CLEARANCE. Within the primary missed approach area, no obstacle may penetrate the missed approach surface. This surface begins over the MAP at a height determined by subtracting the required final approach ROC and any minimums adjustments, per paragraph 3.2.2 of this volume from the MDA. It ascends uniformly at the rate of one foot vertically for each 40 feet horizontally (40:1). See figure 17. Where the 40:1 surface reaches a height of 1000 feet below the missed approach altitude (paragraph 270), further application of the surface is not required. In the secondary area, no obstacle may penetrate a 12:1 slope which extends outward and upward from the 40:1 surface at the inner boundaries of the secondary area. See figure 18. Evaluate the missed approach segment to insure obstacle clearance is provided.

a. Evaluate the 40:1 surface from the MAP to the clearance limit (end of the missed approach segment). The height of the missed approach surface over an obstacle is determined by measuring the straight-line distance from the obstacle to the nearest point on the line defining the origin of the 40:1 surface. If obstacles penetrate the surface, take action to eliminate the penetration.

b. The preliminary charted missed approach altitude is the highest of the minimum missed approach obstruction altitude, minimum holding altitude (MHA) established in accordance with paragraph 293a, or the lowest airway minimum en route altitude (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. Round the total value to the nearest hundred foot value.

c. Determine if a climbing in holding pattern (climb-in-hold) evaluation is required (see paragraph 293b).

(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 line defining the origin of the 40:1 surface in the shortest distance and perpendicular 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. Order 7130.3, Holding Pattern Criteria, paragraph 35, 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 293a. If this evaluation requires an increase in the MHA, evaluate the new altitude using the higher speed group specified in paragraph 35. 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.

d. The charted missed approach altitude is the higher of the preliminary charted missed approach altitude or the MHA established under paragraph 274c(3)(b).

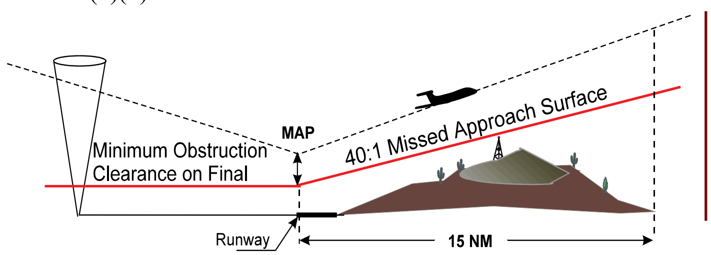
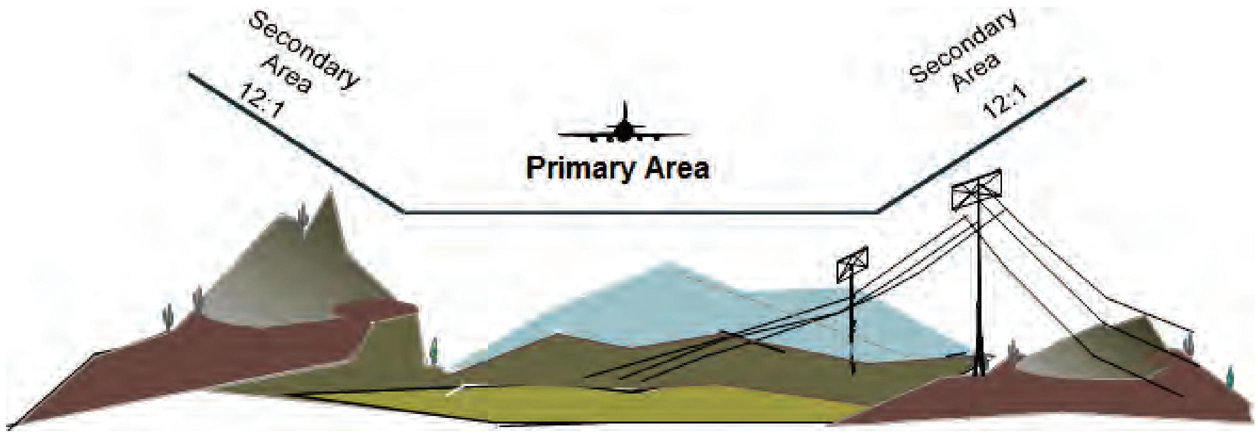


Figure 17. STRAIGHT MISSED APPROACH OBSTACLE CLEARANCE. Par 274.



WHEN COURSE GUIDANCE IS AVAILABLE

Figure 18. MISSED APPROACH CROSS SECTION. Par 274.

275. TURNING MISSED APPROACH AREA. (See volume 3 for special provisions). If a turn of more than 15 degrees from the FAC is required, a turning or combination straight and turning missed approach area must be constructed.

NOTE: If the HAT value associated with the DA/MDA is less than 400 feet, construct a combination straight and turning missed approach (see paragraph 277) to accommodate climb to 400 feet above touchdown zone elevation prior to turn.

a. The dimensions and shape of this area are affected by three variables:

(1) Width of final approach area at the MAP.

(2) All categories of aircraft authorized to use the procedure.

(3) Number of degrees of turn required by the procedure.

288. USING FIXES FOR DESCENT.

a. Distance Available for Descent. When applying descent gradient criteria applicable to an approach segment (initial, intermediate or final approach areas), the measuring point is the plotted position of the fix (see figure 33).

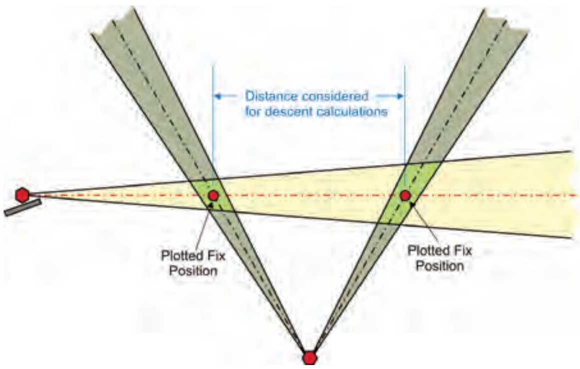


Figure 33. DISTANCE FOR DESCENT GRADIENT APPLICATION. Par 288a.

b. Obstacle Clearance After Passing a Fix. It is assumed that descent will begin at the earliest point the 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 displacement area as it does over those in the approach segment which is being entered (see figures 34-1 and 34-2).

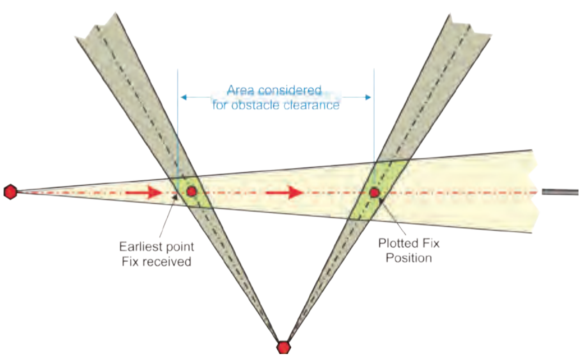


Figure 34-1. OBSTACLE CLEARANCE AREA BETWEEN FIXES. Par 288b.

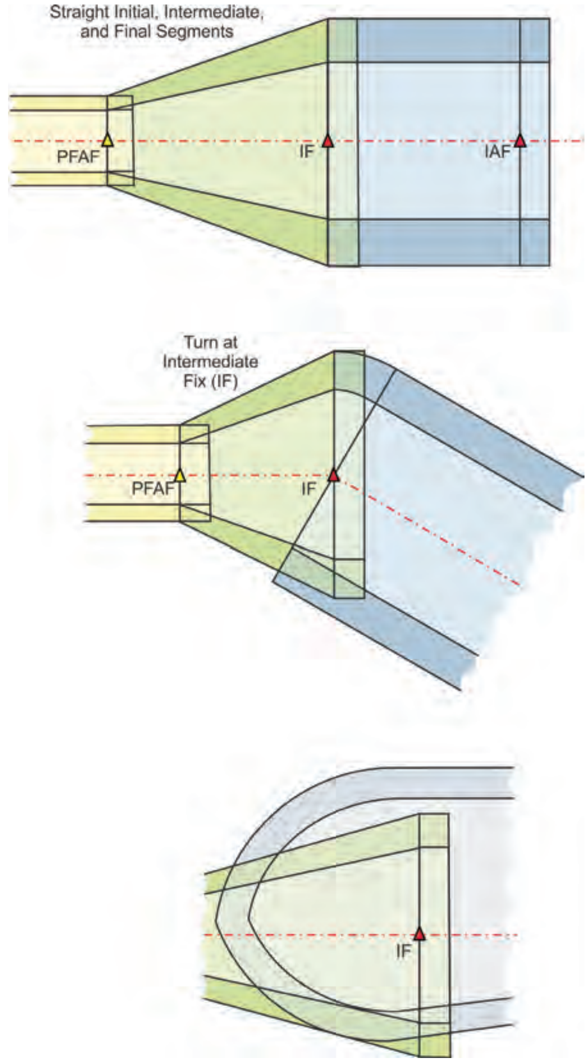


Figure 34-2. CONSTRUCTION OF FIX DISPLACEMENT AREA FOR OBSTACLE CLEARANCE. Par 288b.

c. Stepdown Fixes. See figure 35.

(1) DME, Along Track Distance (ATD) or Radar Fixes. Except in the intermediate segment within a procedure turn (paragraph 244), there is no maximum number of stepdown fixes in any segment when DME, an ATD fix, or radar is used. DME and ATD fixes may be denoted in tenths of a mile. The distance between fixes must not be less than 1 mile.

(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 the last stepdown fix in final must be formed using the same crossing facility.

(c) Apply table 5A to determine the number of stepdown fixes permitted in the initial segment. The distance between fixes must not be less than 1 mile.

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

(4) In the Final Segment:

(a) 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.

(b) 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 final must not exceed 1 NM.

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

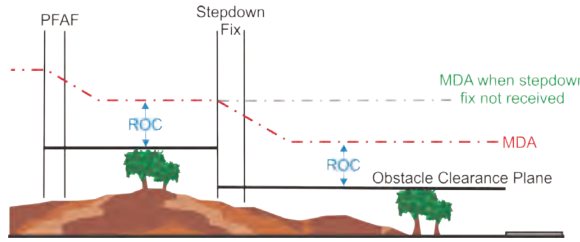


Figure 35. FINAL SEGMENT STEPDOWN FIX. Par 288c.

Table 5A. STEPDOWN FIXES IN INITIAL SEGMENT. Par 288c(2)(c).

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

289. OBSTACLES CLOSE TO A FINAL APPROACH OR STEPDOWN FIX. Obstacles close to the PFAF/stepdown fix 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 FAF/stepdown fix can first be received, and

b. The obstacle does not penetrate a 7:1 (fixed wing) or 3.5:1 (helicopter only) obstacle identification surface (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 applicable adjustments from paragraph 3.2.2 of this volume) from the minimum altitude required at the fix. The surface slopes downward 1 foot vertically for each 7 feet horizontally (3.5 feet for helicopter only procedures) toward the MAP.

c. Obstacles eliminated from consideration by application of this paragraph must be noted on the procedure.

d. The following formulas 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.

Fix Alt = MSL altitude at the fix (round up IAW 288c.(3).)
Obst Dist = Distance from earliest fix reception to obstacle
ROC = Required Obstacle Clearance + adjustments
Obst Elev = MSL obstacle elevation
Slope = 7 (use 3.5 for helicopter only procedures)

$$OIS\ height = FixAlt - ROC - \left[\frac{Obst\ Dist}{Slope}\right]$$

$$MinFixAlt = ObstElev + ROC + \left[\frac{Obst\ Dist}{Slope}\right]$$

See figure 36. To determine fix error, see paragraphs 284, 285, and 286.

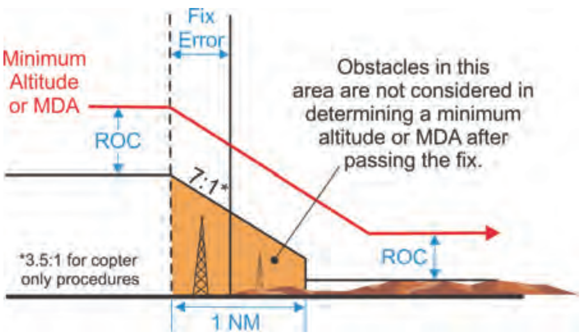


Figure 36. OBSTACLES CLOSE-IN TO A FIX. Par 289.

SECTION 9. HOLDING

290. HOLDING PATTERNS. Criteria for holding pattern airspace are contained in Order 7130.3, and provide for separation of aircraft from aircraft. The criteria contained herein deal with the clearance of holding aircraft from obstacles.

291. ALIGNMENT. Whenever practical, holding patterns should be aligned to coincide with the flight course to be flown after leaving the holding fix. However, when the flightpath to be flown is along an arc, the holding pattern should be aligned on a radial. When a holding pattern is established at a FAF and a PT is not used, the inbound course of the holding pattern must be aligned to coincide with the FAC unless the FAF is a facility. When the FAF is a facility, the inbound holding course and the FAC must not differ by more than 30 degrees.

292. AREA.

a. The primary obstacle clearance area must be based on the appropriate holding pattern area specified in Order 7130.3.

b. No reduction in the pattern sizes for 'on-entry' procedures is permitted.

c. Pattern number 4 is the minimum size authorized.

d. When holding is at an intersection or RNAV fix, the selected pattern must be large enough to contain at least 3 corners of the fix displacement area. See paragraphs 284 and 285 and figure 37-1.

e. When paragraph 293b is used, the primary holding area must encompass the departure or missed approach segment width at the holding fix (see figure 37-2).

f. A secondary area two miles wide surrounds the perimeter of the primary area

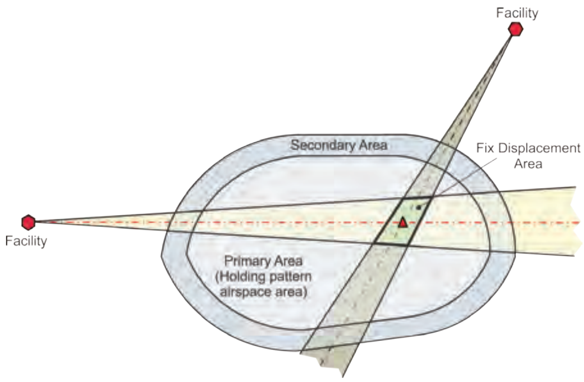


Figure 37-1. HOLDING PATTERN TEMPLATE APPLICATION. Par 292.

293. OBSTACLE CLEARANCE.

a. Level Holding. The minimum ROC in the primary area is 1000 feet. The minimum ROC in the secondary area is 500 feet at the primary boundary, tapering uniformly to zero feet at the outer edge. For computation of obstacle clearance in the secondary area see paragraph 232c. Adjustments for precipitous terrain must be applied as stated in paragraph 3.2.2b of this volume. Establish minimum holding altitudes in 100-foot increments. The selected altitude must provide the minimum ROC (plus adjustments as specified by paragraph 3.2.2b of this volume); e.g., when obstacle elevation plus ROC and adjustments equals 1501, round up to 1600 feet.

b. Climbing in a Holding Pattern. When a climb in hold is used, as in a departure or missed approach, no obstacle may penetrate the holding surface. This surface begins at the end of the segment leading to the holding fix. Its elevation is that of the departure OIS or missed approach surface at 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 distance to any obstacle is measured from the obstacle to the nearest point on the end of the segment at the holding fix. See figure 37-2 and Order 7130.3, paragraph 35.

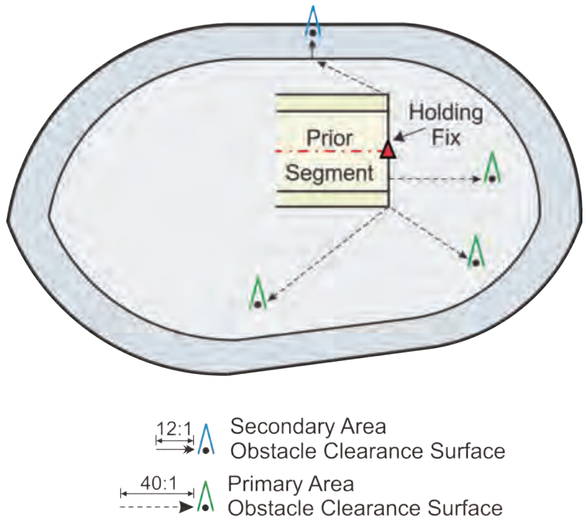


FIGURE 37-2. CLIMBING IN A HOLDING PATTERN. Par 293b.

294. - 299. RESERVED.

Chapter 3. Takeoff and Landing Minimums.
Section One. General Information.

3.0 Application.

The minimums specified in this chapter are the lowest that can be approved through TERPS application at any location for the type of navigation facility concerned. Category (CAT) II/III visibility minima calculation methods and elements are located in volume 3, appendix 1.

3.1 Establishment.

Establish the lowest minimums permitted by the criteria contained in this order. Specify minimums for each condition indicated in the procedure; i.e., straight-in, circling, alternate, and takeoff, as required. List the following minima elements: DA, decision height (DH), minimum descent altitude (MDA), height above touchdown (HAT), height above airport (HAA), height above landing (HAL), or height above surface (HAS) as appropriate, and runway visual range (RVR) or visibility. Alternate minimums, when specified, must be stated as ceiling and visibility. Specify takeoff minimums when required, as visibility only, except where the need to see and avoid an obstacle requires the establishment of a ceiling value. DoD may specify alternate and takeoff minimums in separate directives.

a. Calculate HAT 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 (i.e., 1040 – 633 = 407).

b. Calculate HAA 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 (i.e., 920 – 437 = 483).

Note: Ceiling = (DA/MDA - Airport Elevation) rounded to next higher 100 feet increment. For example, DA 1242 – Airport Elevation 214 = 1028 = Ceiling 1100 feet.

3.1.1 Publication.

3.1.1 a. Publish minimums for each approach category accommodated at the airport.

Note: The Airport Reference Code (ARC) designation of the airport (see Advisory Circular 150/5300-13, Airport Design),is used for airport planning and design only, and does not limit the aircraft that may be able to operate safely at the airport. The set of approach category minimums to publish is made on a case-by-case basis through the RAPT or by appropriate DoD authority, and must accommodate the approach speed (straight-in and circling) of all aircraft expected to use the procedure.

3.1.1 b. Annotate the chart appropriately when one or more approach categories are not authorized. Publish minima for each approach category except those not authorized (e.g., publish only category A and B straight-in minimums when categories C and D are not authorized).

3.1.2 Runway Visual Range (RVR).

RVR is a system of measuring the visibility along the runway. An instrumentally derived value, it represents the horizontal distance a pilot will see down the runway from the approach end. RVR is based on the sighting of either high intensity runway lights or the visual contrast of other targets, whichever yields the greater visual range.

3.1.2 a. Runway Requirements for RVR Approval.

RVR may be published with straight-in landing minima when:

3.1.2 a. (1) RVR equipment is installed to the runway in accordance with the applicable standard (e.g., FAA Standard 008 or appropriate DoD directive).

3.1.2 a. (2) High Intensity Runway Lights are installed to the runway in accordance with appropriate FAA or DoD standards.

3.1.2 a. (3) Runway marking and lighting is appropriate for the intended use. Precision approaches, approaches with vertical guidance (APV), and most nonprecision approach (NPA) procedures require instrument runway markings or touchdown zone and center-line lighting (TDZ/CL). When required runway markings are not available but TDZ/CL is available, RVR equal to the visibility minimum appropriate for the approach light configuration is authorized. See AC 150/5300-13 and AC 150/5340-1, Standards for Airport Markings, for further information.

3.1.3 Approach Lighting Systems.

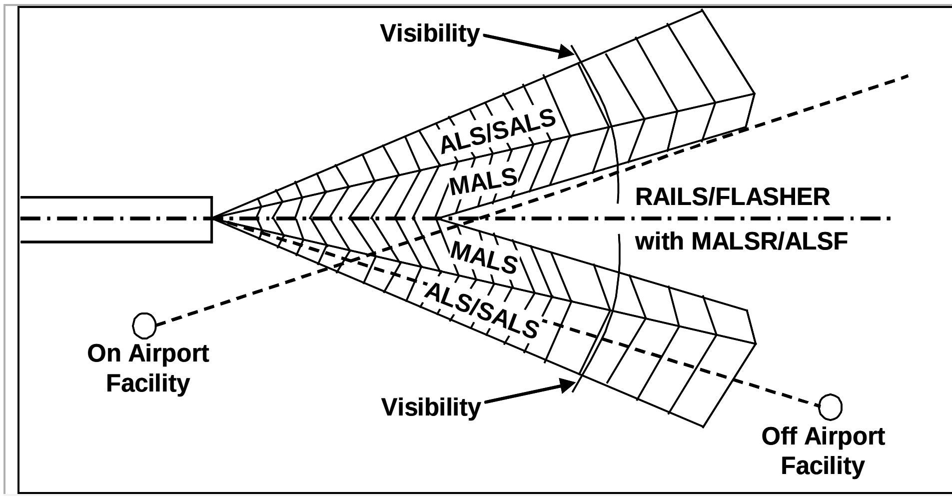
Approach lighting systems extend visual cues to the approaching pilot and make the runway environment apparent with less visibility than when such lighting is not available. For this reason, lower straight-in (not applicable to circling) visibility minimums may be established when standard or equivalent approach lighting systems are present.

3.1.3 a. Standard Lighting Systems.

Table 3-1 provides the types of standard approach and runway lighting systems, as well as the operational coverage for each type. Table 3-2 provides United States and international lighting system classifications.

an "off-airport" facility may be restricted to a standard approach light system (ALSF) or short approach lighting system (SALS) for visibility credit. See figure 3-1.

Figure 3-1. *Application of Lateral Coverage Angles of Table 3-2.*



3.1.3 b. (3) For PA and APV procedures, the TCH must not exceed the upper limit value specified by table 3-3**.**

3.1.3 c. Other Lighting Systems.

Standard system variations, and other systems not included in this chapter, must meet the specified operational conditions in paragraph 3.1.3.b to receive visibility reduction credit. The provisions of volume 1, paragraph 141, govern civil airport lighting systems which do not meet known standards, or for which criteria does not exist. DoD lighting systems may be equated to standard systems for visibility reduction, as illustrated in appendix 5. Where existing systems vary from appendix 5 configurations and cannot be equated to a standard system, consult the appropriate approving authority for special consideration.

Table 3-3. *PA/APV Threshold Crossing Height Upper Limits for Allowing Visibility Credit for Authorized Lighting Systems.*

HAT (Feet)	GLIDEPATH ANGLE (Degrees)	TCH UPPER LIMIT (Feet)
* 200 to 249	# 2.50 - 3.20	75
	3.21 - 3.30	70
	3.31 - 3.40	66
	3.41 - 3.50	63
	3.51 - 3.60	59
	3.61 - 3.70	55
	3.71 - 3.80	50
	3.81 - 3.90	47
	3.91 - 4.00	43
	4.01 - 4.10	39
	4.11 - 4.20	35
250 to 269	# 2.50 - 4.10	75
	4.11 - 4.20	71
	4.21 - 4.30	67
	4.31 - 4.40	62
	4.41 - 4.50	58
	4.51 - 4.60	54
	4.61 - 4.70	50
	4.71 - 4.80	45
	4.81 - 4.90	41
	4.91 - 5.00	37
270 to 299	# 2.50 - 4.40	75
	4.41 - 4.50	73
	4.51 - 4.60	68
	4.61 - 4.70	64
	4.71 - 4.80	59
	4.81 - 4.90	55
	4.91 - 5.00	51

HAT (Feet)	GLIDEPATH ANGLE (Degrees)	TCH UPPER LIMIT (Feet)
300 to 349	# 2.50 - 4.90	75
	4.91 - 5.00	71
	5.01 - 5.10	66
	5.11 - 5.20	61
	5.21 - 5.30	56
	5.31 - 5.40	52
	5.41 - 5.50	48
	5.51 - 5.60	43
	5.61 - 5.70	39
350 and above	# 2.50 - 5.60	75
	5.61 - 5.70	70
	5.71 - 5.80	65
	5.81 - 5.90	60
	5.91 - 6.00	55
	6.01 - 6.10	50
	6.11 - 6.20	45
	6.21 - 6.30	40
	6.31 - 6.40	35

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

GPA < 3.0 DoD only

Chapter 3. Takeoff and Landing Minimums.
Section Two. Establishing Minimum Altitudes/Heights.

3.2 Establish minimum altitudes/heights for each authorized approach CAT.

3.2.1 Minimums altitudes/heights types are:

3.2.1 a. Decision Altitude (DA). A DA is a specified minimum altitude (feet MSL) in a PA or APV instrument approach procedure 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. Determine the DA using the appropriate criteria and round the published value to the next higher one-foot increment (234.10 rounds to 235).

3.2.1 b. Decision Height (DH). RESERVED.

3.2.1 c. Radio Altimeter (RA). See current CAT II/III ILS guidance.

3.2.1 d. Minimum Descent Altitude (MDA). MDA represents the final approach minimum altitude for NPA instrument approach procedures. Each published MDA must be expressed in feet MSL rounded to the next higher 20-foot increment. Apply criteria as specified by the applicable chapter/criteria to determine the MDA.

3.2.1 d. (1) Each straight-in (SI) approach MDA must provide at least the minimum Final Approach Segment (FAS) and Missed Approach Segment (MAS) Required Obstacle Clearance (ROC) as specified by the applicable chapter/criteria.

3.2.1 d. (2) Each circling MDA (CMDA) HAA must be no lower than that specified in paragraph 3.3.3 and table 3-9. Each CMDA must provide the minimum ROC in the circling maneuvering area and meet the missed approach requirements specified in paragraph 3.2.1d(1). Each published CMDA must provide the minimum required final obstacle clearance in the final approach segment and the minimum required circling obstacle clearance in the circling approach area. Each CMDA must not be above the PFAF altitude and, when applicable, below the straight-in MDA (same CAT) for the highest line of NPA minima on the same chart.

Note: When dual minimums are authorized, the CMDA is compared against the SI MDA associated with the corresponding minima set (i.e., circling with stepdown minimums checked against SI with stepdown minimums).

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

3.2.2 a. For PA/APV approaches, determine the minimum HAT based on glidepath angle for each aircraft category using table 3-4.

Table 3-4. Minimum HAT for PA and APV Approach Procedures.

	Aircraft Category			
Glidepath Angle	A	B	C	D & E
2.50° - 2.99° (Military only)	200[1,2]			
3.00° - 3.10°	200[1,2,4]			
3.11° - 3.30°	200[2,4]		250	Not authorized[5]
3.31° - 3.60°	200[2,3,4]		270[4]	Not authorized[5]
3.61° - 3.80°	200[2,3,4]		Not authorized	
3.81° - 4.20°	200[3,4]	250	Not authorized	
4.21° - 5.00°	250	Not authorized		
5.01° - 5.70°	300	Not authorized		
5.71° - 6.40° Airspeed NTE 80 knots	350	Not authorized		

1. PAR minimum HAT = 100 (Military only)
2. LNAV/VNAV and RNP SAAAR minimum HAT = 250
3. LPV w/GPA > 3.5° = 250
4. LDA w/GS = 250
5. USN = 250

3.2.2 **b. Precipitous terrain adjustments.** 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. Evaluate and identify terrain as precipitous or non-precipitous using software implementing the FAA-approved algorithms developed for this purpose (not applicable to USAF).

Note: FAA precipitous terrain algorithms were designed to evaluate instrument approach and feeder segments. Do not use software implementing these algorithms for other TERPS evaluations (e.g., radar vectoring altitude charts, TAA, or other evaluations not addressed in the June 18, 2004 AFS memorandum, subject Automated Precipitous Terrain Adjustments). Use manual methods until otherwise directed by AFS-400.

3.2.2 b. (1) Precipitous terrain identified in the final segment. For conventional NPA approaches, increase ROC values by the amount specified by the software/algorithms (USAF; by the amount deemed appropriate by the specialist/approving authority). For PA/non-Baro 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, e.g., 200 feet increases to 220 feet, 350 feet increases to 385 feet, and recalculate the DA. Do not include adjustments for RASS before determining the precipitous terrain adjustment.

3.2.2 b. (2) Precipitous terrain identified in other approach segments will not directly affect landing minimums, but will impact ROC/minimum altitudes in that segment.

3.2.2 b. (3) Precipitous terrain identified in feeder segments/TAAs in a designated mountainous area. No increase is required, but ROC may not be reduced from 2000 feet (see volume 1, chapter 17, paragraph 1720).

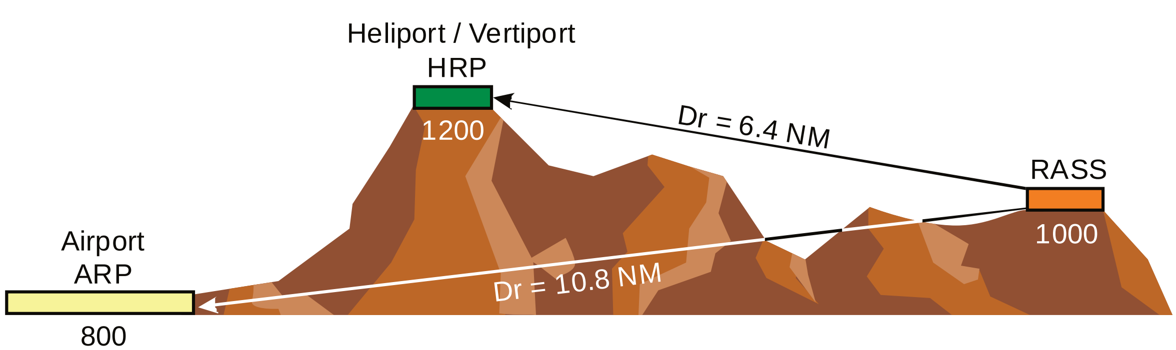
3.2.2 b. (4) Precipitous terrain identified in other segments. When the criteria applicable to the segment requires a precipitous terrain adjustment, increase ROC values by the amount specified by the software/algorithms. (USAF; by the amount deemed appropriate by the specialist/approving authority).

3.2.2 c. Remote Altimeter Setting Source (RASS). Not applicable to minimum safe/sector altitude (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 nautical miles (NM) from the Airport Reference Point (ARP) for an airport, or the Heliport Reference Point (HRP) for a heliport or vertiport, a RASS adjustment must be considered. A remote altimeter-setting source 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 to apply, evaluate the terrain between the RASS and the airport/heliport/vertiport for adverse atmospheric pressure pattern effect. Solicit the best available climatological information from the National Weather Service (NWS), the National Aviation Weather Advisory Unit (NAWAU), the Center Weather Service Unit (CWSU), and the local Flight Service Station (FSS).

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

3.2.2 c. (1) Where intervening terrain does not adversely influence atmospheric pressure patterns, use formula 3-1a to compute the basic RASS adjustment in feet. See figure 3-1a.

Figure 3-1a. Basic RASS adjustment (no intervening terrain).



Formula 3-1a. Basic RASS Adjustment (no Intervening terrain).

$$\text{Adjustment} = 2.30D_r + 0.14E_1$$

Where D_r = horizontal dist (NM) altimeter source to ARP/HRP*
E_1 = elevation differential (feet) between RASS elevation and airport/heliport/vertiport elevation

* Copter PinS Approaches. 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

Examples:

<u>Airport</u>
D_r = 10.8 NM
E_1 = 1000 - 800 = 200 feet

(2.30 * 10.8) + (0.14 * 200) = 52.84 feet basic RASS adjustment
In intermediate segment: 52.84 * 0.6 < 200 (no ROC increase)
In PA/APV final segment: DH = 200 + 52.84 = increase DH 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 * 6.4) + (0.14 * 200) = 42.72 feet basic RASS adjustment
In intermediate segment 42.72 * 0.6 < 200 (no ROC increase)
In PA/APV final segment: DH = 200 + 42.72 = increase DH to 243
In NPA final segment: 1225 (Controlling obs) + 250 ROC + 42.72 = 1520 MDA

3.2.2 c. (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 and the RASS, and includes a circular area enclosed by a 5 NM radius at each end of this line. Use formula 3-1b to compute the basic RASS adjustment in feet. See figure 3-1b.

Formula 3-1b. Basic RASS Adjustment (Intervening Terrain)

$$\text{Adjustment} = 2.30D_r + 0.14E_2$$

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. 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

Table 3-5a. Authorized Straight-in RVR/Visibility,
(<u>except</u> CAT A and B NPA, CAT II/III ILS, SA CAT I/II ILS and helicopters).

HAT Range			FALS			IALS			BALS			NALS		
			RVR	SM	M	RVR	SM	M	RVR	SM	M	RVR	SM	M
		200	1800[1,2], 2400	1/2	550[1,2], 750	4000	3/4	1200	4000	3/4	1200	4000	3/4	1200
201	-	210	1800[1], 2400	1/2	550[1], 750	4000	3/4	1200	4000	3/4	1200	4000	3/4	1200
211	-	220	1800[1], 2400	1/2	550[1], 750	4000	3/4	1200	4000	3/4	1200	4000	3/4	1200
221	-	230	1800[1], 2400	1/2	550[1], 750	4000	3/4	1200	4000	3/4	1200	4000	3/4	1200
231	-	240	1800[1], 2400	1/2	550[1], 750	4000	3/4	1200	4000	3/4	1200	4000	3/4	1200
241	-	250	1800[1], 2400	1/2	550[1], 750	4000	3/4	1200	4000	3/4	1200	4000	3/4	1300
251	-	260	1800[1], 2400	1/2	600[1], 750	4000	3/4	1200	4000	3/4	1200	4000	3/4	1300
261	-	280	2000[1], 2400	1/2	600[1], 750	4000	3/4	1200	4000	3/4	1200	4500	7/8	1300
281	-	300	2200[1], 2400	1/2	650[1], 750	4000	3/4	1200	4000	3/4	1200	4500	7/8	1400
301	-	320	2400	1/2	700[1], 750	4000	3/4	1200	4000	3/4	1200	4500	7/8	1400
321	-	340	2600	1/2	800	4000	3/4	1200	4500	7/8	1300	5000	1	1500
341	-	360	3000	5/8	900	4000	3/4	1200	4500	7/8	1400	5500	1	1600
361	-	380	3500	5/8	1000	4000	3/4	1300	5000	1	1500	5500	1	1700
381	-	400	3500	5/8	1100	4500	7/8	1400	5000	1	1600	6000	1 1/8	1800
401	-	420	4000	3/4	1200	5000	1	1500	5500	1	1700	6000	1 1/8	1900
421	-	440	4000	3/4	1300	5000	1	1600	6000	1 1/8	1800		1 1/4	2000
441	-	460	4500	7/8	1400	5500	1	1700	6000	1 1/8	1900		1 3/8	2100
461	-	480	5000	1	1500	6000	1 1/8	1800		1 1/4	2000		1 3/8	2200
481	-	500	5000	1	1500	6000	1 1/8	1800		1 1/4	2100		1 3/8	2300
501	-	520	5500	1	1600		1 1/4	1900		1 3/8	2100		1 3/8	2400
521	-	540	5500	1	1700		1 1/4	2000		1 3/8	2200		1 1/2	2400
541	-	560	6000	1 1/8	1800		1 3/8	2100		1 3/8	2300		1 5/8	2500
561	-	580		1 1/4	1900		1 3/8	2200		1 1/2	2400		1 5/8	2600
581	-	600		1 1/4	2000		1 3/8	2300		1 5/8	2500		1 3/4	2700
601	-	620		1 3/8	2100		1 1/2	2400		1 5/8	2600		1 3/4	2800
621	-	640		1 3/8	2200		1 1/2	2500		1 3/4	2700		1 3/4	2900
641	-	660		1 3/8	2300		1 5/8	2600		1 3/4	2800		1 7/8	3000
661	-	680		1 1/2	2400		1 3/4	2700		1 3/4	2900		1 7/8	3100
681	-	700		1 1/2	2500		1 3/4	2800		1 7/8	3000		2	3200
701	-	720		1 5/8	2600		1 3/4	2900		1 7/8	3100		2	3300
721	-	740		1 5/8	2700		1 3/4	3000		2	3200		2	3400
741	-	760		1 3/4	2700		1 7/8	3000		2	3300		2	3500
761	-	800		1 3/4	2900		2	3200		2	3400		2 1/2	3600
801	-	850		1 7/8	3100		2	3400		2 1/2	3600		2 1/2	3800
851	-	900		2	3300		2 1/2	3600		2 1/2	3800		2 1/2	4000
901	-	950		2	3600		2 1/2	3900		2 1/2	4100		2 1/2	4300
951	-	1000		2 1/2	3800		2 1/2	4100		2 1/2	4300		3	4500
1001	-	1100		2 1/2	4100		2 1/2	4400		3	4600		3	4900
1101	-	1200		3	4600		3	4900		3	5000		3	5000
1201	-	Above		3	5000		3	5000		3	5000		3	5000

1. Category I PA with TDZ/CL lights.

2. Category I PA <u>without</u> TDZ/CL lights when authorized by Order 8400.13. See Order 8260.19 for charting/annotations.

Table 3-5b. U.S. Military Standard Minimums
PAR with HAT < 200 feet (all CATs)

ALS TDZ/CL			ALS/SSALR/SALS/SSALR			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	½	750

Table 3-6. 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 and above	4000	3/4	1200	5500	1	1600	5500	1	1600	6000	1 1/4	2000

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

Table 3-7. 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]	800[1]	4000[2]	3/4	1200	4000	3/4	1200	5500	1	1600
741-950	4000	3/4	1200	5500	1	1600	5500	1	1600	6000	1 1/4	2000
951-above	5500	1	1600	6000	1 1/4	2000	6000	1 1/4	2000		1 1/2	2400

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

Table 3-8. Minimum Straight-in RVR/Visibility NPA Procedures CAT C/D/E

Procedure Design:					
- 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

3.3.2 b. Step 2. Determine visibility based on MAP/DA to LTP distance [see figure 3-2]:

3.3.2 b. (1) When the NPA MAP is located at or after the LTP, proceed to Step 3. Otherwise, determine the distance from the NPA MAP (plotted position) or PA/APV DA to the LTP. When authorized by paragraph 3.1.3b, subtract the ALS length (2400 feet for FALS, 1400 feet for IALS, and 700 feet for BALS). When this distance is less than or equal to the visibility from Step 1, use the Step 1 value. When greater than the visibility from Step 1, use the next higher visibility value (RVR or SM) from the applicable table or the next higher whole SM when the distance exceeds 3 SM.

CHAPTER 9. LOCALIZER AND LOCALIZER TYPE DIRECTIONAL AIDS (LDA)

900. FEEDER ROUTES, INTIAL APPROACH, AND INTERMEDIATE SEGMENTS. These criteria are contained in chapter 2, section 3. When associated with a precision approach procedure, volume 3, paragraph 2.3 applies.

901. USE OF LOCALIZER ONLY. Where no usable glidepath is available, a localizer-only (front or back course) approach may be approved, provided the approach is made on a LOC from a PFAF located within 10 miles of the runway threshold. Criteria in this section are also applicable to procedures based on localizer type directional aids (LDA). Back course procedures must not be based on courses that exceed six degrees in width and must not be approved for offset LOC.

902. ALIGNMENT. Localizers which are aligned within 3 degrees of the runway alignment must be identified as localizers. If the alignment exceeds 3 degrees, they will be identified as LDA facilities. The alignment of the course for LDA facilities must meet the final approach alignment criteria for VOR on-airport facilities. See chapter 5, paragraph 513, and figure 48.

903. AREA. The final approach dimensions are specified in figure 75. However, only that portion of the final approach area that is between the PFAF and the runway need be considered as the final approach segment for obstacle clearance purposes. The optimum length of the final approach segment is five miles. The MINIMUM length of the final approach segment must be sufficient to provide adequate distance for an aircraft to make the required descent. The area must be centered on the FAC and must commence at the runway threshold. For LDA procedures, the final approach area must commence at the facility and extend to the PFAF. The MAP for LDA procedures must not be farther from the PFAF than a point adjacent to the landing threshold perpendicular to the FAC. Calculate the width of the area using the following formulae:

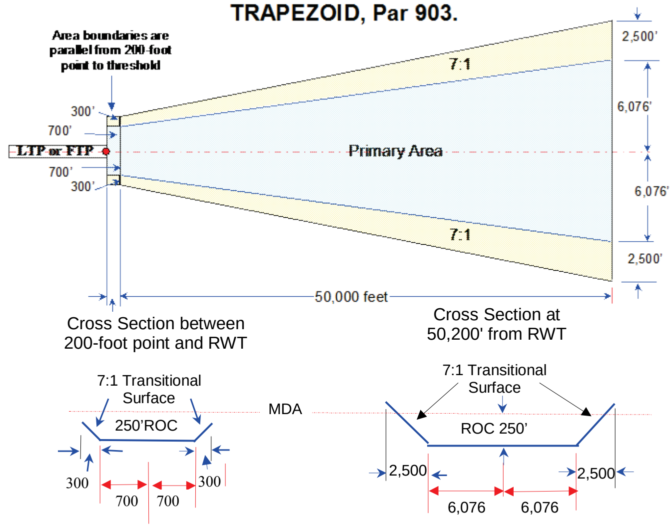
Perpendicular Width from RCL to the Edge of the Primary = $0.10752(D-200)+700$

Perpendicular Width from RCL to the Edge of the Transitional Sfc = $0.15152(D-200)+1000$

Where D = Distance (feet) from RWT measured along RCL

904. OBSTACLE CLEARANCE. The minimum ROC in the final approach area is 250 feet. In addition, the MDA established for the final approach area must assure that no obstacles penetrate the 7:1 transitional surfaces.

Figure 75. LOCALIZER FINAL TRAPEZOID, Par 903.



905. DESCENT GRADIENT. Paragraph 252 of this volume applies.

906. MDA. The lowest altitude on final approach is specified as an MDA. Apply adjustments as specified in paragraph 3.2.2 of this volume.

907. MISSED APPROACH SEGMENT. The criteria for the missed approach segment are contained in chapter 2, section 7. The MAP is on the FAC not farther from the PFAF than the runway threshold (first usable portion of the landing area for circling approach), and must be at least 3000 feet from the LOC/LDA facility. The missed approach surface must commence over the MAP at the required height (see paragraph 274).

908.-909. RESERVED

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Chapter 10. Radar Approach Procedures and Vectoring Charts

Section 1. General Information.

10.0 General.

This chapter applies to radar approach procedures and vectoring charts utilizing ground-based radar or other approved surveillance systems (i.e., satellite-based). The types of systems supported are:

10.0.1 **Precision Approach Radar (PAR)** is a system that graphically displays lateral course, glidepath, and distance from touchdown information of sufficient accuracy, continuity, and integrity to provide precision approach capability to a runway/landing area.

10.0.2 **Surveillance Radar** is a system that displays direction and distance information with suitable accuracy, continuity, and integrity to safely provide radar vectoring capability for departures, arrivals, en route operations, and nonprecision approach (NPA) airport surveillance radar (ASR) approaches to an airport. The standards in this chapter are based on the separation minima specified in Order JO 7110.65 paragraph 5-5-4 and/or associated directives. For TERPS purposes, the term "Single Sensor" applies to configurations/adaptations authorized to use 3 NM lateral separation and the term "Multi-Sensor" applies to those that require 5 NM. For configurations/adaptations where both separation standards apply, either establishes a separate procedure/chart for each standard, or one procedure/chart to accommodate both standards or one procedure/chart to accommodate the larger standard.

Note: Single sensor separation applies to approved full time reinforced Monopulse Secondary Surveillance Radar (MSSR) systems 60 NM or less from the antenna.

10.0.3 **Automatic Dependent Surveillance - Broadcast (ADS-B).** Paragraph 10.0.2 applies, except not authorized for conducting ASR approaches.

Chapter 10. Radar Approach Procedures and Vectoring Charts

Section 2. Radar Approaches.

10.1 Radar Approaches.

Both ASR and PAR approach procedures may be established where the applicable Order 8200.1, U. S. Standard Flight Inspection Manual, coverage and alignment tolerances are met. ASR approaches may be established when the final segment is adapted for single sensor operations and the radar antenna is not more than 20 NM from;

a. The approach runway threshold (RWT) coordinates when the procedure is designed to meet straight-in alignment.

b. The airport reference point (ARP) when the procedure is designed to meet circling-only alignment.

10.1.1 Feeder Routes and Initial Approach Segments.

Feeder and initial segments do not need to be established when navigation guidance and obstacle clearance are provided by Air Traffic Control radar vectors during the transition from the en route to the terminal phase of flight.

10.1.1 a. Feeder/Initial Segments based on Routes [Department of Defense (DoD) Only]. When operationally required, establish feeder routes and/or initial segments based on conventional navigation, area navigation (RNAV), or radar routes.

10.1.1 a. (1) Conventional/RNAV Feeder/Initial. Develop in accordance with volume 1, chapter 2 or Order 8260.58, United States Standard for Performance Based Navigation (PBN) Instrument Procedure Design, volume 6, chapter 1.

10.1.1 a. (2) Radar Feeder/Initial. The route/segment begins at an established fix that permits positive radar identification and ends at the appropriate termination fix for the segment. Display the course centerline on a radar video map (e.g., as a "special use" track per Order 7210.3, Facility Operation and Administration, chapter 3, section 8 or DoD equivalent).

10.1.1 a. (2) (a) Alignment. Design feeder/initial and initial/initial segment intersections with the smallest amount of course change necessary for the procedure. The maximum allowable course change between segments is 90 degrees.

10.1.1 a. (2) (b) Area. The obstacle evaluation area (OEA) begins at the applicable radar fix displacement prior to the route/segment start fix and extends to the

10.1.2 **d. Descent gradient.** Apply volume 1, chapter 2.

10.1.3 **PAR Final Approach Segment (FAS).**

10.1.3 **a. Inoperative/unused Components.** Failure of the azimuth component renders the entire PAR system inoperative. When the elevation component (glidepath) fails or is not used (i.e., to support pilot or controller training) the PAR azimuth may be used to provide an ASR approach. A stand-alone PAR azimuth without glideslope procedure is not required when ASR minimums are established to the same runway and used during the approach, the missed approach instructions are the same, and the ASR missed approach point is identifiable on the PAR scope.

Alternatively, a separate PAR azimuth without glideslope procedure may be established when required and/or operationally advantageous. Evaluate using the localizer area and obstacle clearance requirements specified in volume 1, chapter 9. NPA minimums are established according to volume 1, chapter 3, section 3 and documented in accordance with applicable directives.

10.1.3 **b. General**. Apply the current basic vertically guided final segment general criteria applicable to instrument landing system (ILS) for glidepath angle (GPA), threshold crossing height (TCH), precise final approach fix (PFAF), glidepath qualification surface (GQS), and precision obstacle free zone (POFZ).

10.1.3 b. (1) Use the highest applicable MVA to determine the PFAF distance to LTP/coordinates when there is no preceding segment.

10.1.3 b. (2) ILS height above touchdown (HAT) and decision altitude (DA) standards apply (to include volume 1, chapter 3 adjustments), except the *minimum* HAT may be 100 feet for DoD-only approaches when the OCS is clear. Adjusting TCH to reduce/eliminate OCS penetrations is not applicable to PAR FAS evaluations.

10.1.3 **c. Obstacle Evaluation Area (OEA)/Obstacle Clearance Surface (OCS).** [USN: See applicable directives.] Apply current ILS FAS criteria for alignment, OCS slope, width, height, and OEA/OCS evaluation *except* the OEA extends to the PFAF (no radar fix tolerance applied). Also, where the PFAF must be located more than 50200 feet from the RWT coordinates, the OEA continues to splay to the PFAF or until reaching the minimum lateral clearance applicable to the radar adaptation (volume1, chapter 10, paragraph 10.0.2).

10.1.3 **d. Simultaneous PAR Procedures (DoD only).** Where military authority determines facilities and equipment are adequate, PAR approach procedures to parallel runways may be established. See applicable DoD directives.

10.1.4 **ASR Final Approach Segment (FAS).** Use the highest applicable MVA to determine the PFAF location when there is no preceding segment.

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

10.1.4 **b. Alignment.** Align the final approach course (FAC) with the extended runway centerline for a straight-in approach, or to the airport reference point for a circling approach. When an operational advantage can be achieved, the FAC for circling approaches may be aligned to pass through any portion of the usable landing surface.

10.1.4 **c. Area.** The final approach begins at the applicable radar fix displacement prior to the PFAF and ends at the RWT (straight-in)/FEP (circling) or the appropriate radar fix displacement beyond the missed approach point (MAP), whichever is encountered last.

10.1.4 c. (1) Determine the primary area half-width (½Wp) using *formula 10-1*. Connect the width calculated at the PFAF to the width calculated at the RWT/FEP (straight line connection). The width at the early or late fix displacement points is equal to the width at the PFAF and RWT/FEP. *See figure 10-2.*

Formula 10-1. *Final Area Half-Width at PFAF and RWT/FEP (H_W).*

$$H_W = 0.1 \cdot D + 1$$

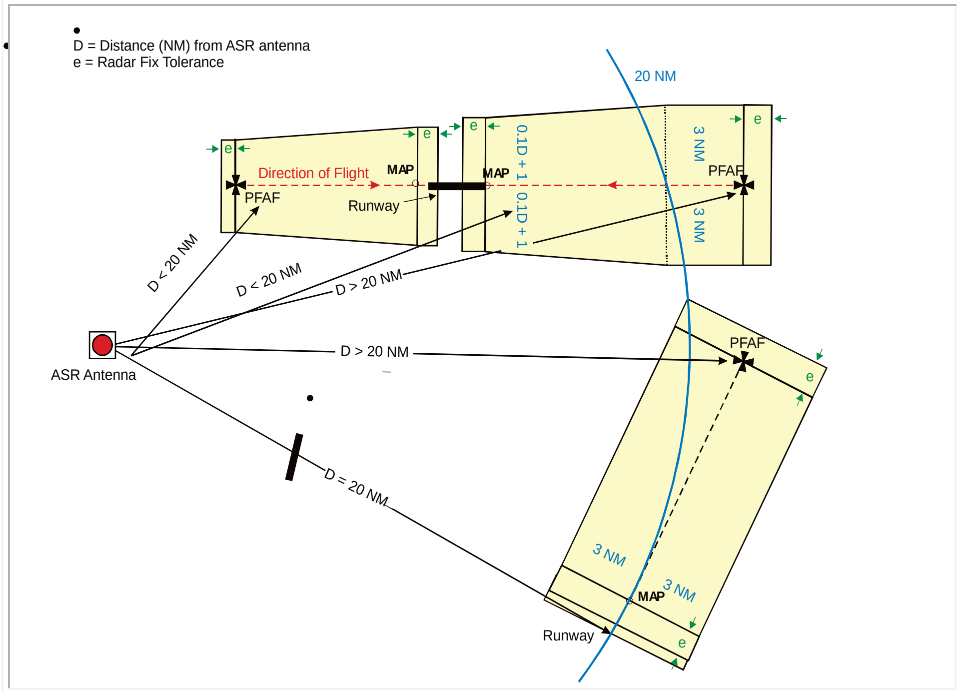
where

D = Distance, FAC point to Antenna (NM)
(H_W = 3 NM where D > 20 NM)

0.1*D+1

10.1.4 c. (2) When the distance of any point on FAC centerline > 20 NM, the primary area ½Wp is 3 NM. *See figure 10-2.*

Figure 10-2. *ASR Final Approach Segment.*



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

10.1.4 **e. Obstacle Clearance.** Apply 250 feet of ***ROC*** to the highest obstacle in the area. Volume 1, chapter 3 precipitous terrain, remote altimeter, and excessive length of final adjustments apply.

10.1.4 **f. Descent Angle.** Apply current NPA criteria, except do not publish the VDA.

10.1.4 **g. Recommended Altitudes (RecAlt**). Determine recommended altitudes at each mile on final approach for ATC use. Determine RecAlt values using *formula 10-2.*

Formula 10-2. *Recommended Altitudes (RecAlt).*

$$RecAlt = A - DG$$

where

A = PFAF altitude or last RecAlt (unrounded)

DG = (1852/0.3048) x tan [VDA calculated per Vol. 1, Chap. 2, para 252]

A-DG

RecAlt values below MDA are not issued. Round recommended altitudes to the *nearest* 20-foot increment. See the examples below.

Example:

PFAF altitude = 2000 feet, MDA = 660 feet, VDA = 3.00 degrees (318.436/NM)
6 NM (PFAF) = 2000 feet
5 NM recommended altitude: 2000 - 318.436 = 1681.564 (1,680)
4 NM recommended altitude: 1681.564 - 318.436 = 1363.128 (1,360)
3 NM recommended altitude: 1363.128 - 318.436 = 1044.692 (1,040)
2 NM recommended altitude: 1044.692 - 318.436 = 726.256 (720)
1 NM recommended altitude: 726.256 - 318.436 = 407.82 (Not issued)

10.1.4 **h. RecAlt with Stepdown Fix above the VDA.** When the minimum altitude at a stepdown fix is above the vertical path of the VDA, calculate RecAlt using the appropriate VDA for each subsegment (i.e., VDA from PFAF to stepdown altitude prior to stepdown fix, and VDA from stepdown altitude to TCH after the stepdown fix).

Example:

PFAF altitude = 3300 feet, MDA = 1400 feet, VDA PFAF to stepdown fix = 3.00 degrees (318.436/NM), VDA at 4 NM SDF to TCH = 3.39 degrees (359.924/NM)
6 NM (PFAF) = 3300
5 NM recommended altitude: 3300 - 318.436 = 2981.564 (2,980)
4 NM recommended altitude: 2981.564 - 318.436 = 2663.128 (2,660)
3 NM recommended altitude: 2663.128 - 359.924 = 2303.204 (2,300)
2 NM recommended altitude: 2303.204 - 359.924 = 1943.280 (1,940)
1 NM recommended altitude: 1943.280 - 359.924 = 1583.356 (1,580)

10.1.5 **Missed Approach Segment (MAS).**

10.1.5 **a. PAR.** Apply the current volume 3 Category (CAT) I ILS missed approach criteria to approaches with HAT values greater than or equal to 200 feet. Apply current CAT II ILS missed approach criteria for approaches with HAT values lower than 200 feet, except USN approaches annotated “Not for Civil Use.”

10.1.5 **b. ASR.** Apply the current volume 1, chapter 2 NPA missed approach criteria. The MAP is located on the final approach course not farther from the PFAF than the FEP.

1113. INTERMEDIATE APPROACH SEGMENT BASED ON STRAIGHT COURSES. Volume 1, paragraph 242 is changed as follows:

a. Alignment. The provisions of paragraph 242a apply with the exception that the intermediate course must not differ from the final approach course by more than 60 degrees.

b. Area.

(1) Length. The OPTIMUM length of the intermediate approach segment is two miles. The minimum length is one mile and the recommended maximum is five miles. A distance greater than five miles should not be used unless an operational requirement justifies the greater distance. When the angle at which the initial approach course joins the intermediate course exceeds 30 degrees (see figure 3), the MINIMUM length of the intermediate course is as shown in table 24.

1114 . INTERMEDIATE APPROACH SEGMENT BASED ON AN ARC. Paragraph 243 is changed as follows: Arcs with a radius of less than four miles or more than 30 miles from the navigation facility must not be used.

a. Area.

(1) Length. The OPTIMUM length of the intermediate approach segment is two miles. The minimum length is one mile and the recommended maximum is five miles. A distance greater than five miles should not be used unless an operational requirement justifies the greater distance. When the angle at which the initial approach course joins the intermediate course exceeds 30 degrees (see figure 3), the MINIMUM lengths of the intermediate course is as shown in table 24.

Table 24. Minimum Intermediate Course Length (Not applicable to PAR and ILS)

ANGLE (degrees)	MINIMUM LENGTH (miles)
30	1.0
60	2.0
90	3.0
120	4.0

Note: This table may be interpolated

1115 . INTERMEDIATE SEGMENT WITHIN A PROCEDURE TURN SEGMENT. Paragraph 244b is changed as follows: The normal procedure turn distance is five miles from the fix or from the facility. This produces an intermediate segment five miles 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 five miles should not be used unless an operational requirement justifies the greater distance. See figure 13, paragraph 244.

1116 . FINAL APPROACH. Paragraph 250 applies except that the word runway is understood to include landing area and the reference to circling approach does not apply. The final approach course in precision approach procedures must be aligned as indicated in paragraphs 1152 and 1159. For nonprecision procedures final approach course alignment must be as follows:

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

b. Point-in-Space Approaches. The final approach course should be aligned to provide for the most effective operational use of the procedure consistent with safety.

1117. MISSED APPROACH POINT Paragraph 272 is changed to state that the specified distance may not be more than the distance from the final approach fix 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; e.g., MAP 3800 feet from landing area, basic visibility is 3/4 mile. See figure 108. For point-in-space approaches the MAP is on the final approach course at the end of the final approach area.

1118. STRAIGHT MISSED APPROACH AREA. Paragraph 273 applies with the exception that the length of the primary and secondary missed approach area is reduced from 15 miles to 7.5 miles and will have the width of the appropriate airway at termination.

1119. STRAIGHT MISSED APPROACH OBSTACLE CLEARANCE. Paragraph 274 applies except that "TDZ or airport elevation" is changed to "landing area elevation;" 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.

1120. TURNING MISSED APPROACH AREA. The provisions of volume 1, paragraph 275 apply with the exception that when applying missed approach criteria shown in figures 19 through 24, and table 5 of this volume, change all flight path lengths to 7.5 miles, missed approach surface slope to 20:1, secondary slopes to 4:1, obstacle clearance radius (R) to 1.3 miles, and flight path radius (R_1) to 4000 feet (.66 miles). The area width will expand uniformly to the appropriate airway width.

1121. TURNING MISSED APPROACH OBSTACLE CLEARANCE. All missed approach areas described in paragraph 276 and depicted in figures 25 and 26 will be adjusted for helicopter operation using the values shown in paragraph 1120. The area width will expand uniformly to the appropriate airway width.

1122. COMBINATION STRAIGHT AND TURNING MISSED APPROACH. Paragraph 277 applies except that the values shown in paragraph 1120 must be used, and point B is relocated to a position abeam the MAP. The area width will expand uniformly to the appropriate airway width. See figure 106.

1123. HOLDING ALIGNMENT. The provisions of paragraph 291 apply with the exception when the final approach fix is a facility, the inbound holding course must not differ from the final approach course by more than 90 degrees.

1124. HOLDING AREA. Paragraph 292 applies except that the minimum size pattern is No. 1.

Section 3. Takeoff and Landing Minimums

1125. APPLICATION. The minimums specified in this section apply to Helicopter Only procedures.

1126. ALTITUDES. The following changes apply:

a. Volume 1, paragraphs 3.2.1a, paragraph 10.1.3b(2), and volume 3, paragraph 3.7 apply except that a DH of 100 feet may be approved without approach lights; and table 29 in paragraph 1167 governs the establishment of the DH.

b. Paragraph 3.2.1d(2) does not apply.

1127. VISIBILITY. Apply chapter 3 of this volume, except:

a. Nonprecision Approaches.

(1) Approach to Runway. The minimum visibility may be 1/2 the computed straight-in value from chapter 3, table 3-6.

(2) Approach to Landing Area. (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 25. Paragraph 3.3.2 does not apply.

b. Precision Approaches.

(1) Approach to Runway. The minimum visibility may be 1/2 the computed straight-in value specified in table 3-5a of chapter 3, but not less then 1/4 mile/1200 RVR.

(2) Approach to Landing Area. The minimum visibility authorized prior to applying credit for lights is 1/2 mile/2400 RVR. Paragraph 3.3.2 does not apply.

c. Point-in-Space Approaches. The minimum visibility prior to applying credit for lights is 3/4 mile. If the HAS exceeds 800 feet, the minimum no-lights visibility is 1 mile. No credit for lights will be authorized unless an approved visual lights guidance system is provided. See also paragraph 3.1.3c. Alternate minimums are not authorized. Table 25 does not apply.

Example:

Given:

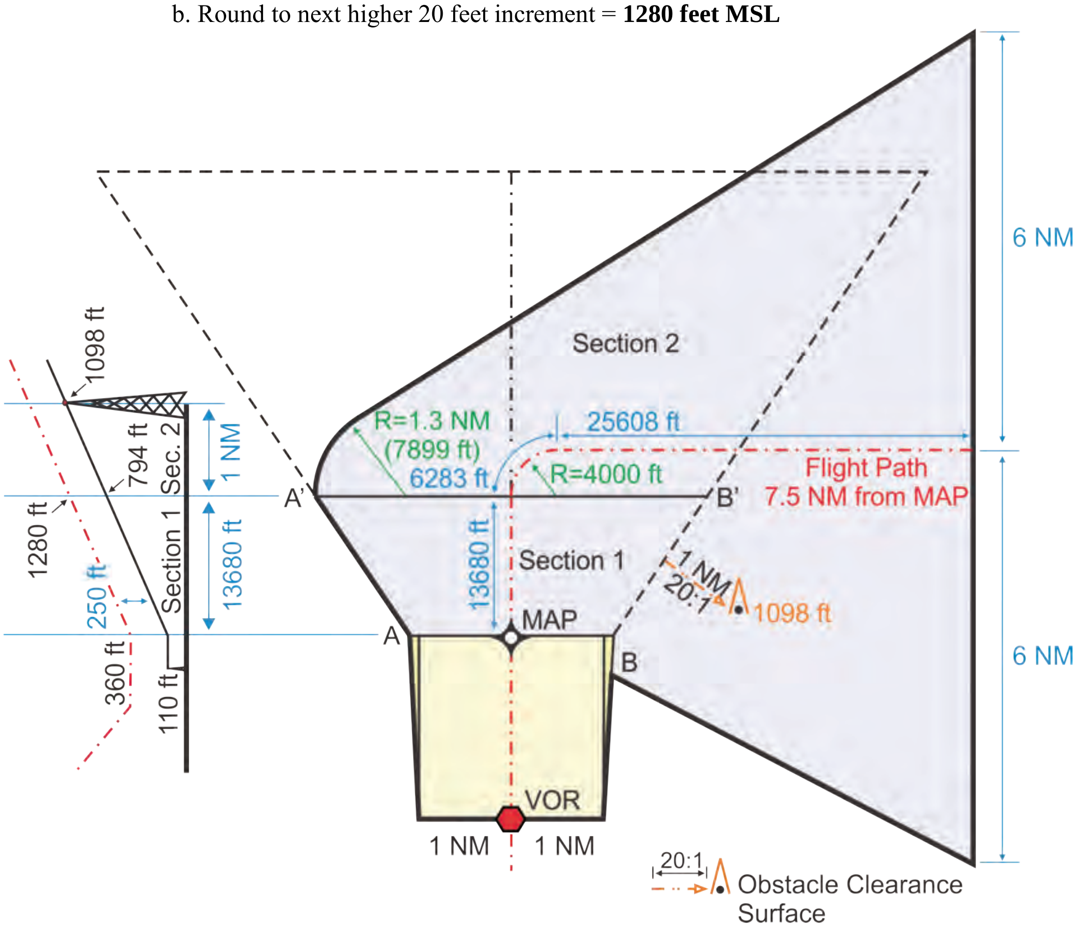
1. MDA is 360 feet MSL based on obstacles in the approach area
2. 1098 feet MSL obstacle is 1 NM (6076 feet) from the near edge of section 1

Determine:

1. Section 1 length
2. Minimum turn altitude

Solution:

1. Section 1 length
   a. 1 NM (6,076 feet) ÷ 20 = 304 feet
   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. (13,680 feet ÷ 15.19) + MDA = 1261
   b. Round to next higher 20 feet increment = **1280 feet MSL**



1128. 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. The concepts stated in chapter 3, paragraph 3.1.3b of this volume apply, except heliport markings may be substituted for the runway marking requirements specified therein.

Table 25. Effect of HAL Height on Visibility Minimums. Par 1127a

HAL	250-600 feet	601-800 feet	More than 800 feet
Visibility Minimum (SM)	1/2	3/4	1

1129. TAKEOFF MINIMUMS. Chapter 3, section 5, of this volume does not apply. Helicopter takeoff minimums must be in accordance with the appropriate FAA regulations and DoD directives.

Section 4. On-Heliport VOR (No PFAF)

1130. GENERAL. Paragraph 400 does not apply. 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.

1131. INITIAL AND INTERMEDIATE SEGMENTS. These criteria are contained in section 2 of this chapter.

1132. FINAL APPROACH SEGMENT. Paragraph 413 does not apply, except as noted below. The final approach begins where the procedure turn intersects final approach course inbound.

a. Alignment. Paragraph 1116a applies.

b. Area. The primary area is longitudinally centered on the final approach course. The MINIMUM length is five miles. This may be extended if an operational requirement exists. The primary area is two miles wide at the facility and expands uniformly to four miles wide at 5 miles from the facility. A secondary area is on each side of the primary area. It is zero miles wide at the facility and expands uniformly to .67 mile on each side of the primary area at five miles from the facility. See figure 107.

c. Obstacle Clearance. Paragraph 4-13c(1) applies.

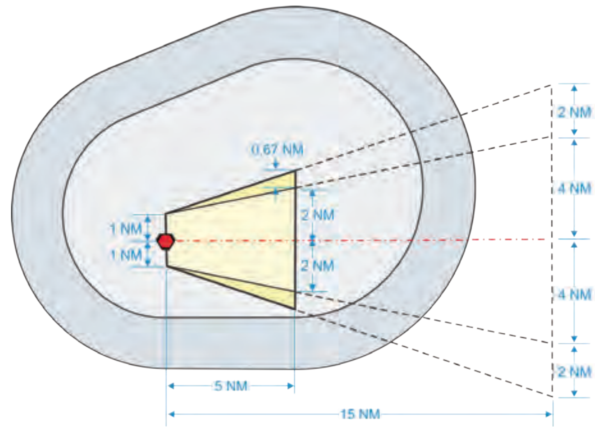


Figure 107. Final Approach Primary and Secondary Area. On-Heliport VOR, No PFAF, Par 1132b. See also Figure 105.

d. Procedure Turn Altitude. The procedure turn completion altitude must be in accordance with table 23.

e. Use of Stepdown Fix. Paragraph 413e applies, except that 4 miles is changed to 2.5 miles.

f. Minimum Descent Altitude. Criteria for determining MDA are contained in section 3 of this chapter and in chapter 3 of this volume.

Section 5. TACAN, VOR/DME, and VOR with FAF

1133. FINAL APPROACH SEGMENT. Paragraph 513 does not apply, except as noted below.

a. Alignment. Paragraphs 1116a and b apply.

b. Area. Paragraph 513b applies, except that portion which refers to the minimum length of the final approach segment. The minimum length of the final approach segment is shown in table 26.

Table 26. Minimum Length Of Final Approach Segment (NM)

Magnitude of Turn Over Facility		
30°	60°	90°
1.0	2.0	3.0

Note: This table may be interpolated.

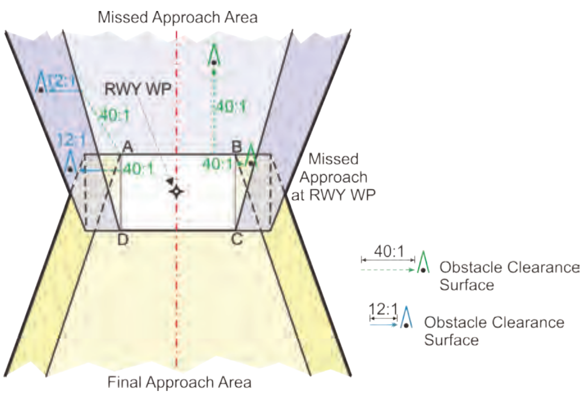


Figure 15-20. Straight Missed Approach at the RWY WP. Par 1533a(1).

(2) When the MAP is at an ATD fix, the area starts at the earliest point the MAP can be received and has the same width as the final approach primary and secondary areas at that point (see figure 15-21).

(3) The area expands uniformly to a width of six miles each side of the course line at a point 15 flight-track miles from the plotted position of the MAP. When PCG is provided, the secondary areas splay linearly from a width of one mile at the MAP to a width of two miles at the end of the 15-mile area. The splay of these areas begins at the earliest point the MAP can be received.

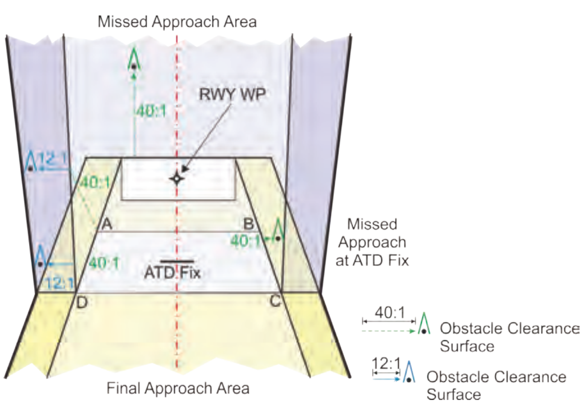


Figure 15-21. Straight Missed Approach at an ATD Fix. Par 1533a(2).

(4) When a turn of 15 degrees or less causes the outside edge of the primary missed approach boundary to cross inside the lateral dimensions of the fix displacement area of the MAP, that boundary line is then constructed from the corner of the lateral dimension of the area abeam the latest point the MAP can be received. This point is identified as point A at the MAP when represented by a WP or an ATD fix which is established as the MAP. See figures 15-22 and 15-23, respectively.

b. Obstacle Clearance. The 40:1 missed approach surface begins at the edge of the area of the WP displacement tolerance or the displacement area of the ATD fix of the MAP identified as the line D-A-B-C in figures 15-20 and 15-21. For the triangular area shaded in figures 15-22 and 15-23 resulting from a skewed course of 15 degrees or less, the 12:1 slope is measured from point A. The obstacle slope is established by measuring the shortest distance from the line D-A-B-C to the obstacle (see figures 15-22 and 15-23). The height of the missed approach surface at its beginning slope is determined by subtracting the required final approach obstacle clearance and adjustments specified in paragraph 3.2.2 of this volume from the MDA.

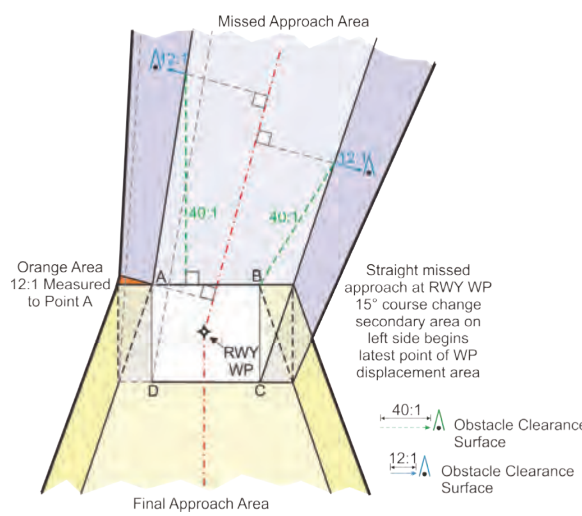


Figure 15-22. Construction of Straight Missed Approach When Turns ≤ 15° Cause Outside Boundary to Cross Inside MAP Fix Displacement Tolerance at RWY WP. Par 1533a(4).

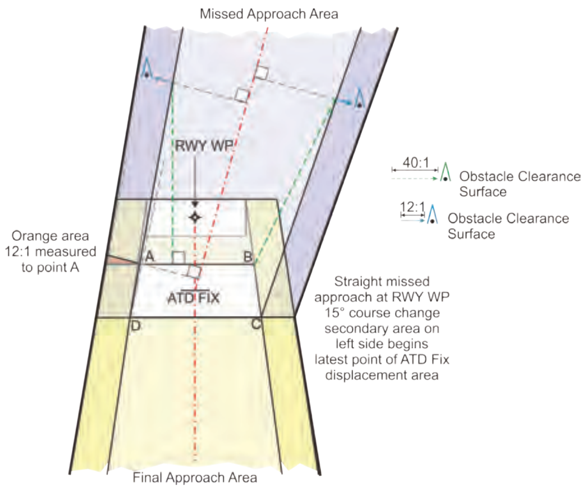


Figure 15-22. Construction of Straight Missed Approach When Turns ≤ 15° Cause Outside Boundary to Cross Inside MAP Fix Displacement Tolerance at an ATD Fix. Par 1533a(4).

1534. TURNING MISSED APPROACH. Turning missed approach criteria apply whenever the missed approach course differs by more than 15 degrees from the FAC.

a. Area.

(1) Zone 1 begins at a point abeam the latest point the MAP can be received (see figure 15-24).

(2) The turning missed approach area should be constructed by the methods described in paragraph 275, except as follows:

(a) The radii for the outer boundary is constructed from a baseline at the latest point the MAP can be received.

(b) Where the width "d" of the final approach area at the latest point the MAP can be received exceeds the value of the radius of the outer boundary R in table 5, use "wide final approach area at the MAP" construction methodology. If the width "d" is less than or equal to R, use "narrow" methodology (see figure 15-24). Point C_1, for turns of 90 degrees or less, Connects to the WP or fix displacement area at point C, which is located at the earliest point the MAP can be received. See figures 15-25 and 15-27. Point C_1, for turns more than 90 degrees, connects to the corner of the WP or fix displacement area at the non-turn side at point D at the earliest point the MAP can be received. See figures 15-26 and 15-28. Point C_1, for turns which expand the missed approach area boundary beyond line E-D-Z, connects to point E (see figure 15-29). Point C_1, for turns which expand the missed approach area boundary beyond line E-Z (parallel to the FAC line), connects to point E_1, a TP of the obstacle boundary arc (see figure 15-30).

b. Obstacle Clearance. The 40:1 obstacle clearance surface begins at the edge of the WP or fix displacement area or the MAP. The height of the missed approach surface over an obstacle in zone 2 is determined by measuring a straight-line distance from the obstacle to the nearest point on the A-B-C line and computing the height based on the 40:1 ratio (see figure 15-26). The height of the missed approach surface in zone 3 is determined by measuring the distance from the obstacle to point C, as shown in figure 15-26, and computing the height based on the 40:1 ratio. The height of the missed approach surface over point C for zone 3 computations is the same height as the MDA, less adjustments specified in paragraph 3.2.2 of this volume.

1535. COMBINATION STRAIGHT AND TURNING MISSED APPROACH.

a. Area.

(1) Section 1 is a portion of the normal straight missed approach area and is constructed as specified in paragraph 1533 (see figure 15-31). The end of section 1 is based on a turn at a WP, or a climb to an altitude prior to commencing a turn.

(2) RNAV Route Missed Approach Procedure. A turn WP is used to base the length of section 1 for a route RNAV MAP.

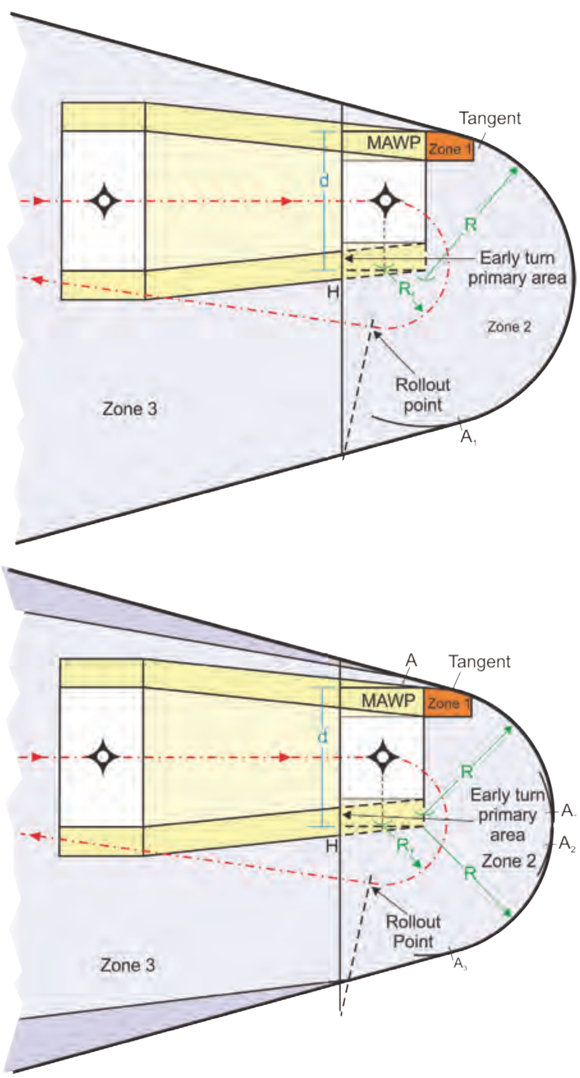


Figure 15-24. Wide and Narrow Missed Approach Methodology. Par 1534a(1) and (2).

(a) Secondary area reductions apply except where the turn exceeds 90 degrees, when the reduction applies only on the non-turning side. See figure 15-32.

(b) For VOR/DME systems, the turn WP must be limited to a TPD of 30 NM or less and to within the 4 NM zone.

(c) A turn anticipation area must be constructed at the turn point.

(d) Construction.

<u>1</u> Points F, T_1, T_2, and J represent the end of section 1. For turns 90 degrees or less, point C_1 connects to point J. See figure 15-31. For turns of more than 90 degrees, point C_1 of Section 3 connects to point T_2 (see figure 15-32).

<u>2</u> The radius for the obstruction boundary is measured from a baseline at the latest point the turn WP can be received.

<u>3</u> The outer boundary line connects tangentially to the outside radius of the boundary arc. Then, the secondary area boundary connects to that line at the point abeam the plotted position of the turn WP (see figures 15-31 and 15-32).

(3) RNAV Direct Procedure. For an RNAV direct missed approach, the end of section 1 is based on a climb to altitude, and secondary area reductions are not applied.

(a) The end of section 1 is established as described in paragraph 1531a(2)(c). PCG is not assumed, and secondary area obstruction clearance may not be applied. The end of Section 1 is represented by line H-T_3 (see figure 15-33).

(b) Construction.

<u>1</u> A baseline extension of line G-D-C separates sections 2 and 3. When point C_1 is established prior to the baseline, C_1 connects to point C (see figure 15-33).

<u>2</u> When C_1 is established beyond the baseline, but inside line G-Z, C_1 connects to point G. G-Z is established parallel to the FAC line (see figure 15-34).

<u>3</u> When point C_1 is established beyond an area of line G-Z, C_1 connects to point H (see figure 15-35).

<u>4</u> When point C_1 is established beyond an area of line H-Z, C_1 connects to point K, a tangent point on the boundary arc. H-Z is established paralleled to the FAC line (see figure 15-36).

b. Obstruction Clearance.

(1) RNAV route missed approach of turns 90 degrees or less.

(a) Obstacles in Section 2 are evaluated based on the shortest distance in the primary area from the obstacle to any point on line T_2-T_3 (see figure 15-31).

(b) Obstacles in Section 2b are evaluated based on the shortest distance in the primary area from the obstacle to point T_3 through Point J (see figure 15-31).

(2) RNAV Route Missed Approach of Turns More than 90 degrees. Obstacles in sections 2 and 3 are evaluated based on the shortest distance in the primary area from the obstacle to any point on line T_2-T_3 (see figure 15-32).

(3) RNAV Direct Procedure. Obstacles in section 2 are evaluated based on the shortest distance from the obstacle to any point on line G-H-T_3-X. Obstacles in section 3 are evaluated based on shortest distance from the obstacle to point X (see figure 15-36).

(4) The height of the missed approach surface over an obstacle in sections 2 or 3 is determined by measuring the shortest distance from the obstacle to the nearest point on the T_2-T_3 line for RNAV routes missed approach procedures and to the nearest point on the H-T_3 line for RNAV direct missed approach procedures. Compute the height of the surface by using the 40:1 ratio from the height of the missed approach obstacle surface at the end of section 1. The height of the obstacle surface at the end of section 1 is determined by computing the 40:1 obstacle surface slope beginning at the height of the missed approach surface measured from the latest point of the MAP (see figures 15-32 and 15-36).

(5) The height of the missed approach surface over point X for section 3 computations is the height of the MDA less adjustments specified in paragraph 3.2.2, plus a 40:1 rise in section 1 as measured from line A-B to the end of section 1.

1536. CLEARANCE LIMIT. The missed approach procedure must specify an appropriate fix as a clearance limit. The fix must be suitable for holding. For VOR/DME systems, the clearance limit WPs must meet terminal fix displacement tolerance criteria from table 15-1. For non-VOR/DME systems, clearance limit WPs must meet en route fix displacement tolerance criteria from table 15-3

1537.-1539. RESERVED.

SECTION 4. APPROACH MINIMUMS.

1540. APPROACH MINIMUMS. Chapter 3, section 3, applies. Table 15-5 specifies the minimum visibility based on the XTRK fix displacement tolerance of the plotted position of the MAP. XTRK values in table 15-2 must be applied for VOR/DME. An XTRK value of 0.6 NM must be applied for non-VOR/DME.

1541.-1599. RESERVED.

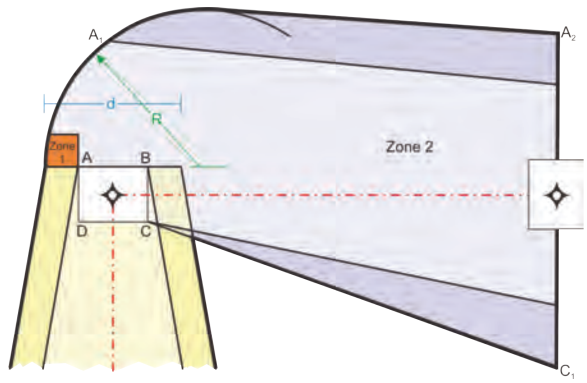


Figure 15-25. RNAV Turning Missed Approach, 90 degrees or Less. Par 1534a(2)(b)

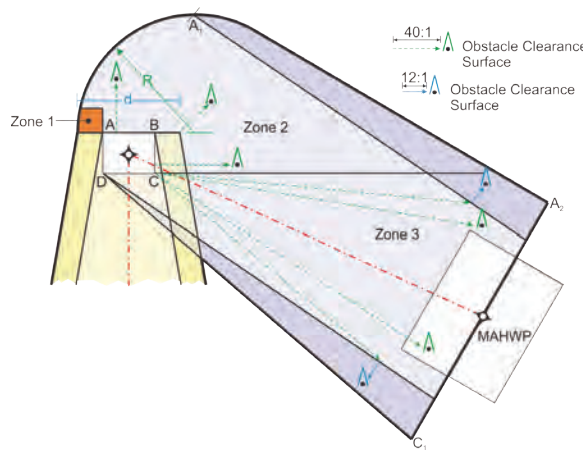


Figure 15-26. RNAV Turning Missed Approach, More than 90 degrees up to 120 degrees. Par 1534a(2)(b)

CHAPTER 17. ENROUTE CRITERIA

1700. – 1709. RESERVED.

Section 1. VHF Obstacle Clearance Areas

1710. ENROUTE OBSTACLE CLEARANCE AREAS. Obstacle clearance areas for en route planning are identified as "primary," "secondary," and "turning" areas.

1711. PRIMARY AREAS.

a. Basic Area. The primary en route obstacle clearance area extends from each radio facility on an airway or route to the next facility. It has a width of 8 NM; 4 NM on each side of the centerline of the airway or route. See figure 17-1.

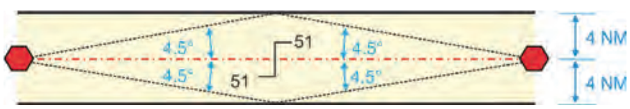


Figure 17-1. PRIMARY OBSTACLE CLEARANCE AREA. Par 1711a.

b. System Accuracy. System accuracy lines are drawn at a 4.5-degree angle on each side of the course or route. See figure 17-1. The apexes of the 4.5-degree angles are at the facility. These system accuracy lines will intersect the boundaries of the primary area at a point 50.8 NM from the facility (normally 51 NM is used). If the distance from the facility to the changeover point (COP) is more than 51 NM, the outer boundary of the primary area extends beyond the 4 NM width along the 4.5-degree line. See figure 17-2. These examples apply when the COP is at midpoint. Paragraph 1716 covers the effect of offset COP or dogleg segments.

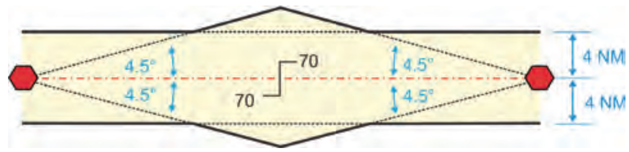


Figure 17-2. PRIMARY OBSTACLE CLEARANCE AREA. Application of System Accuracy. Par 1711b.

c. Termination Point. When the airway or route terminates at a navigational facility or other radio fix, the primary area extends beyond that termination point. The boundary of the area may be defined by an arc which connects the two boundary lines. The center of the arc is, in the case of a facility termination point, located at the geographic location of the facility. In the case of a termination at a radial or DME fix, the boundary is formed by an arc with its center located at the most distant point of the fix displacement area on course line. Figure 17-8 and its inset show the construction of the area at the termination point.

1712. SECONDARY AREAS.

a. Basic Area. The secondary obstacle clearance area extends along a line drawn 2 NM on each side of the primary area. See figure 17-3.

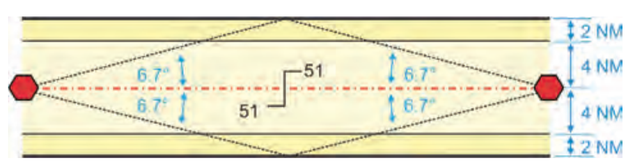


Figure 17-3. SECONDARY OBSTACLE CLEARANCE AREAS. Par 1712a.

b. System Accuracy. Secondary area system accuracy lines are drawn at a 6.7-degree angle on each side of the course or route. See figure 17-3. The apexes are at the facility. These system accuracy lines will intersect the outer boundaries of the secondary areas at the same point as primary lines, 51 NM from the facility. If the distance from the facility to the COP is more than 51 NM, the secondary area extends along the 6.7-degree line. See figure 17-4. See paragraph 1716.c. and d. for offset COP or dogleg airway.

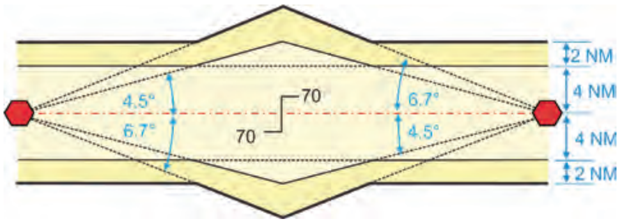


Figure 17-4. SECONDARY OBSTACLE CLEARANCE AREAS. Application of System Accuracy Lines. Par 1712b.

c. Termination Point. Where the airway or route terminates at a facility or radio fix, the boundaries are connected by an arc in the same way as those in the primary area. Figure 17-8 and its inset shows termination point secondary areas.

1713. TURNING AREA.

a. Definition. The en route turning area may be defined as an area which may extend the primary and secondary obstacle clearance areas when a change of course is necessary. The dimensions of the primary and secondary areas will provide adequate protection where the aircraft is tracking along a specific radial, but when the pilot executes a turn, the aircraft may go beyond the boundaries of the protected airspace. The turning area criteria supplement the airway and route segment criteria to protect the aircraft in the turn.

b. Requirement for Turning Area Criteria. Because of the limitation on aircraft indicated airspeeds below 10000 feet MSL (14 CFR Part 91.117); some conditions do not require the application of turning area airspace criteria.

(1) The graph figure 17-5 may be used to determine if the turning area should be plotted for airways/routes below 10000 feet MSL. If the point of intersection on the graph of the "amount of turn at intersection" versus "VOR facility to intersection distance" falls outside the hatched area of the graph, the turning area criteria need not be applied.

(2) If the "amount of turn" versus "facility distance" values fall within the hatched area or outside the periphery of the graph, then the turning area criteria must be applied as described in paragraph 1714.

c. Track. The flight track resulting from a combination of turn delay, inertia, turning rate, and wind effect is represented by a parabolic curve. For ease of application, a radius arc has been developed which can be applied to any scale chart.

d. Curve Radii. A 250 knot IAS, which is the maximum allowed below 10000 feet MSL, results in radii of 2 NM for the primary area and 4 NM for the secondary area up to that altitude. For altitudes at or above 10000 feet MSL up to but not including 18000 feet MSL the primary area radius is 6 NM and the secondary area radius is 8 NM. At or above 18000 feet MSL the radii are 11 NM for primary and 13 NM for secondary

e. System Accuracy. In drawing turning areas it will be necessary to consider system accuracy factors by applying them to the most adverse displacement of the radio fix or airway/route boundaries at which the turn is made. The 4.5- and 6.7-degree factors apply to the VOR radial being flown, but since no pilot or aircraft factors exist in the measurement of an intersecting radial, a navigation facility factor of plus-or-minus 3.6 degrees is used. See figure 17-6.

Note: *If a radio fix is formed by intersecting signals from two low frequency (LF), or one LF and VOR facility, the obstacle clearance areas are based upon accuracy factors of 5.0 (primary) and 7.5 (secondary) degrees each side of the course or route centerlines of the LF facilities. If the VOR radial is the intersecting signal, the 3.6-degree value stated in paragraph 1713.e. above applies.*

b. When a change of altitudes is involved with a course change, course guidance must be provided if the change of altitude is more than 1500 feet and/or if the course is more than 45 degrees.

EXCEPTION: Course changes of up to 90 degrees may be approved without course guidance provided that no obstacles penetrate the established MEA requirement of the previous airway/route segment within 15 NM of the boundaries of the system accuracy displacement area of the fix. See figure 17-22 and paragraph 1740b(2).

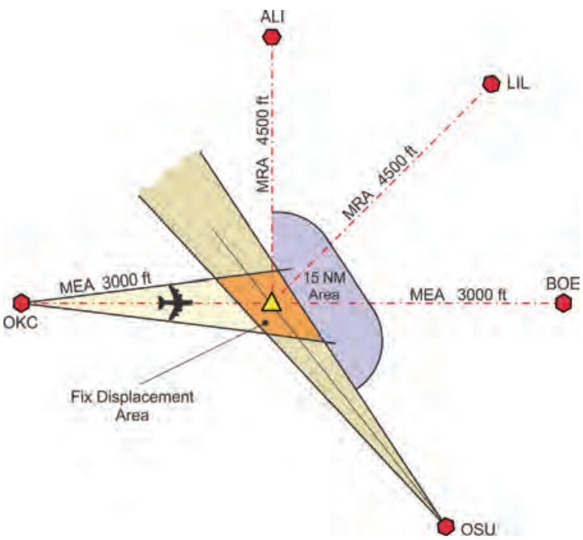


Figure 17-22. MEA WITH NAVIGATION GAP AT TURNING POINT. Par 1740b(2)

1731. EN ROUTE MINIMUM HOLDING ALTITUDES. Criteria for holding pattern airspace are contained in Order 7130.3, Holding Pattern Criteria, and provide for separation of aircraft from aircraft. The criteria contained in this document deal with the clearance of holding aircraft from obstacles.

a. Area. The primary obstacle clearance area for holding must be based on the appropriate holding pattern airspace area specified in Order 7130.3. No reduction in the pattern sizes for "on entry" procedures is permitted. In addition, when holding at an intersection fix, the selected pattern must also be large enough to contain at least three corners of the fix displacement area. See paragraphs 284, 285, and figure 37-1. A secondary area two miles wide surrounds the perimeter of the primary area.

b. Obstacle Clearance. The minimum ROC of the route must be provided throughout the primary area. The minimum ROC in the secondary area is 500 feet at the primary boundary, tapering uniformly to zero feet at the outer edge. For computation of obstacle clearance in the secondary area, the computation formula specified in paragraph 1721 must be applied. Adjustments for precipitous terrain must be applied as stated in paragraph 3.2.2b of this volume. Establish minimum holding altitudes in 100-foot increments. The selected altitude must provide the minimum ROC (plus adjustments as specified by paragraph 3.2.2b of this volume); e.g., when obstacle elevation plus ROC and adjustments equals 1501, round up to 1600 feet.

c. Communications. The communications on appropriate ATC frequencies (as determined by ATS) must be required throughout the entire holding pattern area from the MHA up to and including the maximum holding altitude. If the communications are not satisfactory at the minimum holding obstacle clearance altitude, the MHA must be authorized at an altitude where the communications are satisfactory. For communications to be satisfactory, they must meet the standards as set forth in Order 8200.1, United States Standard Flight Inspection Manual.

d. Holding Patterns On/Adjacent to ILS Courses. Holding patterns on or adjacent to ILS courses must comply with Order 7130.3, paragraph 4-7.

1732.-1739. RESERVED.

Section 4. Navigational Gaps

1740. NAVIGATIONAL GAP CRITERIA. Where a gap in course guidance exists, an airway or route segment may be approved in accordance with the criteria set forth in paragraph 1740c, provided:

a. Restrictions.

(1) The gap may not exceed a distance which varies directly with altitude from zero NM at sea level to 65 NM at 45000 feet MSL, and

(2) Not more than one gap may exist in the airspace structure for the airway/route segment, and

(3) A gap may not occur at any airway or route turning point, except when the provisions of paragraph 1740b(2) are applied, and

(4) A notation must be included on FAA Form 8260-16 which specifies the area within which a gap exists where the MEA has been established with a gap in navigational signal coverage. The gap area will be identified by distances from the navigation facilities.

b. Authorizations. MEA's with gaps may only be authorized where a specific operational requirement exists. Where gaps exceed the distance in paragraph 1740a(1), or are in conflict with the limitations in paragraph 1740a(2) or (3), the MEA must be increased as follows:

(1) For straight segments:

(a) To an altitude which will meet the distance requirement of paragraph 1740a(1), or

(b) When in conflict with paragraph 1740a(1) or (2) to an altitude where there is continuous course guidance available.

(2) For turning segments. Turns to intercept radials with higher MEA's may be allowed provided:

(a) The increase in MEA does not exceed 1500 feet, and

(b) The turn does not exceed 90 degrees, and

(c) No obstacles penetrate the MEA of the course being flown within 15 NM of the fix displacement area (see figure 17-22).

(3) When in conflict with paragraph 1740b(1) or (2) to an altitude where there is continuous course guidance available.

c. Use of Steps. Where large gaps exist which require the establishment of altitudes that obviate the effective use of airspace, consideration may be given to the establishment of MEA

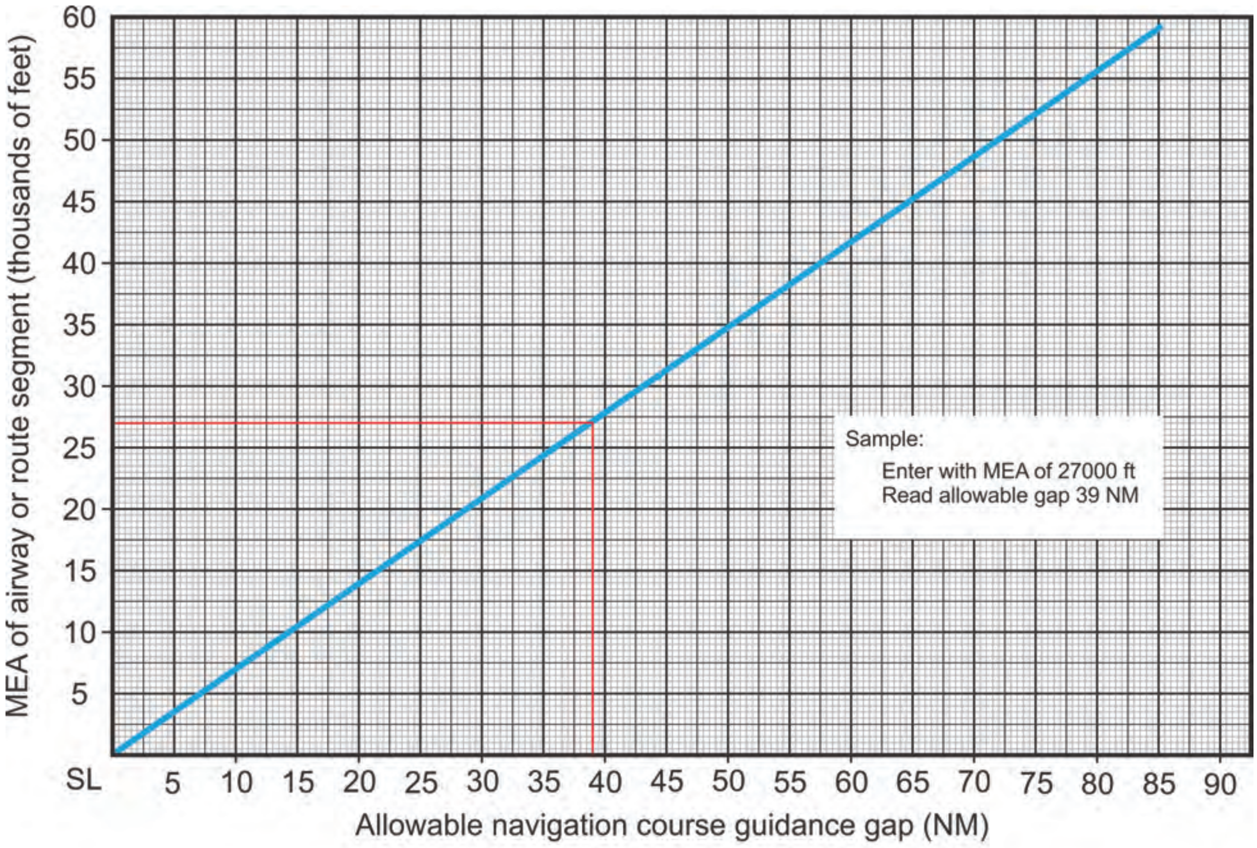


Figure 17-23. NAVIGATION COURSE GUIDANCE GAPS. Par 1740.

Chapter 1. General Information

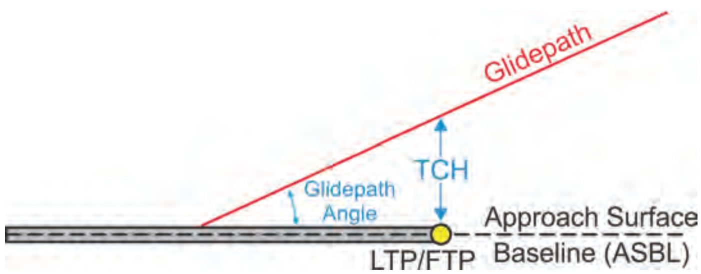
1.0. Purpose. This volume contains criteria applicable to conventional instrument approach procedures with vertical guidance. Apply these criteria to approaches based on instrument landing system (ILS), mobile microwave landing system (MMLS), precision approach radar (PAR), and Localizer Directional Aid (LDA) with glide slope.

1.1. Background. ILS meets the PA performance standard and may be authorized CAT I, II, or III landing minimums. LDA with glide slope only qualifies for APV minimums. PAR and MMLS meet the PA performance standard, but may be authorized CAT I landing minimums only.

1.2. Definitions.

a. Approach Surface Baseline (ASBL). A horizontal line tangent to the surface of the earth at the runway threshold (RWT) point, aligned with the final approach course (see figure 1-1).

Figure 1-1. Basic Precision Terms



b. Decision Altitude (DA). A specified altitude in reference to mean sea level in an approach with vertical guidance at which a missed approach must be initiated if the required visual references to continue the approach have not been established.

c. Fictitious Threshold Point (FTP). The equivalent of the landing threshold point (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 1-2).

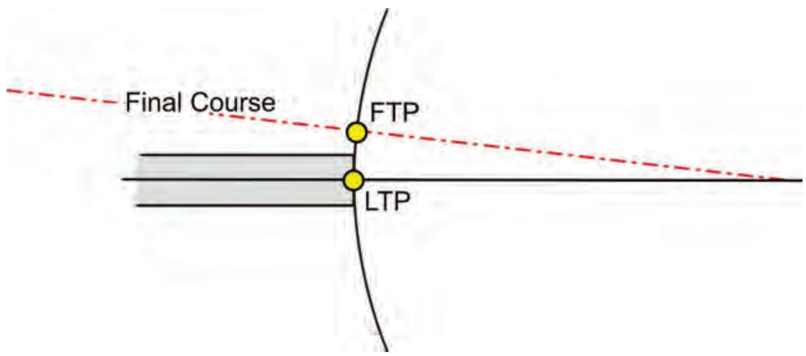
d. Glidepath Angle (GPA). The angular displacement of the glidepath from a horizontal plane that passes through the LTP/FTP. This angle is published on approach charts (e.g., 3.00 degrees, 3.20 degrees, etc.).

e. Glidepath Intercept Point (GPIP). The point on the final approach course where the glidepath of an ILS, MMLS, PAR, or LDA w/glide slope intercepts the intermediate segment altitude.

f. Height Above Touchdown (HAT). The height of the DA above touchdown zone elevation (TDZE).

g. Landing Threshold Point (LTP). The LTP is the intersection of the runway centerline and the runway threshold (see figure 1-2). 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.

Figure 1-2. Landing Threshold Point and Fictitious Threshold Point



h. Legacy. When text in this volume is prefaced with "(LEGACY)," it indicates a term, policy, formula, OEA construction, or OCS evaluation associated with a previous standard that is considered valid until the current standard is implemented in procedure design software.

i. Mobile Microwave Landing System (MMLS) [Military Only]. MMLS can be configured in two ways; "Split Site" where the azimuth and elevation antennas are sited the same as an ILS, or "Collocated Site" where the azimuth and elevation antennas are located together along side the runway. "Split Site" is the normal configuration for "fixed" MMLS locations to meet the capability of standard MMLS avionics receiver equipment. Aircraft that will use MMLS procedures configured as a "Collocated Site" must have a special avionics receiver capable of computing the offset runway centerline location. These procedures will have the following caveat: "COMPUTED APPROACH: FOR USE BY AIRCRAFT CAPABLE OF COMPUTING OFFSET RUNWAY CENTERLINE ONLY." Since the MMLS has a selectable azimuth and glide slope, procedures will be published with the caveat: "FLYING OTHER THAN PUBLISHED AZIMUTH AND/OR GS ANGLE RENDERS THE PROCEDURE UNUSABLE." MMLS equipment computing capability for "collocated" configuration requires that all system components (DME/P, AZ, and EL) must be operating, thus the following caveat must be published: "ALL SYSTEM COMPONENTS MUST BE OPERATIONAL."

j. Obstacle Clearance Surface (OCS). An inclined obstacle evaluation surface associated with a glidepath. The separation between this surface and the glidepath defines the MINIMUM required obstacle clearance.

k. Positive Vertical/Horizontal Guidance. Glidepath or course guidance based on instrumentation indicating magnitude and direction of deviation from the prescribed glidepath or course on which obstacle clearance is based.

l. Precise Final Approach Fix (PFAF). For PA/APV approaches, it is the point on the final approach course where the GPA intercepts the intermediate segment altitude (glidepath intercept altitude). The PFAF is identified by a fix to define the beginning of the PA/APV final segment.

m. Radio Altimeter Height (RA). An indication of the vertical distance between a point on the nominal glidepath at DA and the terrain directly beneath this point.

n. Runway Threshold (RWT). The RWT marks the beginning of that part of the runway usable for landing (see figure 1-3). It extends the full width of the runway. Threshold elevation (THRe) is equal to the highest MSL point along the RWT line.

Figure 1-3. Runway Threshold

o. Touchdown Zone Elevation (TDZE). The highest elevation in the first 3000 feet of the landing surface.

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Chapter 2. General Criteria

2-0. Policy Directives. The following directives apply unless otherwise specified in this volume:

a. Order 7130.3, Holding Pattern Criteria.

b. Order 8260.3, United States Standard for Terminal Instrument Procedures (TERPS), volume 1;

c. Order 8260.19, Flight Procedures and Airspace;

2-1. Calculations. Formulas within this volume require radian calculations.

2-2. Feeder, Initial, and Intermediate Segments. Apply criteria in volume 1 except as follows:

a. Initial Segment.

(1) Procedure Turn (PT). The PT completion altitude must not be lower than the glidepath intercept altitude or more than 500 feet above the PFAF altitude.

(2) High Altitude Teardrop Penetration Turn. The penetration turn completion altitude must not be lower than the PFAF altitude or more than 4000 feet above the glidepath intercept altitude.

b. Intermediate Segment. The intermediate segment begins at the IF and extends along the final approach course extended to the PFAF. Where a turn from the initial course to the final approach course extended is required, the initial course must intercept at or before the IF.

(1) Length. The MINIMUM length of the intermediate segment is 2 NM. Minimum segment length varies where a turn is required at the IF. The length is determined by the magnitude of heading change in the turn on to the final approach course extended (see figure 2-1 and formula 2-1). The maximum angle of intersection is 90 degrees unless a lead radial as specified in volume 1, paragraph 232a, is provided and the length of the intermediate segment is increased as specified in volume 1, table 3. Where the initial segment is based on an arc and the DME source is not collocated (see Order 6050.32 for collocation parameters) with the FAC facility, determine the intercept initial/intermediate segment intercept angle on approach procedures as follows:

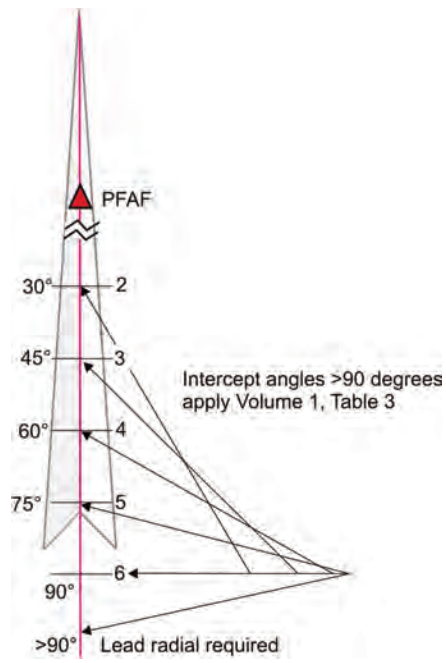
Formula 2-1. Minimum Intermediate Segment Length

$$\text{CAT A,B} = \frac{\theta}{18} \qquad \text{CAT C,D,E} = \frac{\theta}{15}$$

where θ = Intercept angle

Example: $\frac{42}{18} = 2.33$ NM **Example:** $\frac{42}{15} = 2.8$ NM

Figure 2-1. Minimum Intermediate Segment Length, CAT C, D, E



(a) Use formula 2-2 where the DME source is on the arc side of the FAC extended (see figure 2-2A).

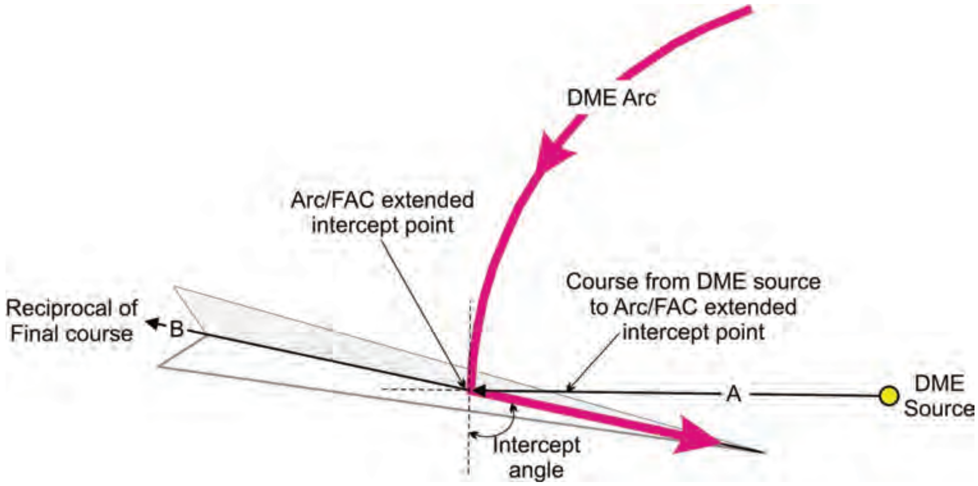
Formula 2-2. FAC intercept angle, DME Source on Arc Side

$$90 - |A-B| = \text{Intercept Angle}$$

where
A = Course from DME source to intercept point
B = Reciprocal of FAC

Example: $90 - |270-285| = 75°$

Figure 2-2A. DME Source on Arc Side



(b) Use formula 2-3 where the DME source is not on the arc side of the FAC extended (see figure 2-2B).

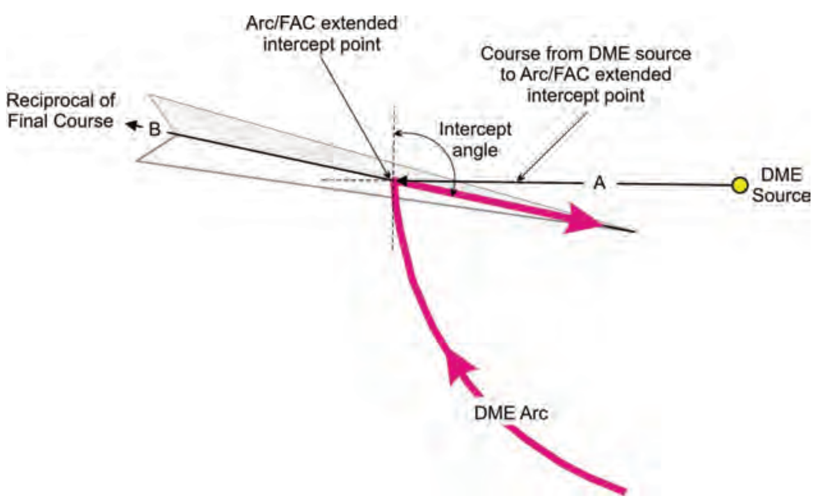
Formula 2-3. FAC Intercept Angle, DME Source Opposite the Arc Side

$$90 + |A-B| = Intercept\ Angle$$

where
A = Course from DME source to intercept point
B = Reciprocal of FAC

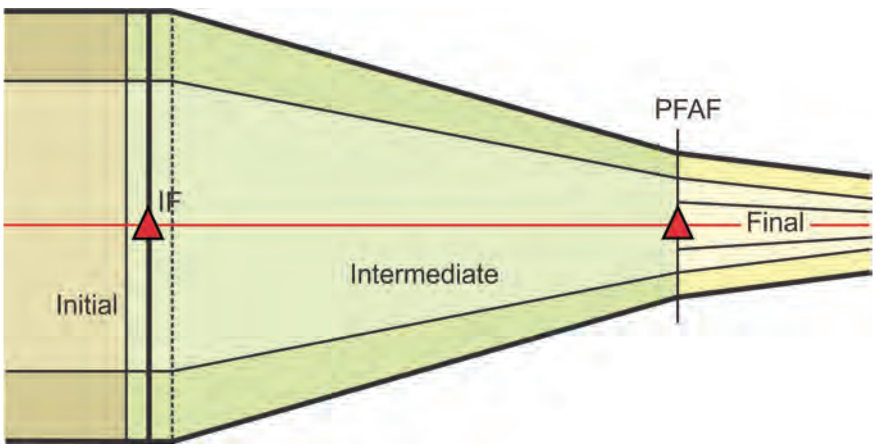
Example: 90 +|270–285|= 105º

Figure 2-2B. DME Source Opposite the Arc Side



(2) Width. The intermediate trapezoid begins at the width of the initial segment at the earliest point the IF can be received, and beginning at the latest point the IF can be received it tapers to the width of the final segment at the plotted position of the PFAF (see figure 2-3).

Figure 2-3. Intermediate Segment Width



(3) Altitude selection. The intermediate altitude must not be lower than the glidepath intercept altitude.

2-3. General PA Requirements. See Order 8260.19 for requirements related to GPA/TCH coincidence.

a. GPA. Utilize a standard 3-degree GPA where possible. GPAs greater than 3 degrees but not more than the maximum (table 2-1) are authorized without approval when needed to provide obstacle clearance or to meet simultaneous parallel approach standards. Other cases or GPAs less than 3 degrees require Flight Standards or military authority approval (USAF not applicable).

Table 2-1. Maximum GPAs

Category	GPA
A (80 knots or less)	6.4
A (81-90 knots)	5.7
B	4.2
C	3.6
D & E	3.1

b. TCH. The published TCH (nearest whole foot) should accommodate the largest aircraft height group normally expected to use the runway and must not be less than the minimum or exceed the maximum TCH.

Note: 60 feet is the maximum TCH regardless of height group.

(1) CAT I. The TCH is based on achieving an acceptable wheel crossing height (WCH). The WCH is the difference between the TCH and the approximate glidepath antenna-to-wheel height (see table 2-2).

(a) The optimum TCH provides a 30-foot WCH. It must provide a WCH no less than 20 feet or greater than 50 feet.

(b) Displaced Threshold Considerations. The TCH over a displaced threshold can result in a WCH of not less than 10 feet if the height of the glide path over the beginning of the full strength runway pavement suitable for landing falls within the minimum/maximum TCH values.

(2) CAT II/III. The optimum TCH is 55 feet and must be between 50 and 60 feet regardless of height group.

Table 2-2. TCH Requirements

Representative Aircraft Type	Glidepath-to-Wheel Height*	Recommended TCH	Remarks
HEIGHT GROUP 1 General Aviation, Small Commuters, Corporate Turbojets, T-38, C-12, C-20, C-21, T-1, Fighter Jets, UC-35, T-3, T-6	10 feet or less	40 feet	Normally runways <6,000 long with reduced widths and/ or limited weight bearing, limiting larger aircraft use.
HEIGHT GROUP 2 F-28, B-737, C-9, DC-9, C-130, T-43, B-2	15 feet	45 feet	Regional airport with limited air carrier service.
HEIGHT GROUP 3 B-727/707/720/757, B-52, C-135, C-141, C-17, E-3, P-3, E-8, C-32	20 feet	50 feet	Runways not normally used by aircraft with ILS glidepath-to-wheel heights > 20 feet.
HEIGHT GROUP 4 B-747/767/777, DC-10, A-300, B-1, KC-10, E-4, C-5, VC-25	25 feet	55 feet	Most primary runways at major airports.

***Approximate**

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

c. PFAF/GPIP.

(1) Calculate the along-track distance in feet from the LTP/FTP to the PFAF/GPIP using formula 2-4.

Formula 2-4. Distance LTP/FTP to PFAF/GPIP

$$D_{PFAF(ft)} = r \times \frac{\ln\left(\frac{r + PFAF_{alt}}{r + LTP_{elev} + TCH}\right)}{\tan\left(GPA \times \frac{\pi}{180°}\right)}$$

where
LTP_{elev} = LTP/FTP MSL elevation
$PFAF_{alt}$ = minimum intermediate segment altitude
r = 20890537

(2) Distance Measuring Equipment (DME). The plotted position of a DME fix used to identify a PFAF/GPIP must be within 16.66 NM of the DME facility. When the DME facility is not collocated with the facility providing FAC lateral guidance, the angular divergence must not exceed 6 degrees (Military 23 degrees).

d. Glidepath Qualification Surface (GQS). PA/APV approaches are not authorized where obstacles penetrate the GQS surface, except where mitigated (e.g., approach restricted to Height Group 1 and 2 aircraft) and approved by Flight Standards or military authority or when obstacles are permitted by paragraph 2-4c.

(1) Area. The GQS area begins at the LTP and extends to the DA point. Its beginning width is 100 feet from the runway edges. All width calculations are based on distance measured along runway centerline. Calculate GQS half-width at DA point using formula 2-5a. Calculate the half-width at any distance using formula 2-5b (see figure 2-4).

Formula 2-5a. GQS Half-Width at DA Point

$$0.036D + 392.8$$

where
D = LTP to DA point distance (ft)

Formula 2-5b. GQS Half-Width at Specified Distance

$$\left(\frac{E-k}{D} \times d\right) + k$$

where

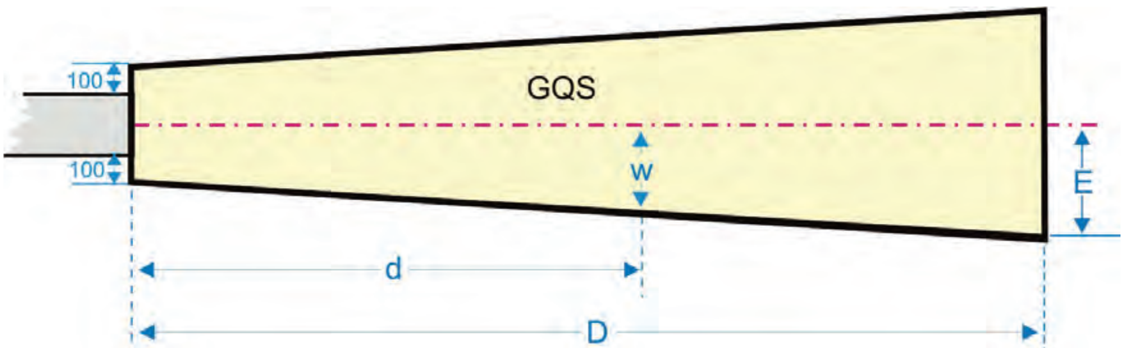
D = LTP to DA point distance (ft)

d = specified distance (ft) from LTP

$E = 0.036D + 392.8$

$$k = \frac{RWY_{WIDTH}}{2} + 100$$

Figure 2-4. GQS Area



(2) Offset Area. Where the course is offset from the runway centerline more than 3 degrees, expand the GQS area on the side of the offset as follows, referring to figure 2-5A:

(a) Step 1 - Construct line "BC." Locate point "B" at the intersection of the runway centerline extended and a line perpendicular to the final approach course at the DA point. Calculate the half-width (E) of the GQS for the distance from point "B" to the LTP. Locate point "C" at distance "E" on a line perpendicular to the final approach course. Connect points "B" and "C."

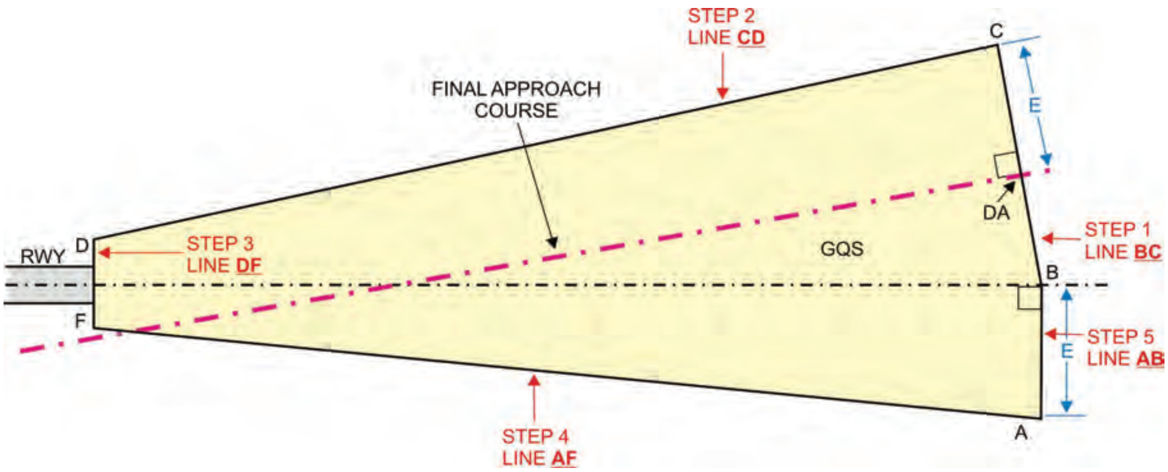
(b) Step 2 - Construct line "CD." Locate point "D" abeam the LTP on a line perpendicular to runway centerline at a point 100 feet from the runway edge. Connect points "C" and "D."

(c) Step 3 - Construct line "DF." Locate point "F" abeam the LTP on a line perpendicular to runway centerline at a point 100 ft from the runway edge (opposite point "D"). Connect points "D" and "F."

(d) Step 4 - Construct line "AF." Locate point "A" on a line perpendicular to the runway centerline extended at distance "E" from point "B." Connect points "A" and "F."

(e) Step 5 - Construct line "AB." Connect points "A" and "B."

Figure 2-5A. Offset GQS Area Construction



e. Calculate the width of the non-offset side at a specified distance using formula 2-6a. Calculate the width of the offset side at a specified distance using formula 2-6b. See figure 2-5B.

Formula 2-6a. GQS Non-offset Side Width at Specified Distance

$$\left(\frac{E-k}{D} \times d\right) + k$$

where

D = distance (ft) LTP to point B

d = specified distance (ft) from LTP

$E = 0.036D + 392.8$

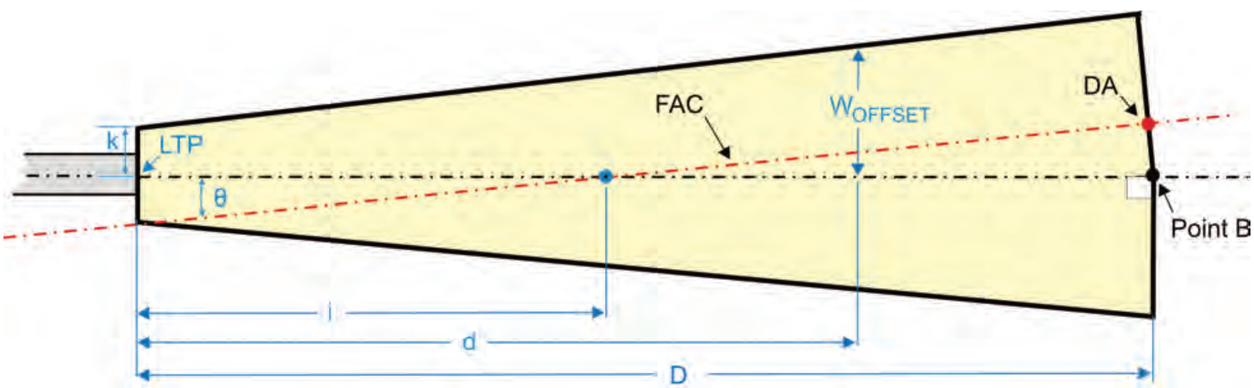
$$k = \frac{RWY_{WIDTH}}{2} + 100$$

Formula 2-6b. GQS Offset Side Width, at Specified Distance

$$W_{OFFSET} = d\left(\frac{\cos\left(\theta \times \frac{\pi}{180^\circ}\right) \times \left[\sin\left(\theta \times \frac{\pi}{180^\circ}\right) \times (D-i)+E\right]-k}{D-\sin\left(\theta \times \frac{\pi}{180^\circ}\right) \times \left[\sin\left(\theta \times \frac{\pi}{180^\circ}\right) \times (D-i)+E\right]}\right)+k$$

where
- d = specified distance (ft) from LTP
- θ = FAC offset (degrees)
- D = distance (ft) LTP to point B
- i = distance (ft) LTP to FAC/RCL intersection
- $E = 0.036D + 392.8$
- $k = \frac{RWY_{WIDTH}}{2} + 100$

Figure 2-5B. Offset GQS Area Width at Specified Distance



2-4. Obstacle Clearance Surface.

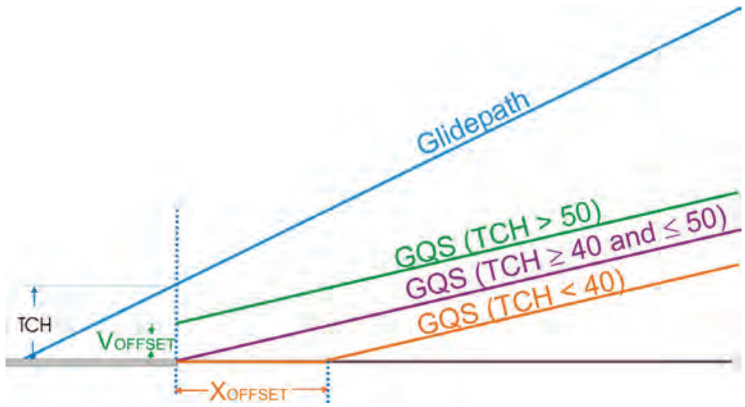
a. Origin. The surface origin and height is based on TCH. See figure 2-5C.

(1) Where the TCH is > 50 feet, the sloping surface starts at the beginning of the area. Starting height is TCH - 50 (V_{OFFSET}) above THRe.

(2) Where the TCH $\geq$ 40 feet and $\leq$ 50 feet, the sloping surface starts at the beginning of the area. Starting height is THRe.

(3) Where the TCH is < 40 feet, starting height is THRe. The area between the RWT and point X_{OFFSET} is a level surface and must be clear of obstacles except those permitted by the airport design standard. The sloping surface begins at X_{OFFSET} distance from RWT. Calculate X_{OFFSET} using formula 2-7.

Figure 2-5C. GQS Surface Origin/Height



Formula 2-7. GQS Sloping Surface X_{OFFSET} Distance

$$X_{OFFSET} = \frac{40 - TCH}{\tan\left(\theta \times \frac{\pi}{180°}\right)}$$

where
θ = GPA

b. Slope. The OCS slope is based on 2/3 x GPA.

(1) Calculate the height of the GQS above THRe (h_{GQS}) for distances greater than X_{OFFSET} using formula 2-8 (adjusts for along-centerline earth curvature):

Formula 2-8. GQS Height above THRe

$$h_{GQS} = \frac{(r + F + V_{OFFSET})\cos\left(\frac{2\theta}{3} \times \frac{\pi}{180°}\right)}{\cos\left(\frac{d - X_{OFFSET}}{r} + \frac{2\theta}{3} \times \frac{\pi}{180°}\right)} - r$$

where
r = 20890537
F = THRe
d = distance (ft) greater than X_{OFFSET} from LTP
θ = GPA

(2) Lateral Earth Curvature. The MSL elevation (OBS_{MSL}) of an obstacle may be reduced to account for earth curvature based on distance from runway centerline. This reduced value is termed the obstacle effective elevation (O_{EE}). Calculate O_{EE} using formula 2-9.

Formula 2-9. Obstacle MSL Elevation Adjusted For Earth Curvature

$$O_{EE} = OBS_{MSL} - (r + THRe) \times \left(\frac{1}{\cos\left(\frac{OBS_Y}{r}\right)} - 1 \right)$$

where

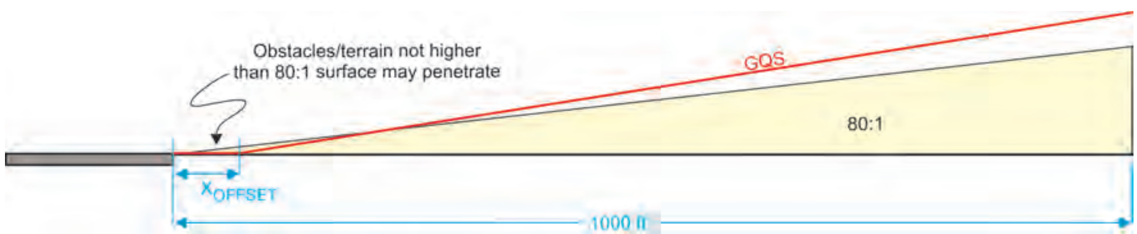
OBS_{MSL} = obstacle MSL elevation
r = 20890537
OBS_Y = distance (ft) from RCL to obstacle

c. Obstacles and terrain allowed by standard application of AC 150/5300-13, Airport Design requirements (military equivalent at military airfields) may penetrate the GQS without mitigation as follows. See figure 2-5D.

(1) Where the TCH is less than 40 feet, obstacles with an effective height at or below an 80:1 surface (or military equivalent) originating at LTP at threshold elevation for a distance of 1000 feet.

(2) Above-ground objects permitted by AC 150/5300-13 (or military equivalent).

Figure 2-5D. GQS Surface Origin/Height



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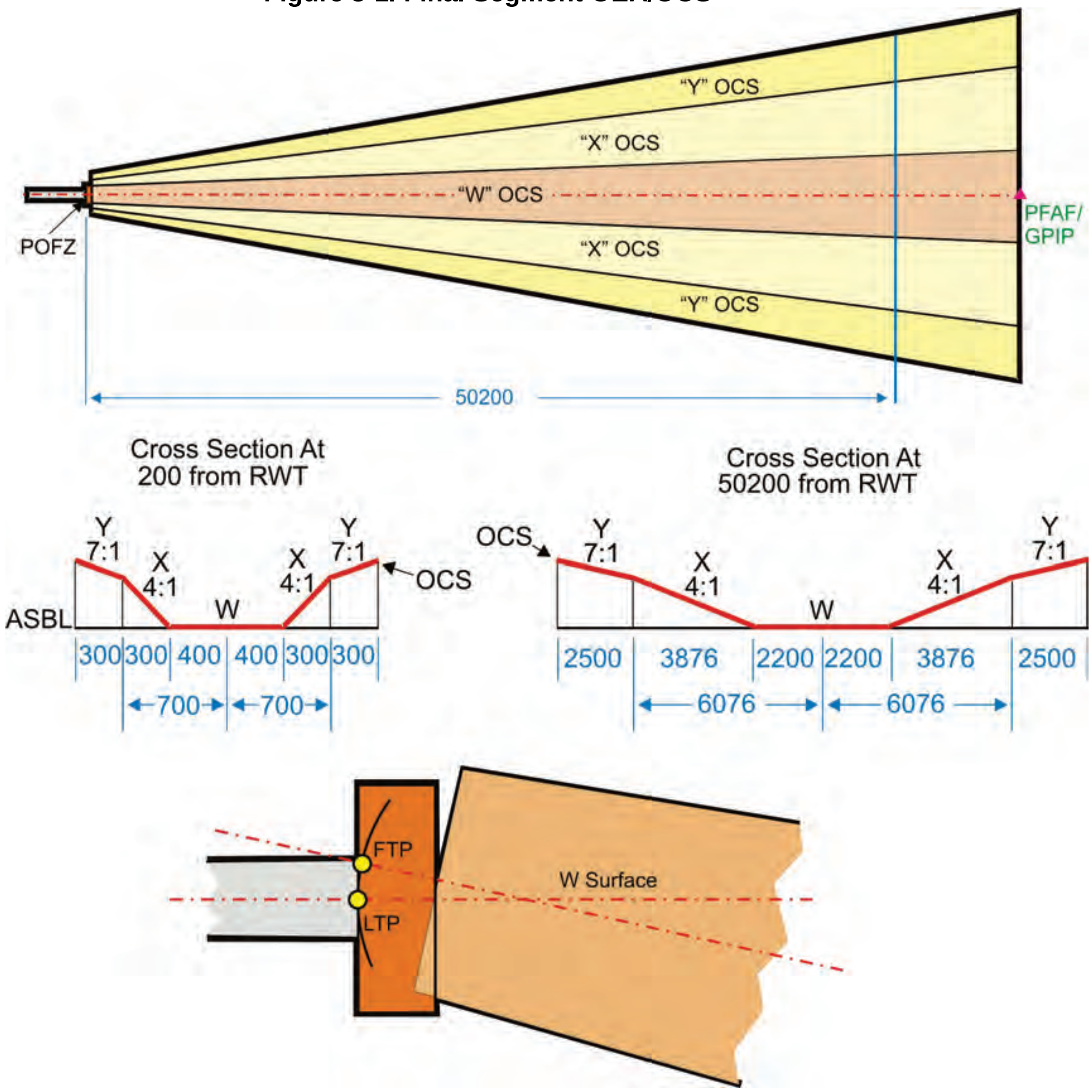
CHAPTER 3. PRECISION FINAL AND MISSED APPROACH SEGMENTS

3.0 FINAL SEGMENT.

The area originates 200 feet from LTP or FTP and ends at the PFAF/Glide path intercept point (GPIP). The primary area consists of the “W” and “X” OCS, and the secondary area consists of the “Y” OCS. See figure 3-1.

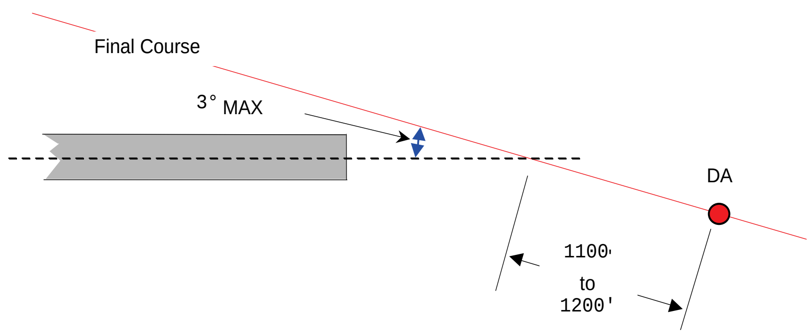
Figure 3-1. Final Segment OEA/OCS



3.1 ALIGNMENT.

The final course is normally aligned with the RCL extended (±0.03°) through the LTP/RWT (± 5 feet). Where a unique operational requirement indicates a need to offset the course from RCL, the offset must not exceed three degrees. The offset course must intersect the runway centerline at a point 1100 to 1200 feet inside the DA point (see figure 3-2). For offset courses the minimum HAT is 250 feet and RVR 2400.

Figure 3-2. Offset Final



3.2 OCS SLOPE(S).

In this document, slopes are expressed as run over rise; e.g., 34:1. Determine the OCS slope associated with a specific GPA using the following formula:

$$S = \frac{102}{GPA}$$

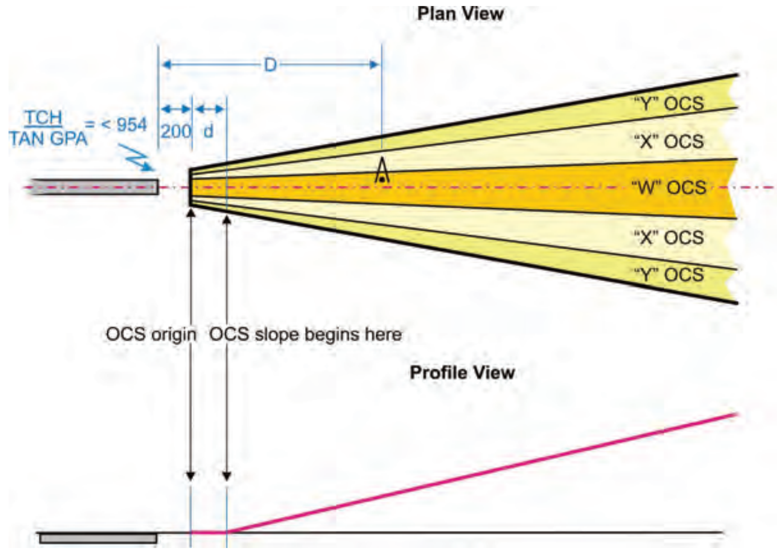
3.2.1 Origin.

The OEA (all OCS surfaces) originates from LTP elevation at a point 200 feet from LTP/FTP (see figure 3-3) measured along course centerline and extends to the GPIP. The longitudinal (along-track) rising W surface slope begins at a point 200+d feet from OEA origin. Calculate "d" using the following formula(s).

where $\frac{TCH}{\tan\left(GPA \times \frac{\pi}{180^\circ}\right)} \geq 954$, d equals 0.

where $\frac{TCH}{\tan\left(GPA \times \frac{\pi}{180^\circ}\right)} < 954$, calculate d using $d = 954 - \frac{TCH}{\tan\left(GPA \times \frac{\pi}{180^\circ}\right)}$

Figure 3-3. OCS Slope Origin When $\frac{TCH}{\tan\left(GPA \times \frac{\pi}{180°}\right)} < 954$



3.2.2 Revising GPA for OCS Penetrations.

Raising the GPA may eliminate OCS penetrations. To determine the revised minimum GPA, use the following formula:

$$GPA_{revised} = \frac{102\left[\frac{D-(200+d)}{s} + p\right]}{D-(200+d)}$$

where

D = distance (ft) from LTP/FTP
d = value from paragraph 3.2.1
s = W surface slope
p = penetration in feet

Note: *Round to the next higher hundredth (0.01) degree to avoid small penetration values caused by the revised angle*.

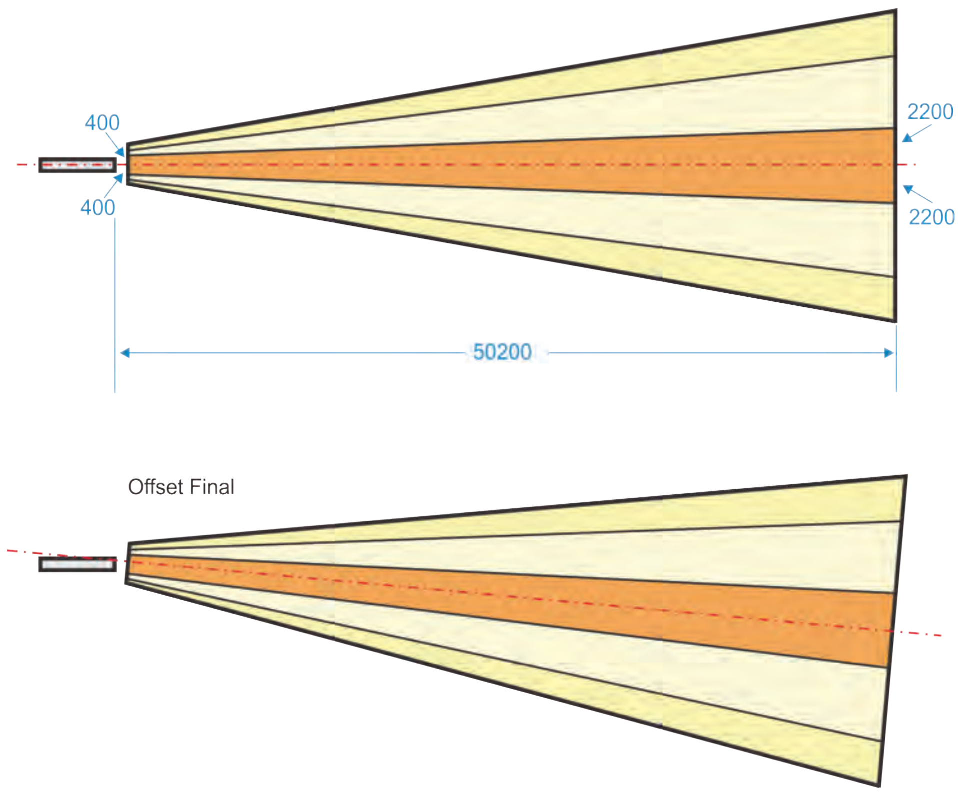
3.3 AIRPORT DESIGN STANDARDS/OBSTACLE FREE ZONES (OFZ).

The airport owner/sponsor is responsible for meeting AC 150/5300-13, Airport Design OFZ requirements (military directives apply at military installations). Minimums may be impacted where OFZ requirements have not been met.

Figure 3-4. Reserved.

3.4 **"W" OCS.** See figure 3-5.

Figure 3-5. "W" OCS



3.4.1 **Width.** The width is 400 feet either side of course at the beginning, and expands uniformly to 2200 feet either side of course 50200 feet from LTP/FTP, as defined by the formula:

3.6.2 Height. The "Y" OCS begins at the height of the "X" surface at distance "D" from LTP or FTP, and rises at a slope of 7:1 in a direction perpendicular to the final approach course. The height (Z_Y) of the "Y" surface above ASBL is defined by the formula:

$$Z_Y = \frac{D-(200+d)}{S} + \frac{D_X-D_W}{4} + \frac{D_O-D_X}{7}$$

where

- D = *distance (ft) from LTP/FTP*
- d = *value from paragraph 3.2.1*
- D_W = *perpendicular distance (ft) from FAC to "W" surface outer boundary*
- D_x = *perpendicular distance (ft) from FAC to "X" surface outer boundary*
- D_O = *perpendicular distance (ft) from FAC to "Y" surface obstacle*

3.6.3 "Y" OCS Penetrations. Lowest minimums can be achieved when the "Y" OCS is clear. When the OCS is penetrated, remove the obstacle or reduce its height. If not possible, take one or more of the following actions:

3.6.3 **a. Adjust DA** for existing obstacles (see paragraph 3.8).

3.6.3 **b. Displace threshold.**

3.6.3 **c. Offset final course.**

3.6.3 **d. Raise GPA** (see paragraph 3.2.2).

3.7 DECISION ALTITUDE (DA) AND HEIGHT ABOVE TOUCHDOWN (HAT).

The DA value may be derived from the HAT. The minimum HAT for PA Category I is 200 feet. The minimum HAT for APV is 250. Calculate DA/HAT as follows:

$$DA = HAT + TDZE; \; HAT = DA - TDZE$$

3.8 ADJUSTMENT OF DA FOR FINAL APPROACH OCS PENETRATIONS. See figure 3-8. The DA may be increased to provide sufficient obstacle clearance. This adjustment is available for existing obstacles only. Proposed obstacles must not penetrate the OCS.

3.8.1 DA Distance from LTP/FTP. Determine the distance from LTP/FTP to the adjusted DA point using the formula:

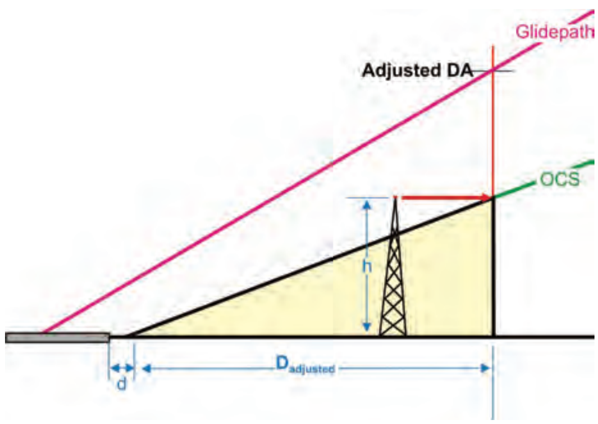
$$D_{adjusted} = \frac{102h}{GPA} + (200 + d)$$

where

$D_{adjusted}$ = *adjusted distance (ft) from LTP/FTP to DA*
d = *value from paragraph 3.2.1*
h = *obstacle height (ft) above ASBL*

Note: *For obstacles in the "X" surface, subtract "X" surface rise from h. If obstacle is in the "Y" surface, subtract "X" and "Y" surface rise from h.*

Figure 3-8. DA Adjustment



3.8.2 Calculate the adjusted DA. Application of this method need not require a DA greater than maximum ROC (paragraph 3.8.3) plus obstacle elevation.

$$DA = \tan GPA \left(\left[\frac{102h}{GPA} + (200 + d) \right] + \frac{TCH}{\tan\left(GPA \times \frac{\pi}{180^\circ}\right)} \right) + LTP/FTP_{elev}$$

where

d = *value from para. 3.2.1*
h = *obstacle height (ft) above ASBL*

Note: *For obstacles in the "X" surface, subtract "X" surface rise from h. If obstacle is in the "Y" surface, subtract "X" and "Y" surface rise from h.*

3.8.3 **Calculate the revised minimum HAT/maximum ROC** using the formula:

$$\frac{GPA}{3} \times 250$$

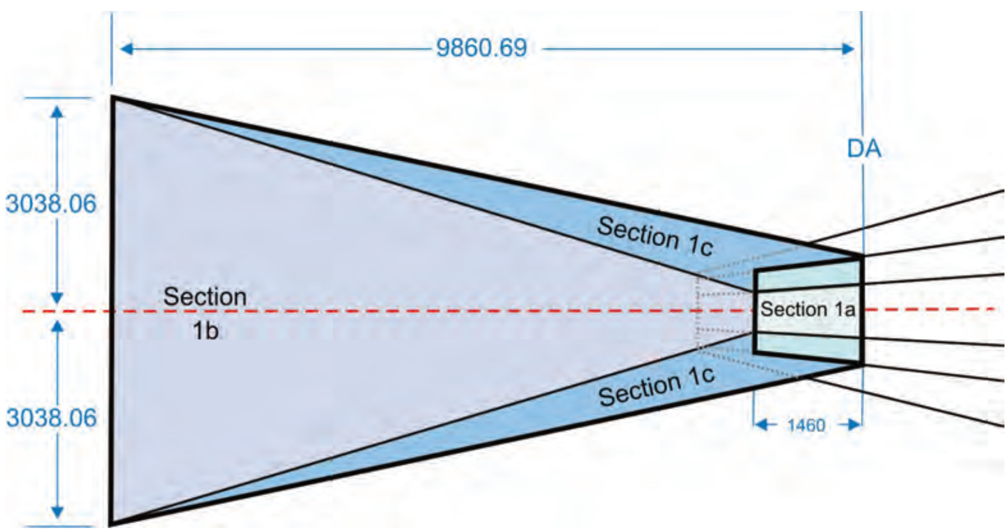
3.8.4 **Compare HAT based on adjusted DA and Minimum HAT.** Publish the DA associated with the higher of the two.

3.9 MISSED APPROACH.

The missed approach segment begins at DA and ends at the clearance limit. It is comprised of section 1 (initial climb) and section 2 (from end of section 1 to the clearance limit). Section 2 beginning width is ± 0.5 NM (± 3038.06 feet). The OCS begins at the elevation of section 1b at centerline. The MA procedure is limited to two turn fixes. Apply volume 1, paragraph 277e for climb-in-hold guidance.

3.9.1 **Section 1** (LEGACY)**.** Section 1 is aligned with the final approach course. It is comprised of 3 subsections, beginning at DA and extending 9860.69 feet (see figure 3-9A).

Figure 3-9A. Missed Approach Sections 1a, 1b, and 1c



3.9.1 **a. Section 1a** (LEGACY)**.**

3.9.1 a. (1) Area. Section 1a begins at the DA point and overlies the final approach primary ("W" and "X" surfaces) OCS, extending 1460 feet in the direction of the missed approach. This section is always aligned with the final approach course (see figure 3-9A).

3.9.1 a. (2) OCS. The height of the section 1a surface is equal to the underlying "W" or "X" surface as appropriate. If this section is penetrated, increase the DA using the formula (see figure 3-9B).

$$D_{adjusted} = \tan\left(GPA \times \frac{\pi}{180°}\right) x \left[\left(\frac{p}{\frac{1}{28.5}+\frac{GPA}{102}}\right) + d\right]$$

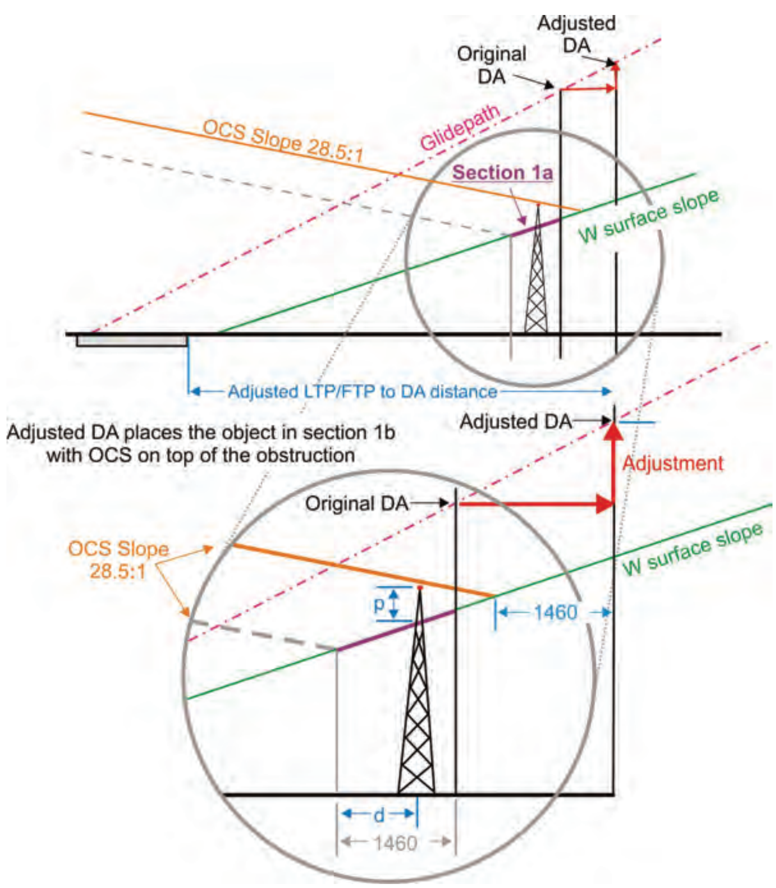
where

$d = X_O$ - [distance (ft) LTP/FTP to DA_{FINAL} - 1460]

X_O = distance (ft) LTP/FTP to obstacle

p = penetration (ft)

Figure 3-9B. Penetration of Section 1a OCS

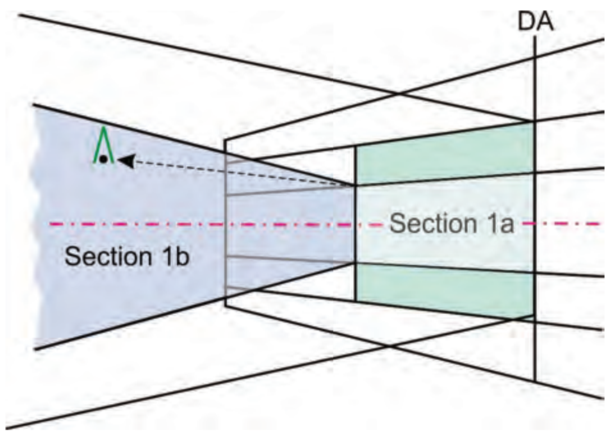


3.9.1 **b. Section 1b** (LEGACY)**.**

3.9.1 b. (1) Area. Section 1b begins at the end of section 1a aligned with the final approach course extended. The area starts at the width of the underlying "W" surface and splays to 1 NM wide at 9860.69 feet from DA (see figures 3-9A).

3.9.1 b. (2) OCS. Section 1b OCS is a 28.5:1 slope. The beginning height is equal to the height of the "W" OCS at the end of section 1a. Evaluate obstacles using the shortest distance from the end of section 1a (see figure 3-9C).

Figure 3-9C. Section 1b Obstacle Measurement



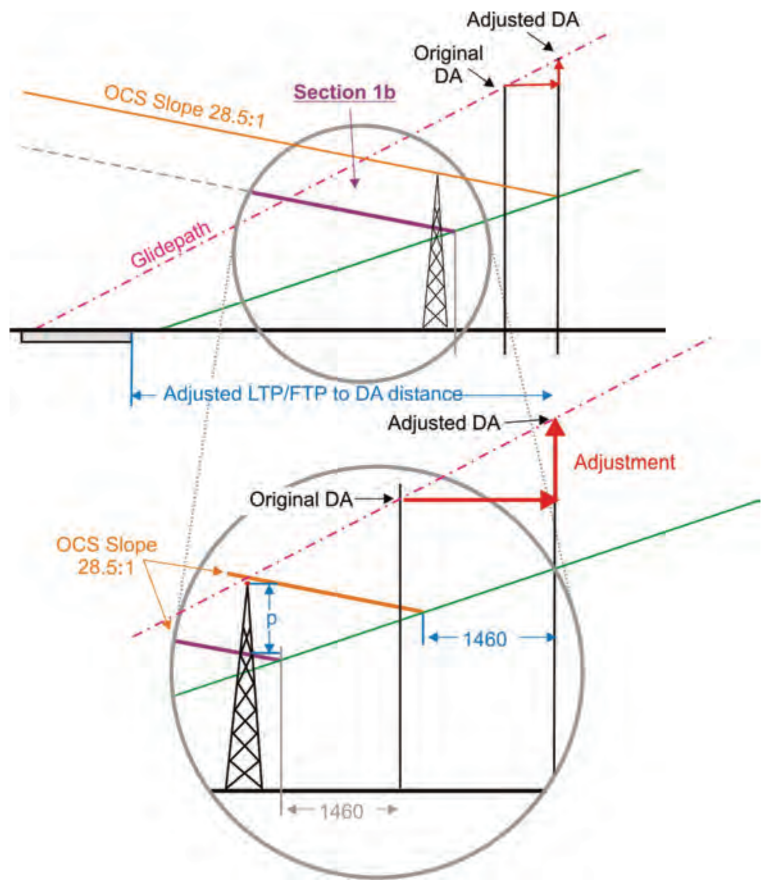
If this section is penetrated, increase the DA using the formula (see figure 3-9D);

$$D_{adjusted} = \tan(GPA \times \frac{\pi}{180^\circ})x\left[\left(\frac{p}{\frac{1}{28.5}+\frac{GPA}{102}}\right)\right]$$

where

p = penetration (ft)

Figure 3-9D. Penetration of Section 1b OCS

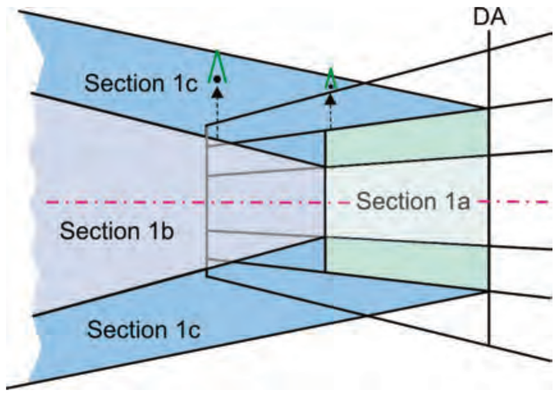


3.9.1 c. Section 1c (LEGACY)**.**

3.9.1 c. (1) Area. Section 1c begins at the DA point at the outer edges of section 1a and extends along both sides of sections 1a and 1b until terminating at the end of section 1b (see figure 3-9A).

3.9.1 c. (2) OCS. Two inclined planes starting at the DA point and sloping 7:1 perpendicular to the MA course. The inner boundaries originate at the elevation of the outer edges of the “W” surface at the beginning of section 1b. The outer boundaries originate at the elevation of the outer edges of the "X" surfaces at the DA point. These inner and outer boundaries converge at the end of section 1b (9860.69 feet from the DA point). Obstacles in section 1c, adjacent to the “X” surfaces, are evaluated with a 7:1 slope from the elevation of the outer boundaries of the “X” surfaces. Obstacles in section 1c, adjacent to section 1b, are evaluated using the 7:1 slope, beginning at the elevation at the outer edge of section 1b. Reduce the obstacle height by the amount of 7:1 surface rise from the edge of section 1a or 1b (measured perpendicular to section 1 course). Then evaluate the obstacle as if it were in section 1a or 1b.

Figure 3-9E. Section 1c Obstacle Measurement



3.9.2 Section 1. (Height Loss and Initial Climb).

Section 1 begins at DA (line CD) and ends at line AB. It accommodates height loss and establishment of missed approach climb gradient. Obstacle protection is based on an assumed minimum climb gradient of 200 ft/NM (≈30.38:1 slope). Section 1 is centered on a continuation of the final approach track and is subdivided into sections 1a and 1b (see figures 3-9F and 3-9G).

3.9.2 a. Section 1a.

Section 1a is a 1460 feet continuation of the FAS OCS beginning at the DA point to accommodate height loss. The portion consisting of the continuation of the W surface is identified as section 1aW. The portions consisting of the continuation of the X surfaces are identified as section 1aX. The portions consisting of the continuation of the Y surfaces are identified as section 1aY.

Figure 3-9F. Section 1, 3-D Perspective

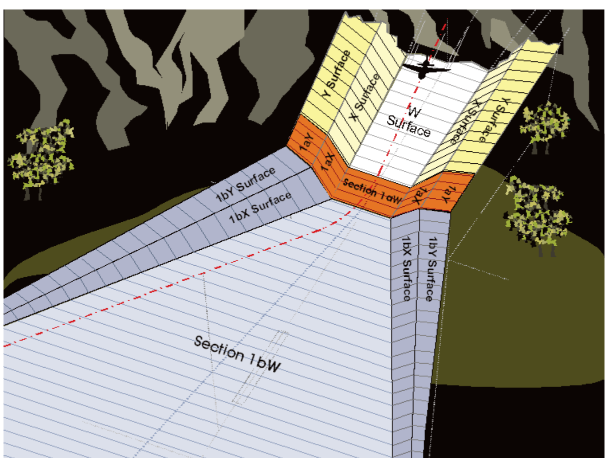
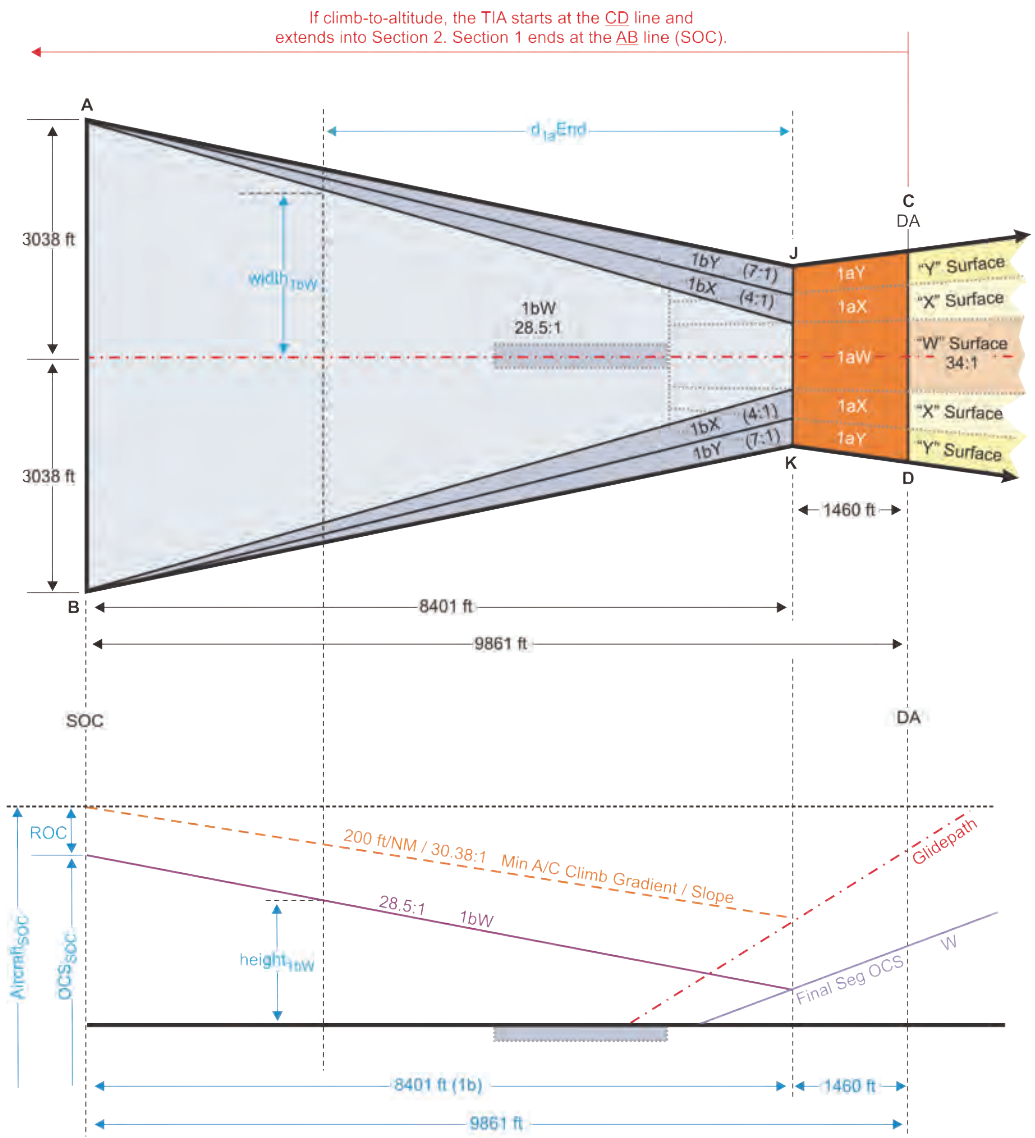


Figure 3-9G. Section 1, 2-D Perspective



3.9.2 b. Section 1b.

The section 1b surface extends from line JK at the end of section 1a as an up-sloping surface for a distance of 8401 feet to the line AB. Section 1b is subdivided into sections 1bW, 1bX, and 1bY (see figure 3-9G).

3.9.2 b. (1) Section 1bW. Section 1bW extends from the end of section 1aW for a distance of 8401 feet. Its lateral boundaries splay from the width of the end of the 1aW surface to a width of ± 3038 feet either side of the missed approach course at the 8401 feet point. Calculate the width of the 1bW surface ($width_{1bW}$) at any distance d_{1aEnd} from the end of section 1a using the formula.

$$width_{1bW}=\frac{d_{1aEnd}\times\left(3038-C_W\right)}{8401}+C_W$$

where

d_{1aEnd} = along-track distance (ft) from end of section 1a
C_W = half-width of 1aW surface at section 1a end

Calculate the elevation of the end of the 1aW surface ($elev_{1aEnd}$) using formula:

$$elev_{1aEnd}=\frac{\left(r+LTP_{elev}\right)\times\cos\left(atan\left(\frac{GPA}{102}\right)\right)}{\cos\left(\frac{X_{DA}-d-1660}{r}+atan\left(\frac{GPA}{102}\right)\right)}-r$$

where

X_{DA} = along-track distance (ft) from LTP to DA
d = value from para. 3.2.1
r = 20890537

The surface rises from the elevation of the 1aW surface at the end of section 1a at a slope ratio of 28.5:1. Calculate the elevation of the surface ($elev_{1bW}$) using the formula:

$$elev_{1bW}=\left(r+elev_{1aEnd}\right)\times e^{\left(\frac{d1_{aEnd}}{28.5\times r}\right)}-r$$

where

d_{1aEnd} = along-track distance (ft) from end of section 1a
r = 20890537

3.9.2 b. (2) Section 1bX. Section 1bX extends from the end of section 1aX for a distance of 8401 feet. Its inner boundary is the outer boundary of the 1bW surface. Its outer boundary splays from the end of the 1aX surface to a width of ± 3038 feet either side of the missed approach course at the 8401 feet point. Calculate the distance from the missed approach course centerline to the surface outer boundary ($width_{1bX}$) using the formula:

$$width_{1bX}=\frac{d_{1aEnd}\times\left(3038-C_X\right)}{8401}+C_X$$

where

d_{1aEnd} = along-track distance (ft) from end of section 1a
C_X = perpendicular distance (ft) from course centerline to 1aX outer edge at section 1a end

The surface rises at a slope ratio of 4:1 perpendicular to the missed approach course from the edge of the 1bW surface. Calculate the elevation of the 1bX missed approach surface ($elev_{1bX}$) using the formula:

$$elev_{1bX} = elev_{1bW} + \frac{a - width_{1bW}}{4}$$

where
a = perpendicular distance (ft) from the MA course

3.9.2 b. (3) Section 1bY. Section 1bY extends from the end of section 1aY for a distance of 8401 feet. Its inner boundary is the outer boundary of the 1bX surface. Its outer boundary splays from the outer edge of the 1aY at the surface at the end of section 1a to a width of ± 3038 feet either side of the missed approach course at the 8401 feet point. Calculate the distance from the missed approach course centerline to the surface outer boundary ($width_{1bY}$) using the formula:

$$width_{1bY} = \frac{d_{1aEnd} \times (3038 - C_Y)}{8401} + C_Y$$

where
d_{1aEnd} = along-track distance (ft) from end of section 1a
C_Y = perpendicular distance (ft) from course centerline to 1aY outer edge at section 1a end

The surface rises at a slope ratio of 7:1 perpendicular to the missed approach course from the edge of the 1bX surface. Calculate the elevation of the 1bY missed approach surface ($elev_{1bY}$) using the formula:

$$elev_{1bY} = elev_{1bX} + \frac{a - width_{1bX}}{7}$$

where
a = perpendicular distance (ft) from the MA course

3.9.2 c. Section 1 Surface Height Evaluation.

3.9.2 c. (1) Section 1a. Obstacles that penetrate these surfaces are mitigated during the final segment OCS evaluation. However, in the missed approach segment, penetrations are not allowed; therefore, penetrations must be mitigated by:

- Raising TCH (if GPI is less than 954 feet).
- Removing or reducing obstruction height.
- Raising glidepath angle.
- Adjusting DA (for existing obstacles).

3.9.2 c. (2) Section 1b. The DA is adjusted (raise and consequently move further away from LTP/FTP) by the amount necessary to raise the 1b surface above the penetration. For a 1b surface penetration of p ft, the DA point must move ΔX_{DA} feet farther from the LTP/FTP using the formula:

$$\Delta X_{DA} = \frac{2907 \times p}{28.5 \times GPA + 102}$$

where

p = amount of penetration (ft)

This increase in the DA to LTP distance raises the DA (and HAT). Calculate the adjusted DA ($DA_{adjusted}$), rounding up the result to the next 1-foot increment using the formula:

$$DA_{adjusted} = \tan\left(GPA \times \frac{\pi}{180^\circ}\right) \times \left(X_{DA} + \Delta X_{DA}\right) + LTP_{elev} + TCH$$

where

ΔX_{DA} = DA adjustment from previous formula

X_{DA} = along track distance from LTP/FTP to original DA

3.9.2 d. End of Section 1 Values.

The end of section 1 (line AB) is considered Start of Climb (SOC). Calculate the assumed MSL altitude of an aircraft on missed approach, the OCS MSL elevation, and the ROC at the end of section 1 (line AB) using the formulas:

$$Aircraft_{SOC} = DA - \tan\left(GPA \times \frac{\pi}{180^\circ}\right) \times 1460 + 276.525$$

$$OCS_{SOC} = \left(r + elev_{1Aend}\right) e^{\left(\frac{8401}{28.5 \times r}\right)} - r$$

$$ROC_{SOC} = Aircraft_{SOC} - OCS_{SOC}$$

where

r = 20890537

DA = Published decision altitude (MSL)

$elev_{1Aend}$ = value from paragraph 3.9.2b(1)

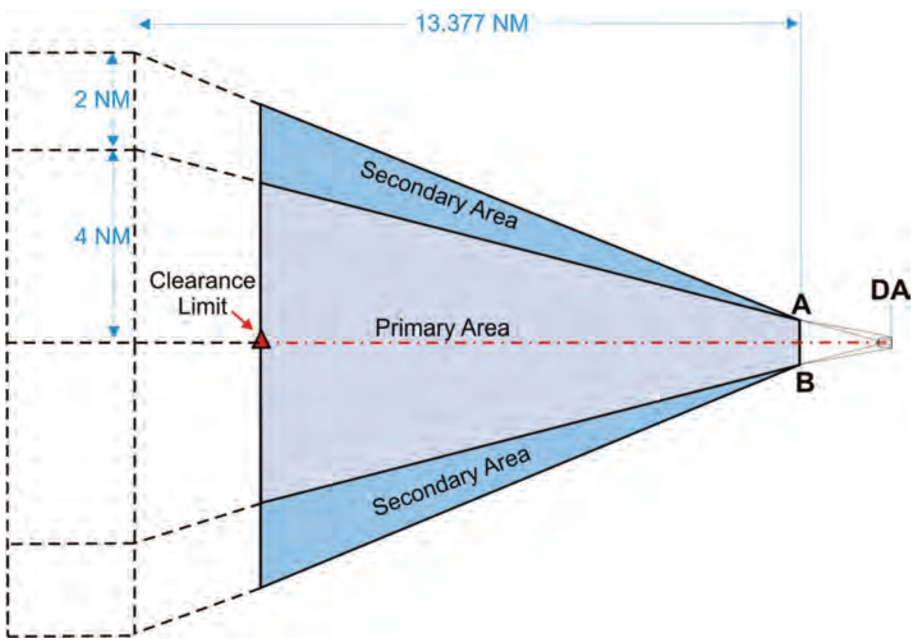
d = value from para. 3.2.1 for GPI $<$ 954, 0 for GPI $\geq$ 954

3.9.3 **Section 2.** Section 2 starts at the end of section 1 centered on the published missed approach course and ends at the clearance limit. Secondary areas may be established where PCG is available. Apply volume 1 paragraph 277d to determine the preliminary charted missed approach altitude; 277e to assess the need for a climb-in-holding evaluation. Apply paragraph 277f to determine the charted missed approach altitude.

3.9.3 **a. Straight.** Apply to turns of 15 degrees or less from continuation of FAC (LEGACY) otherwise apply when missed is a continuation of FAC (within 0.03 degrees).

3.9.3 a. (1) Straight Area. The width increases from ± 3038 feet at line AB to reach ± 6 NM at a point 13.377 NM from the beginning. Where applicable, secondary areas begin at 0 NM wide and expands to reach 2 NM on both sides of the primary area at 13.377 NM (see figure 3-10).

Figure 3-10. Section 2, Straight Missed Approach with PCG



3.9.3 a. (2) Obstacle Clearance. Within the primary area, obstacles are measured shortest distance to line AB. The Section 2 OCS start height is the section 1 OCS end elevation. The standard OCS is a 40:1 slope (LEGACY). Otherwise calculate the OCS slope using formula:

$$MA_{OCSslope} = \frac{1852}{0.3048 \times (CG - 48)}$$

where
CG = Climb gradient (normally 200 ft/NM)

For obstacles in the secondary area, apply the primary OCS slope to a point abeam the obstacle then apply a 12:1 secondary OCS (perpendicular to track) from the primary boundary to the obstacle.

3.9.3 **b. Turning.** Apply to turns of more than 15 degrees from continuation of FAC (LEGACY) otherwise apply when missed differs from FAC more than 0.03 degrees. Design the procedure to accommodate aircraft turning at an altitude at least 400 feet above the TDZE, assuming aircraft are 200 feet above the published DA at the end of section 1b.

3.9.3 b. (1) Turning Area. The inside turn boundary connects to points C, B or T (when it exists) whichever results in the larger area. Point B is on the outside turn edge at the end of section 1b. Point C is on the inside turn edge of section 1a adjacent to DA. Point T (when it can be determined) is the point of tangency between the outer boundary radius and the inner boundary expansion line. The outside turn boundary always connects to point B. The flight track and outer boundary radii must be as specified in volume 1, paragraph 275 and table 5. The outer and inner boundaries expand to reach ± 6 NM at a point 13.377 NM from the beginning. Where applicable, secondary areas begin after completion of the turn at 0 NM wide and expand to reach 2 NM on both sides of the primary area at 13.377 NM (see figure 3-11).

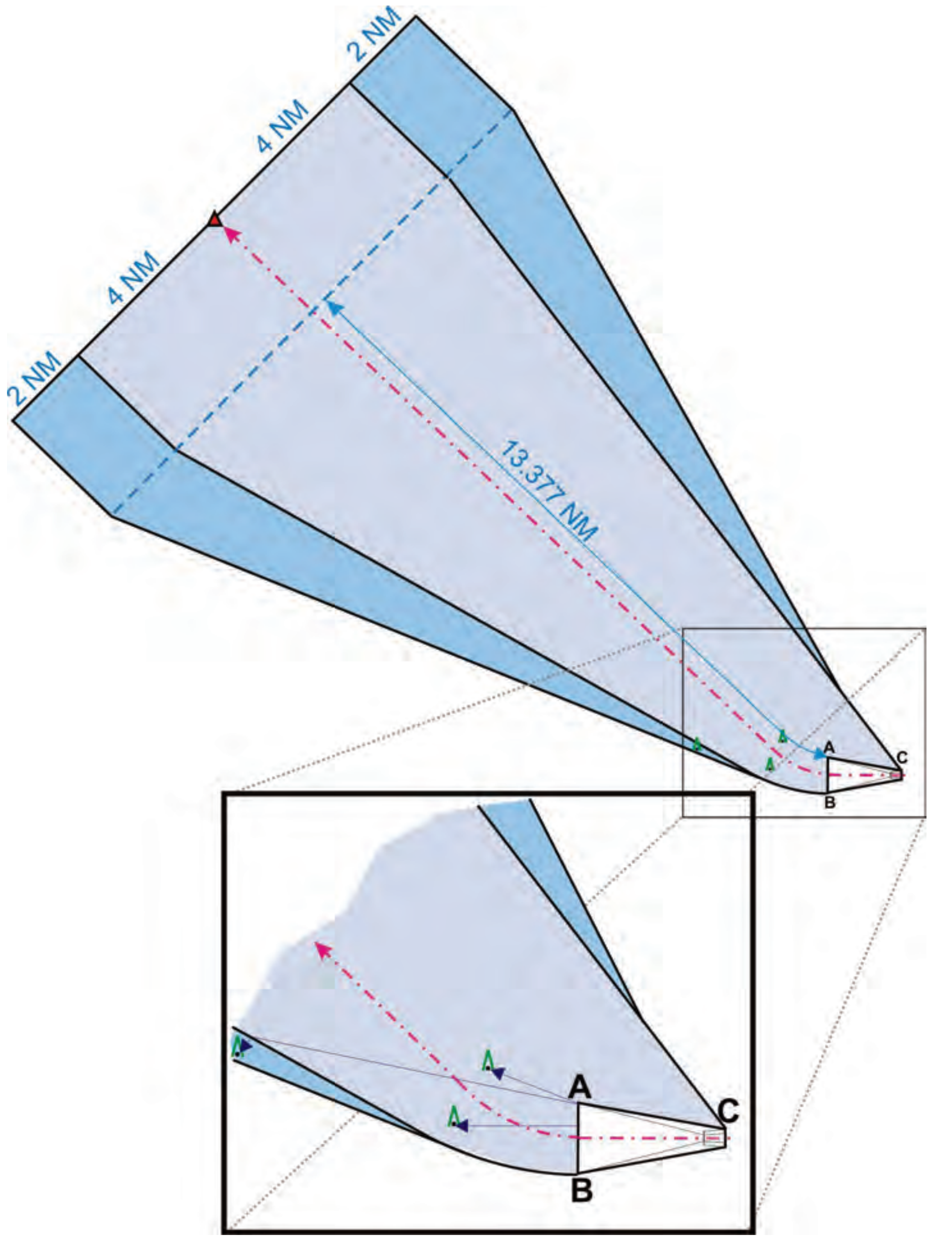
3.9.3 b. (2) Turning Obstacle Clearance. Apply volume 1, paragraph 276 except Zone 1 is not applicable. In Zone 2, obstacles are measured shortest distance to the section 1 outer boundary. In Zone 3, obstacles are measured shortest distance to point C. The OCS start height is the section 1 OCS end elevation. The standard OCS is a 40:1 slope (LEGACY). Otherwise calculate the OCS slope using formula:

$$MA_{OCSslope} = \frac{1852}{0.3048 \times (CG - 48)}$$

where
CG = Climb gradient (normally 200 ft/NM)

For obstacles in the secondary area, apply the primary OCS slope to a point abeam the obstacle then apply a 12:1 secondary OCS (perpendicular to track) from the primary boundary to the obstacle.

Figure 3-11. Section 2, Turning Missed Approach



3.9.3 **c. Combination.** Apply where a turn fix is specified beyond the end of section 1b on a course 15 degrees or less from continuation of FAC (LEGACY) otherwise a continuation of FAC (within 0.03 degrees) or where the aircraft turns at an altitude more than 400 feet above the TDZE.

3.9.3 c. (1) Straight portion. The area and obstacle clearance is as specified in paragraph 3.9.3a, except sections 1 and 1b (extended) correspond to sections 1 and 2 of a normal straight missed approach. Extend section 1b to the turn fix or extend longitudinally 30.39 feet for each foot the turn altitude is above 400 feet. Do not establish secondary areas in section 1b extended. Line A'B' marks the end of section 1b extended.

3.9.3 c. (2) Turning portion. The area and obstacle clearance is as specified in paragraph 3.9.3b, except that it begins at the end of section 1b extended, and:

3.9.3 c. (2) a. When the turn is based on an altitude or when no PCG established in section 2 the inside turn boundary connects to point C, B', or T (when it exists) whichever results in the larger area. Point B' is on the outside turn edge at the end of section 1b extended. The outside turn boundary always connects to point B'. In Zone 2, obstacles are measured shortest distance to the section 1 and section 1b extended outer boundary. Zone 3 obstacles are measured shortest distance to point C. The Zone 2 OCS start height is the section 1b extended OCS end elevation. The Zone 3 OCS start height is the specified turn altitude. See figure 3-12.

3.9.3 c. (2) b. When a fix is established at the end of the section 1b extended and there is PCG in section 2. Connect to point D, B,' or T (when it exists) whichever results in the larger area. Point D is on the inside turn edge of section 1b (extended) 9000 feet prior to Line A'B'. Point B' is on the outside turn edge at the end of section 1b extended. The outside turn boundary always connects to point B'. In Zone 2, obstacles are measured shortest distance to the section 1 and section 1b extended outer boundary. The Zone 2 OCS start height is the section 1b extended OCS end elevation. Zone 3 obstacles are measured shortest distance to point D. The Zone 3 OCS start height is the calculated aircraft altitude at the turn fix. See figure 3-13.

3.9.4 Missed Approach Climb Gradient.

Where the section 2 standard OCS is penetrated and the lowest HAT is required, a missed approach climb gradient (CG) greater than 200 ft/NM) may be specified (military not applicable). Gradients greater than 425 ft/NM require a waiver.

3.9.4 **a. Calculate ROC,** the altitude at which the ROC for the obstacle is achieved, and the required climb gradient using the following formulas:

$$ROC_{OBS} = ROC_{SOC} + 48 \times \mathrm{d}$$

$$Alt_{min} = O_{elev} + ROC_{obs}$$

$$CG = \frac{r}{d} \times \ln\left(\frac{r + Alt_{min}}{r + Aircraft_{SOC}}\right)$$

where

ROC_{SOC} = *Value from paragraph 3.9.2d*

d = *shortest distance (NM) CG origin to obstacle*

O_{elev} = *obstacle elevation (MSL)*

$Aircraft_{SOC}$ = *aircraft altitude (MSL) at CG origin (paragraph 3.9.2d)*

Figure 3-12. Combination Straight and Turning, No Fix at end of Section 1b extended or no PCG in Section 2

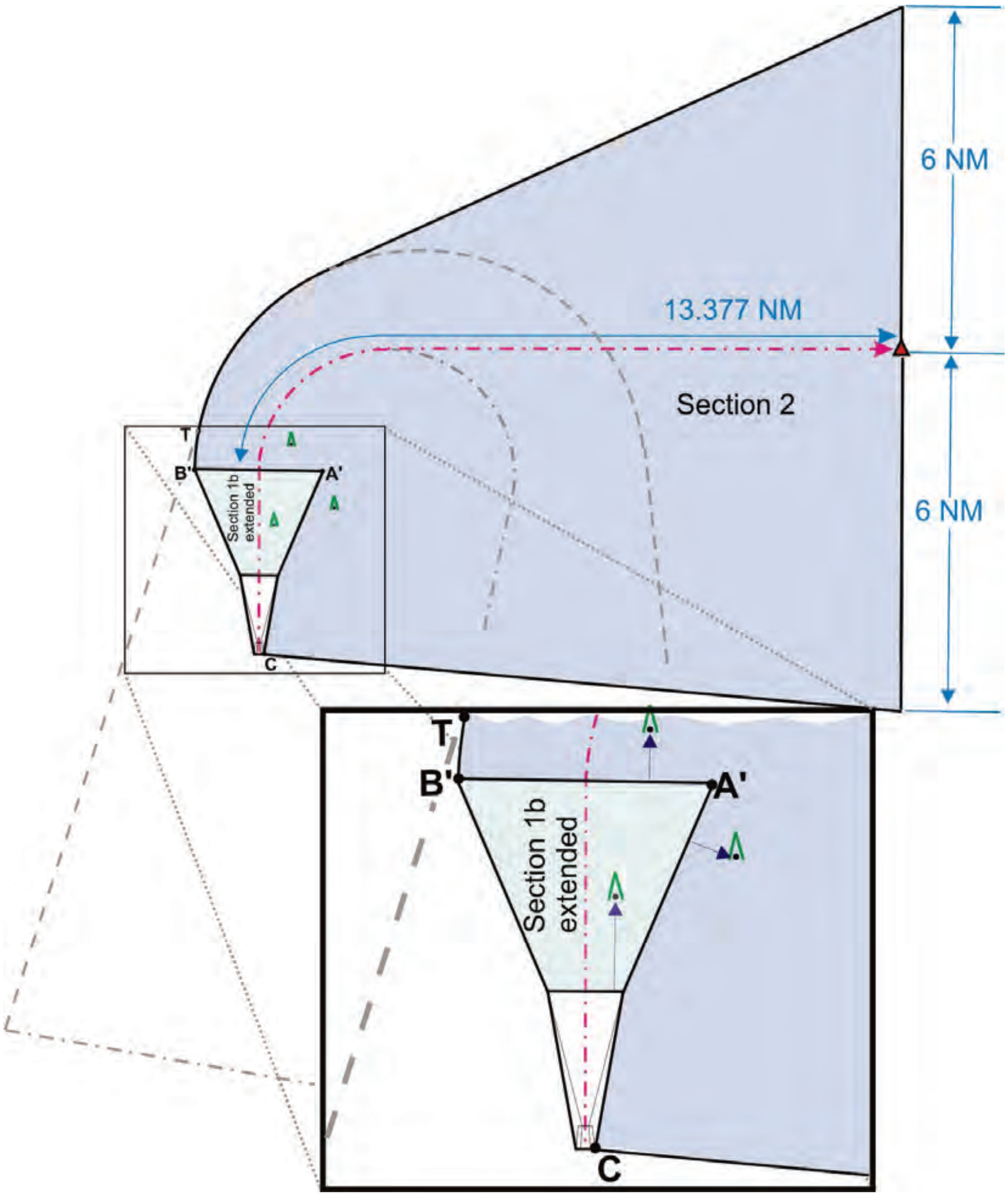
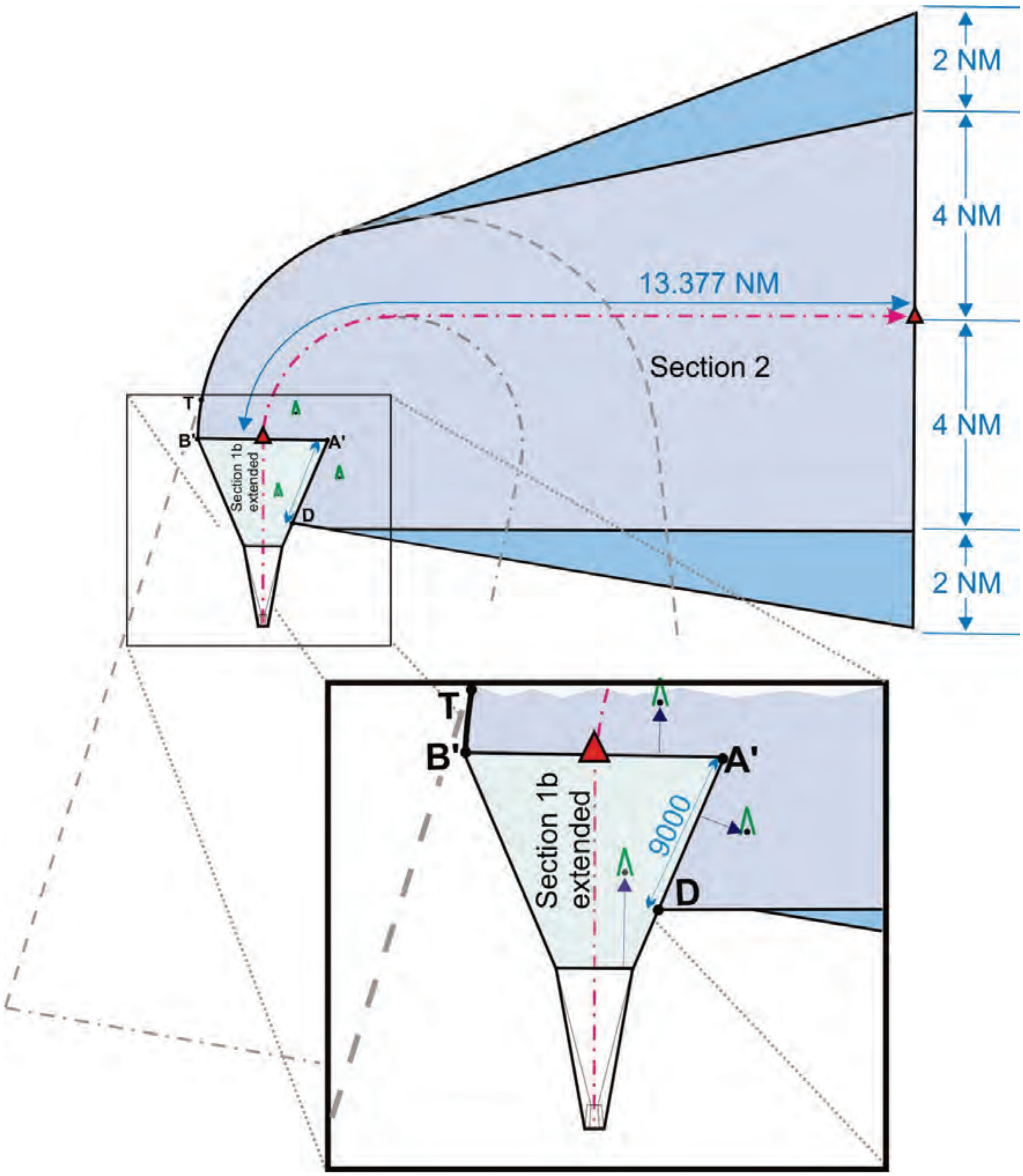


Figure 3-13. Combination Straight and Turning, Fix at end of Section 1b extended and PCG in Section 2



Appendix 2
Simultaneous Independent Parallel Instrument Approaches [SIPIA] – Widely Spaced Runways

1. Overview. This appendix defines requirements for approaches used to support SIPIA operations to parallel runways where the runway centerlines are separated by 4300 feet or more. See Order JO 7210.3, Facility Operation and Administration, and Order JO 7110.65, Air Traffic Control, for operational and equipment requirements. See the Pilot/Controller Glossary for definition of a parallel runway. Requirements for other simultaneous parallel approach operations are defined in ATC directives or other Flight Standards criteria.

2. SIPIA operations require:

a. Radar, communications, and procedures as specified by the applicable ATC directives.

b. Approaches designed to support SIPIA operations with at least one line of vertically guided minima and which include all charting requirements specified by Order 8260.19, Flight Procedures and Airspace. The following types of approaches support SIPIA operations:

(1) ILS. Include localizer minimums on the same chart unless requested otherwise.

(2) RNAV (GPS) with LPV and/or LNAV/VNAV minimums.

(3) RNAV (RNP) with Authorization Required (AR).

(4) GLS.

Note: The operational advantage from including a line of localizer minimums on an ILS approach is that SIPIA operations may continue during a temporary glide slope outage (see Order JO 7210.3, Facility Operation and Administration).

3. Runway Spacing. The required spacing between runways/procedure final approach courses (FAC) for dual/triple widely spaced SIPIA operations is in accordance with Air Traffic Directives as established by FAA Flight Standards. Runway spacing for Quadruple SIPIA operations require a site-specific Flight Standards Flight Systems Laboratory (AFS-450) safety analysis.

4. Approach Procedures. Instrument approach procedures used for widely spaced SIPIA operations must comply with the applicable design standard(s), except as follows:

a. Missed approaches with radius-to-fix (RF) turns require AFS-400 approval.

b. Dual widely spaced SIPIA operations. Missed approach courses must have a combined divergence of at least 45 degrees.

c. Triple widely spaced SIPIA operations. The missed approach course for the center runway is a continuation of the FAC. The course for each 'outboard' runway must diverge at least 45 degrees from the center runway in opposite directions. At least one outside parallel must have a turn height specified that is not greater than 500 feet above the airport elevation.

d. Quadruple widely spaced SIPIA operations. Course divergence is as specified by AFS-450 safety analysis.

e. Where an alternate missed approach has been established for an approach authorized for use during widely spaced SIPIA operations, it must also comply with the preceding restrictions.

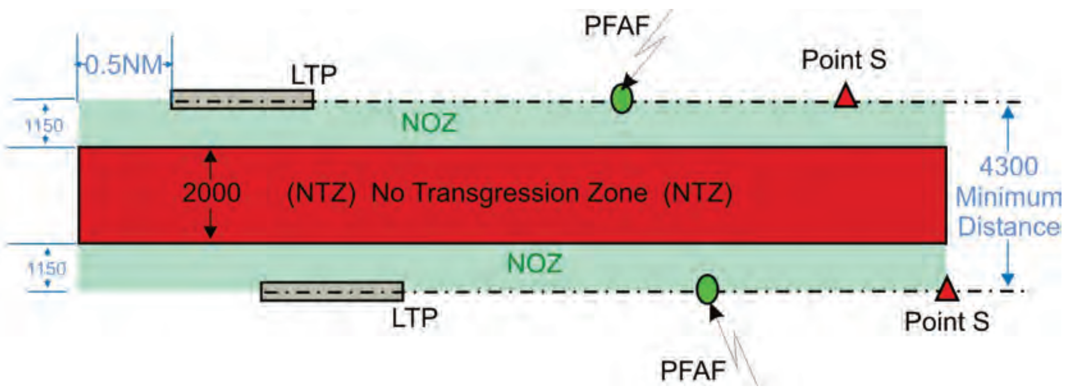
5. No Transgression Zone (NTZ) and Normal Operating Zones (NOZ) are established by ATC for each adjacent runway pair used during widely spaced SIPIA operations.

a. The NTZ is 2000 feet wide equidistant between the approach courses for the runway pair. It begins at the farthest point in the adjacent runway pair where any aircraft established on the approach is permitted to lose vertical/lateral separation (point "S"). It ends 0.5 NM past the farthest departure end runway (DER) in the pair or where the missed approach tracks diverge, whichever occurs last (see figures A2-1 and A2-2).

Note: The NTZ dimensions are not affected by the point where ATC is permitted to discontinue radar monitoring.

b. The area remaining between the approach courses and the edge of the NTZ is the NOZ.

Figure A2-1. No Transgression and Normal Operating Zones (Dual Approach)



Appendix 3. Simultaneous Close Parallel (SCP) Approaches

1.0 Overview and Background.

Under certain conditions, capacity at the nation's busiest airports may be significantly increased by using simultaneous independent close parallel approaches. This appendix defines requirements for authorizing SCP operations to parallel runways separated by less than 4300 feet but at least 3000 feet using ILS, RNAV (with at least one line of vertically guided minima), or Ground Based Augmentation System Landing System (GLS) approaches. Tests have shown that a reduction in minimum separation between parallel runways may be achieved by use of precise navigation capabilities and specific air traffic equipment and procedures. Apply this appendix when air traffic requests simultaneous independent close parallel approaches.

Note: For further information about air traffic guidance concerning simultaneous approaches, see Order JO 7110.65, Order JO 7210.3, and related Notices.

2.0 Terminology.

2.1 Automated Alert.

A feature that provides visual and/or audible alerts to the monitor controller when an aircraft is projected to enter or has entered the no transgression zone (NTZ).

2.2 Breakout.

A technique/procedure to direct aircraft out of the approach stream. In the context of close parallel operations, a breakout is used to direct threatened aircraft away from a deviating aircraft.

2.3 Close Parallel Runways.

Two parallel runways whose extended centerlines are separated by less than 4300 feet, used for simultaneous independent approaches.

2.4 High Update Radar.

High update rate surveillance systems, such as Precision Runway Monitor (PRM), that are approved by air traffic for SCP approach operations. In this context, "RADAR" is used for systems such as PRM E-scan radar and also for systems that include other types of surveillance inputs such as PRM-A multilateration. The term "high update radar" is used interchangeably in this appendix with "high update rate radar" both terms apply to the equipment used for NTZ monitoring for SCP approach operations. Also see PRM (paragraph 2.9).

2.5 Offset Course.

An angular offset of the final approach course from the runway extended centerline in a direction away from the NTZ. An offset course increases the normal operating zone (NOZ) width as distance increases from the runway.

2.6 Monitor Zone.

The monitor zone is the volume of airspace within which the final monitor controllers are monitoring the NTZ during SCP approaches.

2.7 No Transgression Zone (NTZ).

The NTZ is a 2000-foot wide zone, located equidistant between parallel runway final approach courses (FACs) in which flight is not allowed during simultaneous independent approach operations (see figures A3-1 and A3-2).

2.8 Normal Operating Zone (NOZ).

The NOZ is the operating zone within which aircraft flight remains during normal independent simultaneous parallel approaches (see figures A3-1 and A3-2).

Figure A3-1. NTZ, NOZ, and FAC for Straight-In Approaches, Less Than 4300-foot Spacing

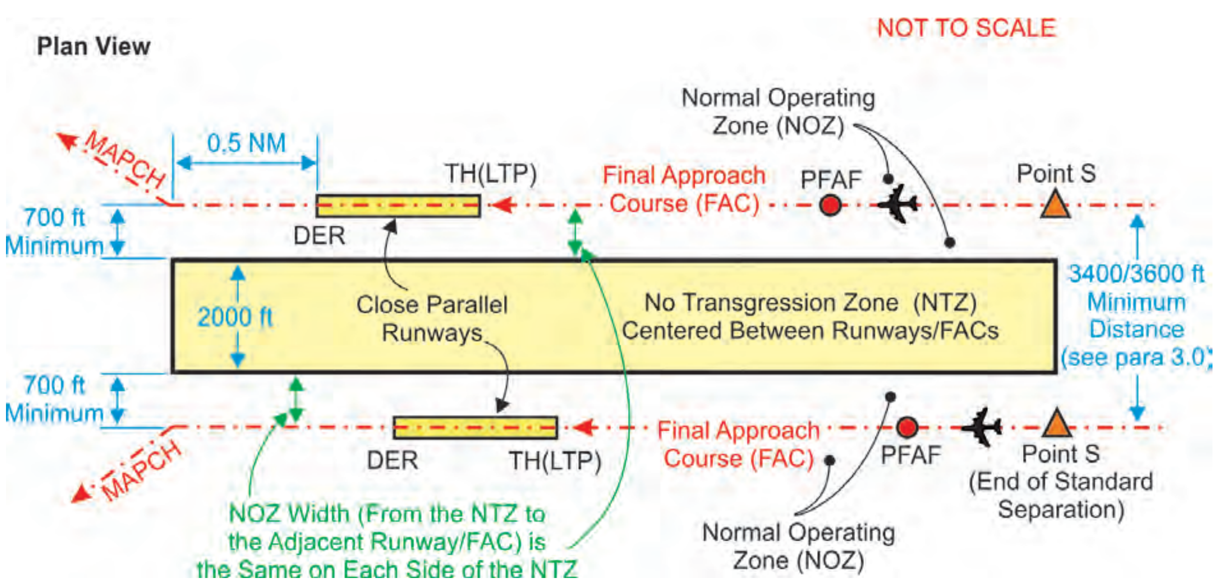
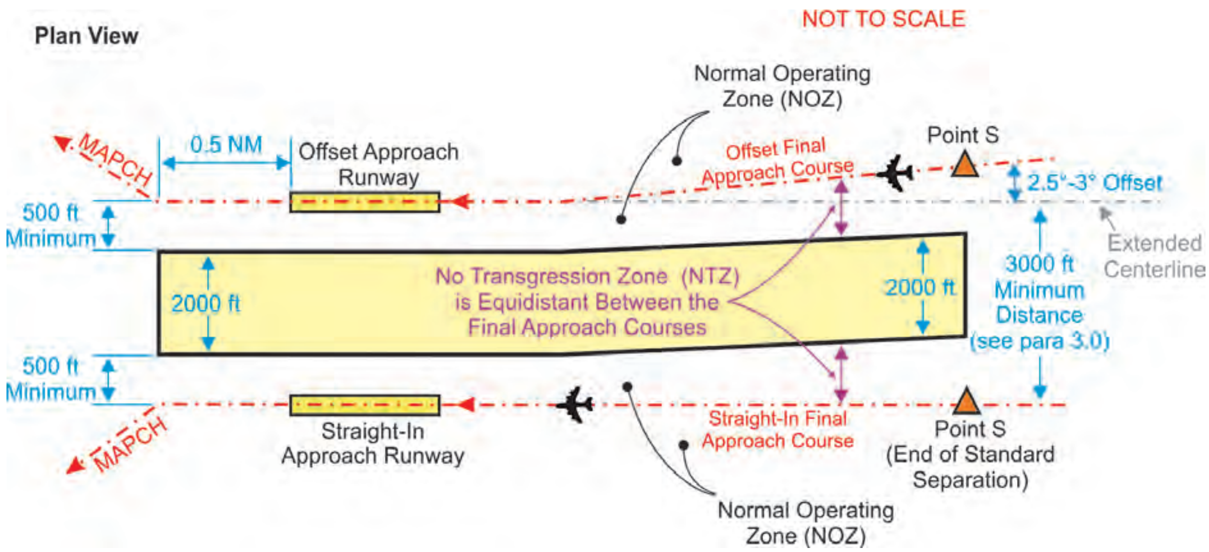


Figure A3-2. NTZ, NOZ, and FAC With an Offset Approach, Less Than 3400-foot Spacing



2.9 Precision Runway Monitor (PRM).

A specialized Air Traffic Control (ATC) surveillance system, using E-scan radar or PRM A multilateration, providing continuous coverage throughout the monitor zone. It includes a high accuracy, high update rate sensor system, and for each runway, a high resolution color Final Monitor Aid (FMA) with automated alerts. The PRM system provides each monitor controller with a precise presentation of aircraft conducting approaches and of the NTZ. Also see FAA Pilot/Controller Glossary. When the term "PRM" is included in the approach designation, it refers to an SCP operation; however, for runways spaced at least 3600 feet, it no longer indicates whether PRM equipment is being used (see paragraph 10).

3.0 General.

Criteria contained in this appendix are designed for independent simultaneous operations to dual parallel runways with centerlines separated by at least 3000 feet, but less than 4300 feet (see figures A3-1 and A3-2). SCP operations at airport elevations above 1000 feet MSL, "triple" / "quadruple" SCP operations, and/or deviations from these criteria must not be established without approval from the FAA, Flight Technologies and Procedures Division (AFS-400). When runway spacing is less than 3400 feet, but not less than 3000 feet, one of the FACs in the close parallel runway pair must be aligned at least 2-½ degrees divergent from the other, but not more than 3.0 degrees (see figure A3-2). When runway spacing is less than 4300 feet, but at least 3600 feet, high update radar is not required (see paragraph 10).

3.0.1 **The point where standard separation is no longer maintained** (Point S) on independent ILS SCP approaches should not be authorized at distances greater than 10 NM from threshold; however, if ATC systems and procedures are established which assure minimal probability of NTZ intrusions, this distance may be extended up to 12.5 NM. Where one ILS course is offset, this distance may be extended beyond 12.5 NM. Also, when the FAC navigation guidance is based on RNAV (GPS), RNAV (RNP) AR or GLS, this distance may be extended beyond 12.5 NM for either straight-in or offset approaches.

Notes:

1. The reason for limiting the distance for simultaneous parallel ILS procedures is that as the range and splay increases, the likelihood of an aircraft that is nominally on course penetrating the NTZ and generating nuisance breakouts increases.

2. The safety studies that support simultaneous close parallel approaches are based on the assumption that standard separation, either altitude or horizontal, is maintained until participating aircraft are established on the FAC, or the extended FAC, and that the NTZ begins at the point where standard separation is no longer maintained. When air traffic makes a procedure request, we recommend documenting that point or distance.

3.0.2 **a. A separate instrument approach chart** described as a "simultaneous close parallel" procedure must be published for each runway in the close parallel pair of runways. Identify SCP procedures by including "PRM" in the title in accordance with volume 1, paragraph 161.

Notes:

1. With the availability of identical approaches, ATC is provided with the flexibility to advertise PRM approaches on the ATIS considerably before traffic density warrants their use and pilots will have ample time to brief the PRM approach.

2. The availability of the non-PRM Approach will permit flight crews that have already briefed the PRM approach procedure, but ATC has yet to begin or has ceased PRM operations, to continue to use the PRM approach chart, during non-PRM operations, without the need to re-brief the non-PRM approach.

3. For the use of identical approaches with a simultaneous offset instrument approach (SOIA) operation, see Order 8260.49.

3.0.2 **b. If a request for triple independent arrival** operations is received and one set of parallel runways is closely spaced (or if both sets are closely spaced), the procedures require approval from Flight Standards.

3.0.3 **A breakout obstacle assessment** specified in volume 3, appendix 4, Obstacle Assessment Surface Evaluation for Simultaneous Parallel Precision Operations, must be completed as part of the initial evaluation for parallel operations.

3.1 System Components.

System requirements for SCP approach procedures are:

3.1.1 **ILS/RNAV/GLS Guidance.** A full ILS on each runway or use of RNAV (GPS), RNAV (RNP) AR or GLS as described in paragraphs 7, 9 and 10.

3.1.2 **High Update Radar.** High update surveillance, such as PRM, must be used when the spacing is less than 3600 feet between runways or FACs. When the spacing is at least 3600 feet, see paragraph 10.

3.2 Procedure Naming and Charting.

3.2.1 **Procedure naming** for SCP approach procedures uses volume 1, chapter 1, section 6.

3.2.2 **Procedure approach chart notes** are specified in Order 8260.19, chapter 8.

4.0 Feeder Routes and Initial Approach Segment.

Apply chapter 2 of this volume for ILS; apply Order 8260.58 for RNAV (GPS), RNAV (RNP) AR and GLS, except as stated in this appendix. The initial approach may be made from a NAVAID, fix, waypoint, and/or by radar vector, as needed by ATC. SCP approaches are normally published without transition routes (unless requested by ATC). Procedure turns and high altitude penetration procedures must not be included on an SCP approach procedure.

4.1 Altitude Selection.

Altitudes selected must provide obstacle clearance requirements and a minimum of 1000 feet vertical separation on the two final approach courses until abeam the NTZ.

4.2 Localizer Intercept Point.

Apply chapter 2 of this volume, except the optimum intercept angle between the FAC extended (localizer) and the initial segment (if used) is 20 degrees or less and the maximum intercept angle must not exceed 30 degrees.

5.0 Intermediate Approach Segment.

Apply chapter 2 of this volume for ILS; apply Order 8260.58 for RNAV (GPS), RNAV (RNP) AR and GLS. Exception: SCP approach procedures must have a straight intermediate segment aligned with the FAC (no course change allowed at the PFAF).

6.0 Final Approach Segment.

Apply chapter 3 of this volume for ILS; apply Order 8260.58 for RNAV (GPS), RNAV (RNP) AR and GLS. In addition to these criteria, SCP approach procedures require the following:

6.1 Close Parallel Runway Separation.

Approaches must have a minimum of 3400 feet separation between parallel FACs. When there is less than 3400 feet separation, but at least 3000 feet, use an offset course as specified in paragraph 3.0 (see figures A3-1 and A3-2).

6.2 High Update Radar.

A PRM or equivalent system must be in operation and providing service if required by paragraphs 3.1.2 or 10.

6.3 NTZ.

An appropriate NTZ is established between the two FACs/parallel runway extended centerlines for straight-in FACs; where an offset course is used, the NTZ is equidistant between the two FACs. The NTZ must begin at or before Point S- where adjacent inbound aircraft conducting SCP approaches first lose standard separation (1000 feet vertical separation or applicable horizontal separation). See paragraph 8 and figures A3-1 and A3-2. If radar coverage in the portion of the NTZ near the runways is not adequate to support simultaneous operations according to safety determinations/assessments, the decision altitude may have to be raised; that determination is made by air traffic and, if applicable, is to be included in the procedure request.

Note: NTZ monitoring equipment/procedures are specified in air traffic guidance.

6.4 NOZ.

An NOZ is provided for each final approach segment. The NOZ must be at least 700 feet wide on the NTZ side of the approach course or runway centerline for a parallel set of FACs. When one approach course is offset, the minimum NOZ width is 500 feet. The width of the NOZ is the distance from the edge of the NTZ to the FAC or runway centerline or missed approach course, whichever is nearest to the NTZ. That width must be equal on each side of the NTZ from point S to the first missed approach turn point/turn altitude. The length of the NOZ equals the length of the NTZ (see figures A3-1 and A3-2 and paragraph 8).

Note: When doing the evaluation of simultaneous approaches, it is not necessary to consider the extent of the NOZ on the side of the FAC or runway centerline or missed approach course that is opposite the NTZ; only the NOZ on the side adjacent to the NTZ is relevant for dual simultaneous approach evaluations.

6.5 Staggered Runway Thresholds.

It is recommended that the approach with the higher glide slope intercept altitude be the runway having the most distant approach threshold (from the point of view of an aircraft on approach).

6.6 Offset Course Approaches.

Where an offset localizer is utilized, apply chapter 3 of this volume; for an offset course using RNAV (GPS), RNAV (RNP) AR or GLS apply Order 8260.58. An offset requires a 50-foot increase in decision height (DH) and is not authorized for Category II and III approaches. (Autopilots with autoland are programmed for localizers to be on runway centerline only.) The NTZ must be established equidistant between the offset and straight-in FACs.

7.0 Minimums.

For SCP procedures, only straight-in precision minimums apply. The lines of approach minimums that can be authorized for simultaneous independent close parallel approaches are as follows:

Table A-3-1. Authorized Lines of Minimums for SCP Approach Operations

Lines of Minimums for SCP Approaches	Minima Authorized for Straight-in PRM and/or Offset PRM Approaches
ILS	Yes
GLS	Yes
LPV	Yes
LNAV/VNAV	Yes
RNP	Yes

NOTES:

1. Use of "LOC only" during simultaneous operations has not been evaluated for runways spaced less than 4300 feet; the LOC line of minima is not authorized for SCP approach procedures.

2. For LNAV/VNAV and RNP lines of minima, the supporting safety studies are based on GPS being a required navigation source; see paragraph 9.

3. LNAV line of minima (without VNAV guidance) is not authorized for simultaneous operations.

4. LP line of minima is not authorized for simultaneous operations.

5. The approach types that are authorized above may be used in any combination with each other for dual simultaneous approaches.

8.0 Missed Approach Segment.

Apply volume 3 chapter 3 for ILS; apply Order 8260.58 for RNAV (GPS), RNAV (RNP) AR and GLS, except as stated in this appendix. Missed approach procedures for SCP approaches should specify a turn as soon as practical.

8.0.1 **Missed approach courses for each pair of SCP procedures must diverge** by a minimum of 45 degrees. **Example 1:** The missed approach for the right runway is straight ahead and the left runway turns 45 degrees left. **Example 2:** The right runway missed approach turns 30 degrees right and the left runway turns 15 degrees left. The 45-degree divergence must be established by 0.5 NM past the most distant departure end of runway (DER). **Exception:** A distance greater than 0.5 NM is allowed if the NTZ is extended to the point where the 45-degree divergence is achieved (see figures A3-3 and A3-4).

8.0.2 **The 45-degree divergence is required until other separation** can be applied.

Figure A3-3. Missed Approach Divergence Within 0.5 NM of DER

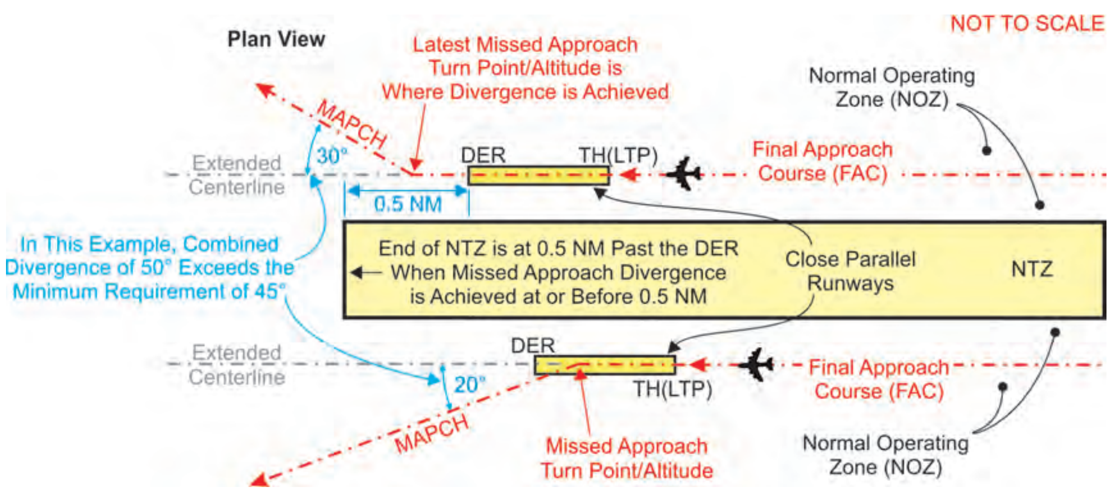
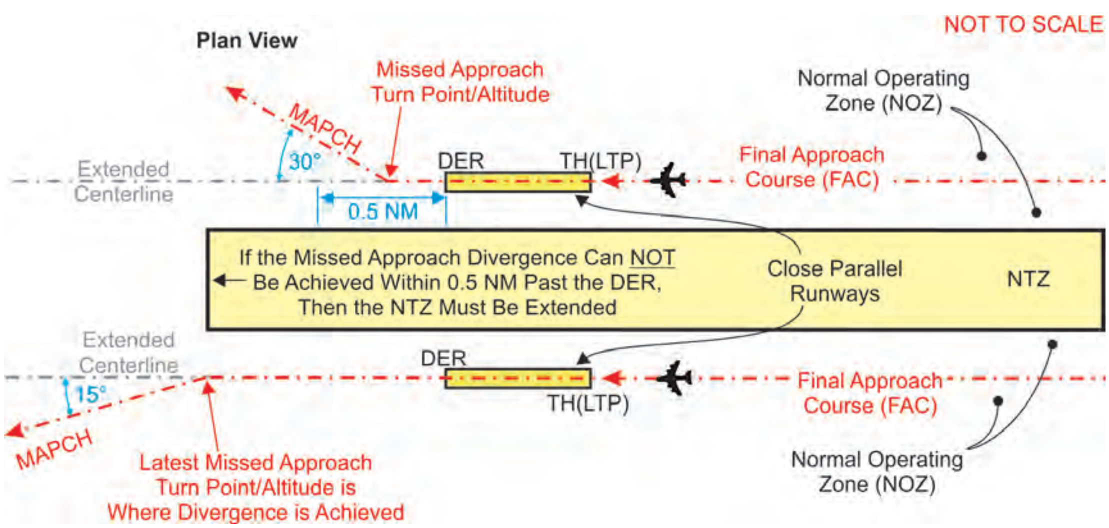


Figure A3-4. Missed Approach Divergence Delayed Beyond 0.5 NM



8.0.3 **Where an offset course is used,** the first missed approach turn point must be established so that the applicable flight track radius (table 5 in volume 1, chapter 2), constructed in accordance with volume 1, chapter 2, section 7, for the fastest category aircraft expected to utilize the offset course must not be less than 700 feet from the NTZ.

8.1 **NTZ.**

The NTZ must be continued into the missed approach segment. The NTZ ends 0.5 NM past the farthest DER in the pair or where the missed approach tracks diverge (combined 45-degree divergence), whichever occurs last (see paragraph 6.3 and figures A3-3 and A3-4).

8.2 NOZ.

The NOZ must be continued into the missed approach segment, with a length equal to the NTZ (see paragraphs 6.4 and 8.0 of this appendix and figures A3-3 and A3-4).

9.0 Use of RNAV, RNP AR, or GLS for SCP Approach Procedures.

Simultaneous operations may be authorized, by applicable chart notes, on RNAV (GPS), RNAV (RNP) AR or GLS approaches when requested by air traffic.

9.0.1 **Vertical guidance is required** for simultaneous operations (see paragraph 7).

9.0.2 **GPS is required** to be available and included in the aircraft navigation solution. The GPS requirement must be in the procedure title for an RNAV (GPS) procedure; GPS REQUIRED must be charted on the procedure for RNAV (RNP) AR and for GLS approaches.

9.0.3 **Flight Director (FD) or Autopilot (AP) is required** during SCP operations and must be charted on RNAV (GPS), RNAV (RNP) AR or GLS approaches.

9.0.4 **Procedure notes must include "Authorization Required"** for RNAV (RNP) AR approaches.

10.0 Close Parallel Approaches With At least 3600-foot Spacing.

High update radar (such as PRM) is not required for simultaneous independent approach operations if all of the following conditions are met:

1. The runways and FACs are spaced at least 3600 feet.

2. The procedures and system used for monitoring the NTZ meet the requirements in air traffic directives.

3. All requirements for SCP operations other than high update radar are met.

4. The approach procedure design, types of approach procedures and lines of minima are as specified in paragraphs 7 and 9 above.

5. Procedure chart notes for SCP approaches are added to the procedure forms as indicated in Order 8260.19, chapter 8.

Note: PRM, as a specific type of equipment, is no longer required for NTZ monitoring for spacing of 3600 feet up to 4300 feet; however, since all other requirements for closely spaced approaches must be adhered to, the SCP approach procedures are still designated as "PRM" to indicate the type of operation. SCP approach procedures are designated as “PRM” regardless of the update rate of the surveillance system used to monitor the NTZ and the FAA characterizes training for pilots related to SCP approaches as PRM training.

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1.1.13 ICA Baseline (ICAB).

A line at DER, perpendicular to runway centerline, denoting the beginning of the ICA.

1.1.14 ICA End-Line (ICAE).

A line at end of ICA perpendicular to the departure course.

1.1.15 Obstacle.

See volume 1, appendix 1 definition. Includes taxiing aircraft except where operational restrictions prevent taxi operations during takeoffs.

1.1.16 Obstacle Clearance Surface (OCS).

An inclined or level surface associated with a defined area for obstacle evaluation.

1.1.17 Obstruction Evaluation Area (OEA).

Areas requiring obstacle evaluation.

1.1.18 Positive Course Guidance (PCG).

A continuous display of navigational data, which enables an aircraft to be flown along a specific course, e.g., radar vector, RNAV, ground-based NAVAIDs.

1.1.19 Reduced Takeoff Runway Length (RTRL).

The calculated distance prior to DER where takeoff must occur in lieu of using a published climb gradient. An RTRL is provided as an option only when the OCS is penetrated by 35 feet or less.

1.1.20 Standard Climb Gradient (SCG).

Departure and missed approach obstacle clearance is based on the assumption that an aircraft will climb at a gradient of at least 200 ft/NM. This is the standard climb gradient.

1.1.21 Start End of Runway (SER).

The beginning of the takeoff runway available.

1.1.22 Visual Climb Area (VCA).

Areas around the airport reference point (ARP) to develop a VCOA procedure.

1.1.23 Visual Climb over Airport (VCOA).

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.

1.2 DEPARTURE CRITERIA APPLICATION.

Evaluate runways for IFR departure operations by applying criteria in the sequence listed below (paragraphs 1.2.1 through 1.2.3).

1.2.1 **Perform a diverse departure evaluation** to each runway authorized for IFR takeoff. Diverse departure is authorized if the appropriate OCS is clear. If the OCS is penetrated, consider development of departure sectors and/or climb gradients.

1.2.2 **Develop departure routes** where obstacles prevent diverse departure operations.

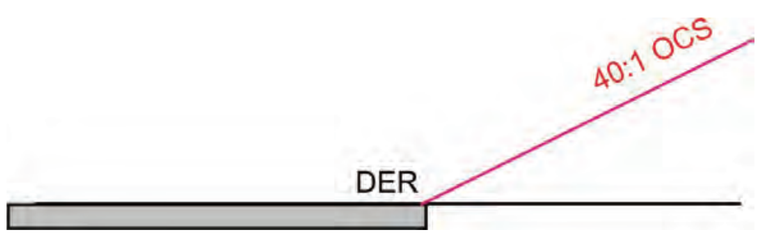
1.2.3 **Develop a VCOA procedure** where obstacles more than 3 SM from DER require climb gradients greater than 200 ft/NM (see chapter 4).

1.2.4 **At locations served by radar**, air traffic control may request development of diverse vector areas to aid in radar vectoring departure traffic (see chapter 5).

1.3 DEPARTURE OCS APPLICATION.

Evaluate the 40:1 departure OCS originating at the DER threshold at DER elevation. Departure operations are unrestricted if the OCS is clear. Where obstructions penetrate the OCS, see Order 8260.46 for required actions.

Figure 1-2. OCS Starting Elevation



1.3.1 Low, Close-In OCS Penetrations.

Do not publish a CG to a height of 200 feet or less above the DER elevation. Annotate the location and height of any obstacles that cause such climb gradients.

1.3.2 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.

1.3.2 **a. Primary Area.** The OCS slope is 40:1. Use the following formula to calculate the OCS elevation:

$$h_{OCS} = \frac{d}{40} + e$$

where

d = shortest distance (ft) from OCS origin to obstacle

e = OCS origin elevation

1.3.2 **b. 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 OCS rise (a) in the primary area to a point the obstacle is perpendicular to the departure course, and the secondary OCS rise (b) from the edge of the primary OCS to the obstacle (see figure 1-3).

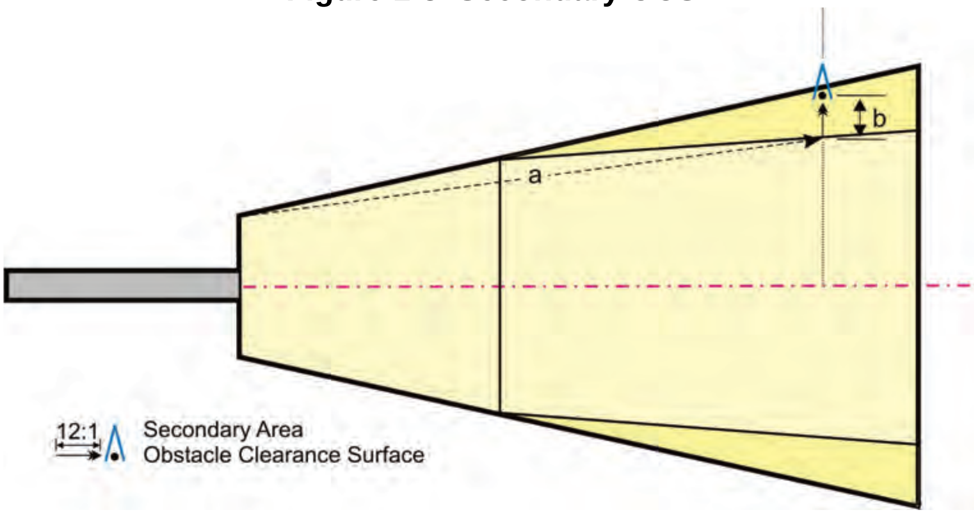
$$h_{SECONDARY} = h_{OCS} + \frac{b}{12}$$

where

h_{OCS} = *primary OCS height*

b = perpendicular distance (ft) from edge of primary

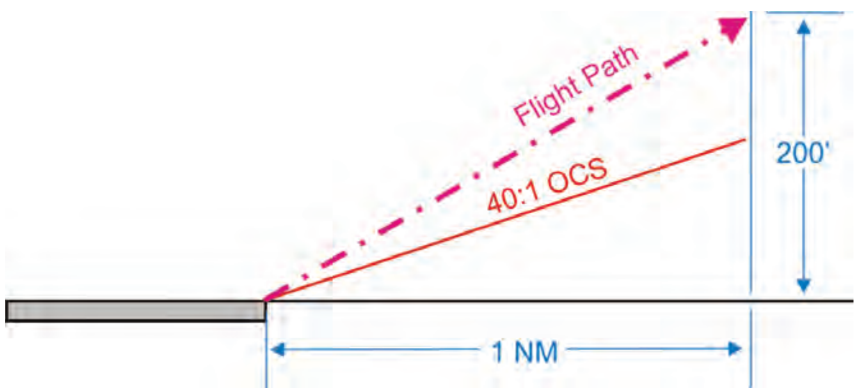
Figure 1-3. Secondary OCS



1.4 CLIMB GRADIENTS.

Departure procedure obstacle clearance is based on a minimum climb gradient performance of 200 ft/NM (see figure 1-4).

Figure 1-4. Standard Climb Gradient



1.4.1 Calculating Climb Gradients to Clear Obstacles.

Climb gradients in excess of 500 ft/NM require approval of the Flight Standards Service or the appropriate military authority. Calculate climb gradients using the following formula:

Standard Formula

$$CG = \frac{O-E}{0.76\ D}$$

DoD Option*

$$CG = \frac{(48D + O)-E}{D}$$

where
O = Obstacle MSL elevation
E = DER elevation
D = Distance (NM) DER to obstacle

** For use by military aircraft only. Not for civil use.*

1.4.2 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 the following formula:

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

where
E = Climb gradient starting elevation (MSL)
D = Distance (NM) from DER to obstacle

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

1.4.3 Climb Gradients to Altitudes for Other than Obstacles, i.e., ATC.

Calculate the climb gradient to the stated "climb to" altitude using the following formula where (D) is the distance from the beginning of the climb to the point where the altitude is required:

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

where
A = CG termination altitude
E = Climb gradient starting elevation (MSL)
D = Distance (NM) from DER to obstacle

Example: $\frac{3000-1221}{5}$ *= 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.*

1.4.4 Multiple Climb Gradients Application.

Do not publish a number of different gradients for a series of segments. Consider only one climb gradient, which is the most efficient gradient to represent the entire length of the climb gradient distance that encompasses all climb gradients required.

1.4.5 Reduced Takeoff Runway Length (RTRL). Where an RTRL is required by Order 8260.46, calculate using the following formula:

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

where
p = OCS penetration (ft)
**Establish in 100 ft increment, round up if required*

1.4.6 Effect of DER-To-Obstacle Distance.

1.4.6 a. Where obstacles 3 SM or less from the DER penetrate the OCS:

1.4.6 a. (1) Publish a note identifying the obstacle(s) type, location relative to DER, AGL height, and MSL elevation, and

1.4.6 a. (2) Publish standard takeoff minimums with a required CG to a specified altitude, and

1.4.6 a. (3) Publish a ceiling and visibility to see and avoid the obstacle(s), and/or

1.4.6 a. (4) Develop a specific textual or graphic route to avoid the obstacle(s).

Note: *Where low, close-in obstacles result in a climb gradient to an altitude 200 feet or less above DER elevation, only paragraph 1.4.6a(1) applies.*

1.4.6 b. Where obstacles more than 3 SM from the DER penetrate the OCS:

1.4.6 b. (1) Publish standard takeoff minimums with a required CG to a specified altitude, and

2.2.3 Sector Limitations.

2.2.3 **a. The maximum turn** from the takeoff runway in any one direction is 180 degrees relative to takeoff runway heading.

Figure 2-7A. Sector Limitations

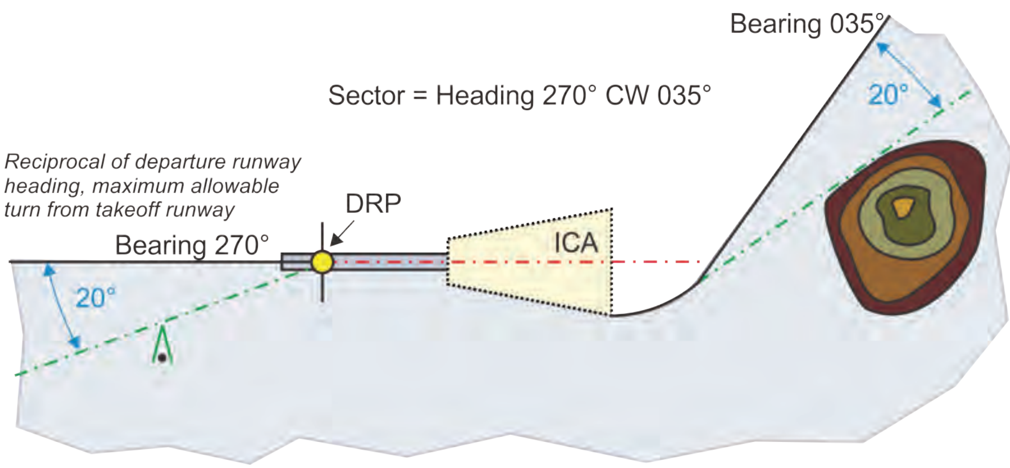
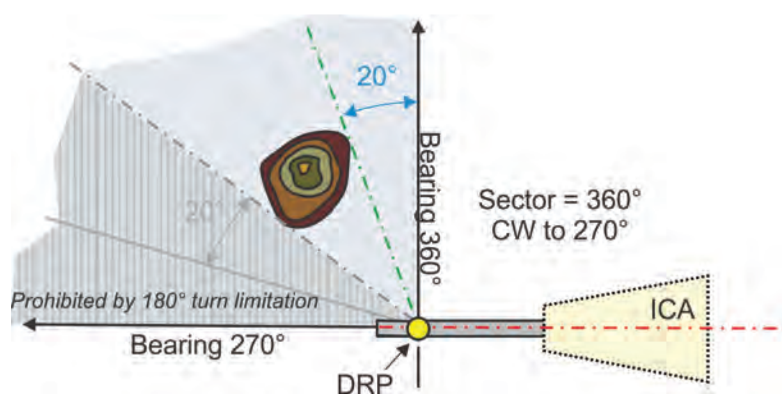


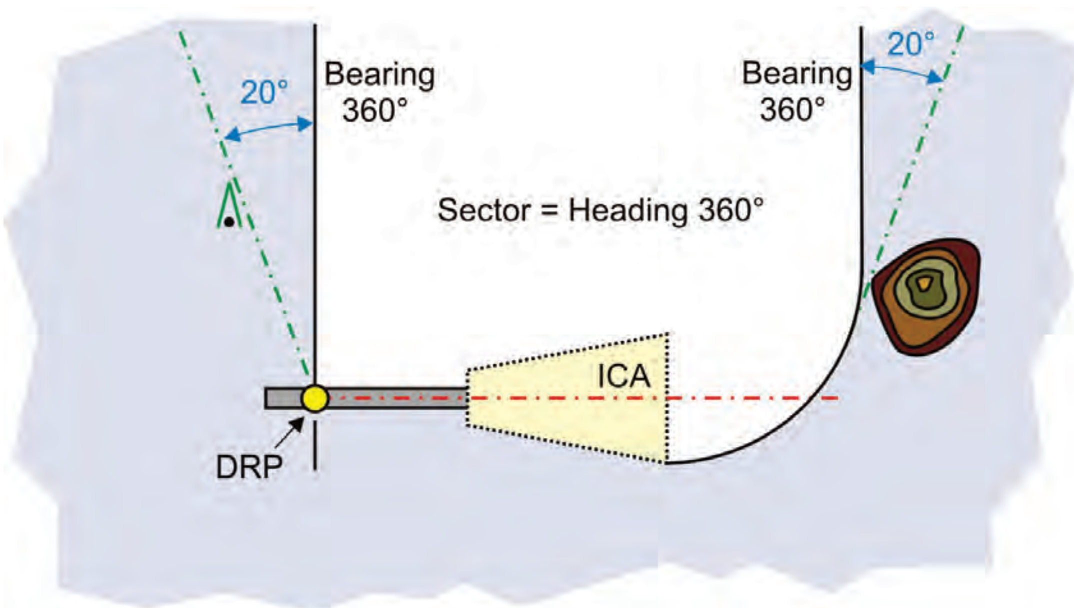
Figure 2-7B shows a sector of 360 degrees clockwise to 270 degrees. Heading 270 degrees could be assigned; however, the maximum turn to the right is a heading not in excess of the reciprocal of the takeoff runway heading.

Figure 2-7B. Maximum Heading Limitation



2.2.3 b. **Assign a single heading for a sector** which has parallel boundaries. The heading must parallel the boundaries. Figure 2-8 shows heading 360 degrees as the only heading allowable.

Figure 2-8. Parallel Boundaries



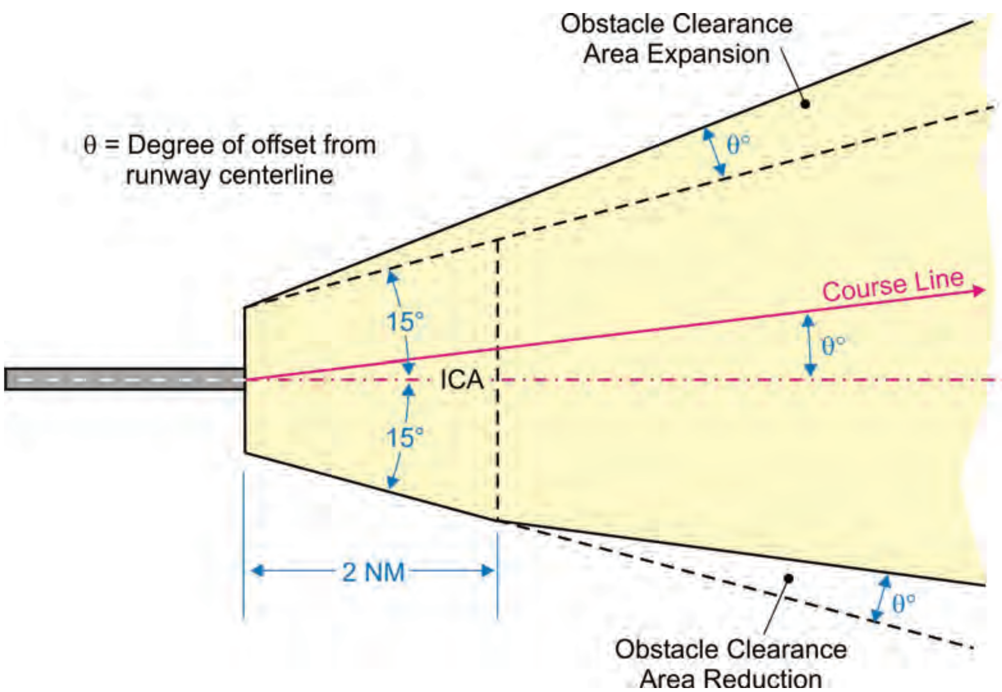
2.2.3 c. **Do not establish a sector** if the boundaries converge. **Example**: In figure 2-8, if the bearing from the DRP had been .001 degrees or greater or the outer bearing 359 degrees or less, the sector could not be established.

CHAPTER 3. DEPARTURE ROUTES

3.0 STRAIGHT ROUTE DEPARTURE SEGMENTS.

Straight departures are aligned within 15 degrees of the runway centerline. The initial climb area (ICA) is aligned along the runway centerline for at least 2 NM (see paragraph 1.6). If a turn at the departure end of runway (DER) 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 (see figure 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.

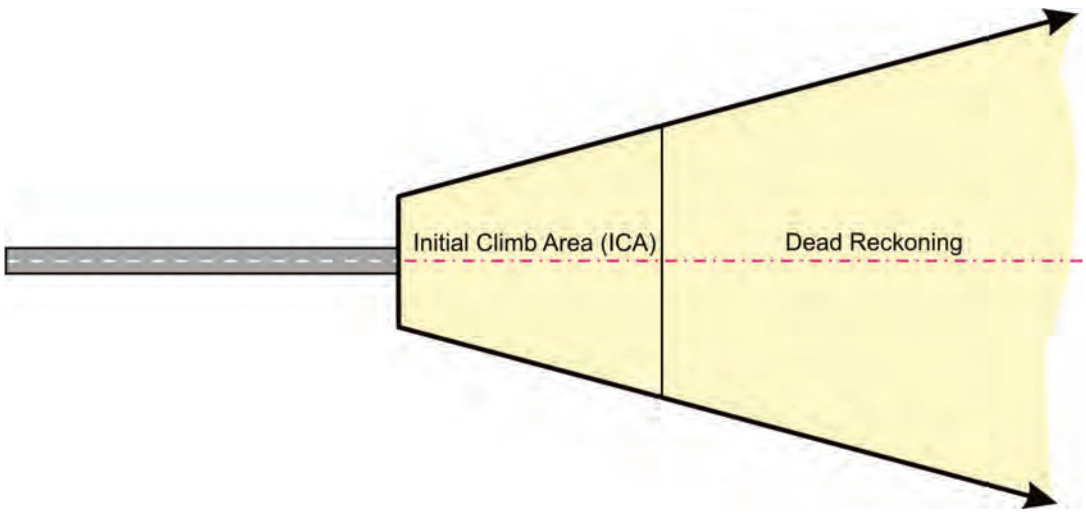
Figure 3-1. Turn ≤15 degrees at DER



3.1 DEAD RECKONING (DR) DEPARTURE.

The boundary lines of the departure obstacle clearance surface (OCS) splay outward 15 degrees relative to the departure course from the end of the ICA (see figures 3-1 and 3-2). Limit the DR segment to a maximum distance of 10 NM from DER.

Figure 3-2. Dead Reckoning



3.2 POSITIVE COURSE GUIDANCE (PCG) DEPARTURE, 15 DEGREES OR LESS.

Calculating Obstruction Area Half Widths. Apply the values from table 3-1 to the following formulae to calculate the obstruction primary area half-width (½W_P), and the width of the secondary area (W_S).

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

$$W_S = k_S \times D$$

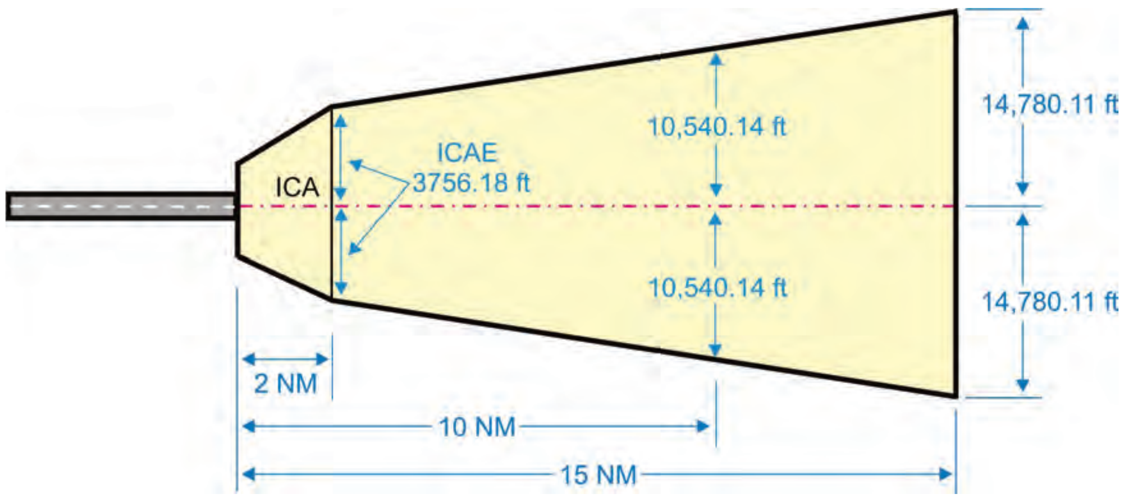
Table 3-1.

½ Width	k_p	k_s	D	A
Dep DR	0.267949	none	Distance (ft) from DER	500 feet
Localizer	0.139562	none	Distance (ft) 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

3.3 LOCALIZER GUIDANCE.

The obstruction evaluation area (OEA) begins at the initial climb area end-line (ICAE). The maximum length of the segment is 15 NM from DER. Evaluate for standard climb gradient (SCG) in accordance with paragraph 1.4.1. If necessary, calculate the required minimum climb gradient using the formula in paragraph 1.4.2 where D is the shortest distance to the initial climb area baseline (ICAB) (see figure 3-3).

Figure 3-3. Localizer Area



3.3.1 **NDB Guidance.** Evaluate for SCG in accordance with paragraph 1.4.1. If necessary, calculate the required minimum climb gradient using the formula in paragraph 1.4.2. Figures 3-4, 3-5, and 3-6 illustrate possible facility area configurations.

3.3.2 **VOR/TACAN Guidance.** Evaluate for SCG in accordance with paragraph 1.4.1. If necessary, calculate the required minimum climb gradient using the formula in paragraph 1.4.2. Figures 3-4, 3-5, and 3-6 illustrate possible facility area configurations.

Figure 3-4. Facility Area and DR Area Relationship

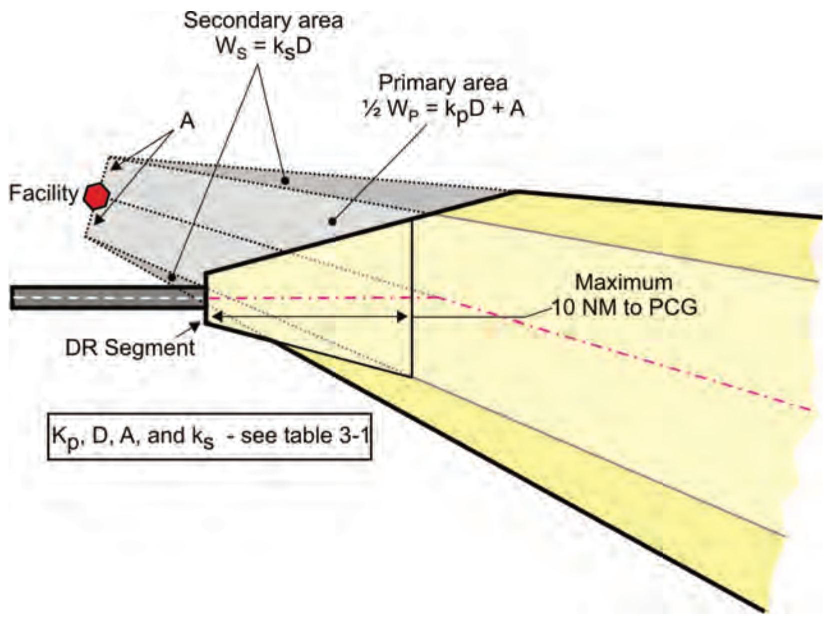
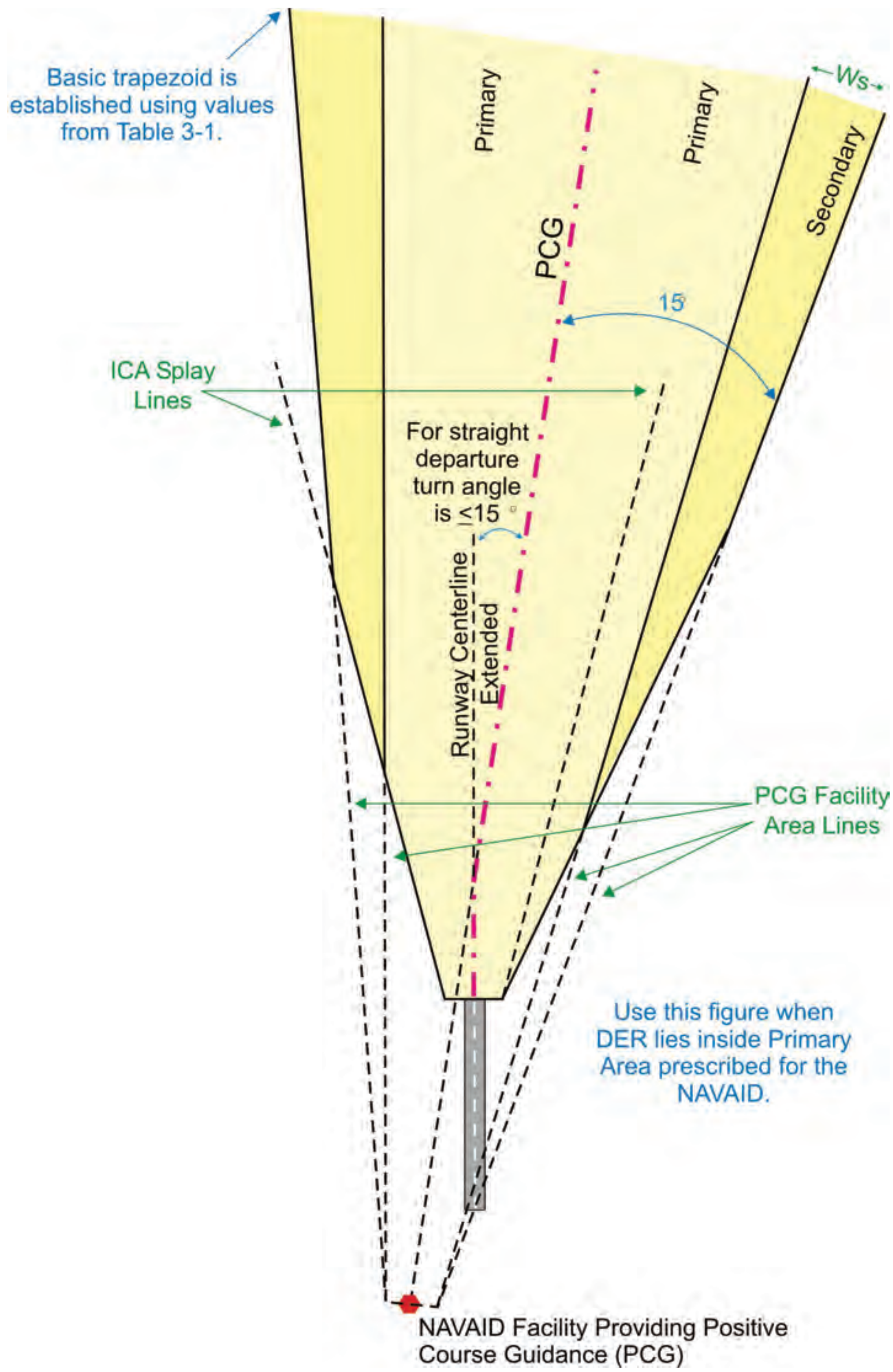


Figure 3-5. DER within Primary Area Facility



3.3.3 **Secondary Area Obstructions.** Secondary areas may be constructed and employed where PCG is provided.

3.4 RESERVED.

CHAPTER 4. VISUAL CLIMB OVER AIRPORT (VCOA)

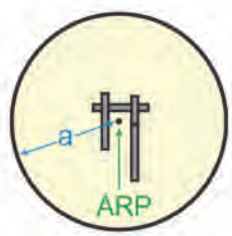
4.0 GENERAL.

VCOA is an alternative method for pilots to depart the airport where aircraft performance does not meet the specified climb gradient. Development of a VCOA is mandatory when obstacles more than three statute miles from the departure end of runway (DER) require a greater than 200 ft/NM climb gradient.

4.1 BASIC AREA.

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

Figure 4-1. VCA



Select 250 KIAS as the standard airspeed and apply the appropriate MSL altitude to determine the R1 value. Use other airspeeds in table 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 4-2).

Figure 4-2. VCA Expanded.

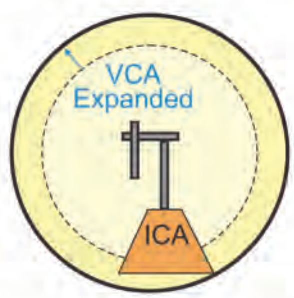


Table 4-1. Radius Values

Altitudes MSL	2,000 ft	5,000 ft	10,000 ft
Speed KIAS			
90	2.0	2.0	2.0
120	2.0	2.0	2.0
180	2.0	2.0	2.5
210	2.1	2.5	3.2
250	2.8	3.4	4.2
310	4.2	4.9	6.0
350	5.2	6.0	7.3

(Table 4-1 speeds include 30-knot tail winds up to 2000 feet MSL, 45-knot tail winds up to 5000 feet MSL, and 60-knot tail winds at 10000 feet MSL; bank angle: 23°.)

4.2 VCOA EVALUATION.

4.2.1 Diverse VCOA.

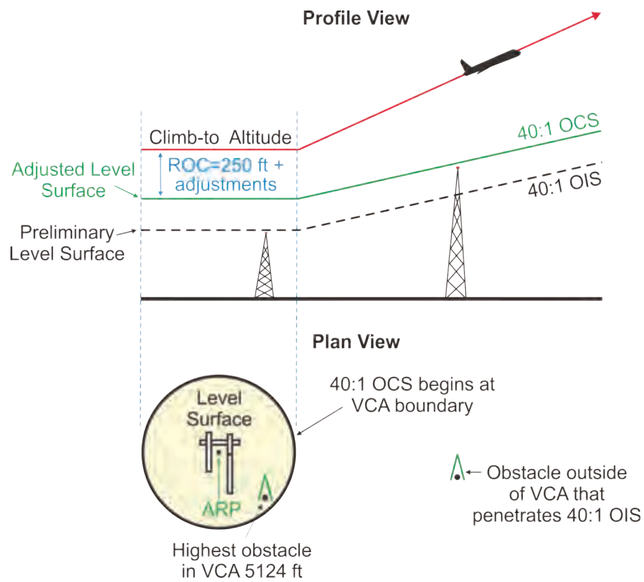
Identify the highest obstruction within the visual climb area (VCA). This is the preliminary height of the VCA level surface. Evaluate a 40:1 surface from the edge of the level surface. If the 40:1 surface is penetrated, raise the VCA level surface height by the amount of the greatest penetration (see figure 4-3). Determine the VCOA "climb-to" altitude using the following formula:

$$\text{climb to altitude} = \text{level surface MSL height} + 250' \text{ ROC} + \text{adjustments (vol. 1, para 3.2.2b)}$$

$$\text{Example: } 5124 + 250 + 0 = 5374 \text{ rounds to } 5400'$$

$$\text{Where OCS height} = 5124$$
$$\text{adjustments} = 0$$

Figure 4-3. Diverse VCOA Evaluation



4.2.2 **Departure Routes.**

Where VCOA Diverse Departure is not feasible, construct a VCOA departure route.

4.2.2 **a. Construct** the VCA per paragraph 4.1.

4.2.2 **b. Determine** the preliminary level surface height as in paragraph 4.2.1.

4.2.2 **c. Locate**, within the VCA, the beginning point of the route.

4.2.2 **d. Construct** the departure route using criteria for the navigation system desired. The 40:1 surface rise begins along a line perpendicular to the route course and tangent to the VCA boundary (see figure 4-4).

4.2.2 **e. OCS Evaluation**. Where obstacles penetrate the route 40:1 OCS:

4.2.2 e. (1) Raise the VCA level surface the amount of penetration. Determine the climb-to altitude using the formula below, **or**…

```
climb to altitude = level  surface  MSL height + 250' ROC + adjustments (vol. 1 para 3.2.2b)

Example:   5124 + 250 + 0 = 5374  rounds to  5400'

Where  OCS  height = 5124
            adjustment = 0
```

4.2.2 e. (2) Determine a climb gradient that will clear the obstacle using the formula:

$$CG = \frac{a - b}{0.76 \times d}$$

where a = obstacle MSL altitude
b = VCA climb - to altitude
d = distance (NM) from 40 : 1 origin to obstacle

$$\text{Example: } CG = \frac{3379 - 2100}{0.76 \times 5.34} = 315.15 \text{ ft/NM}$$

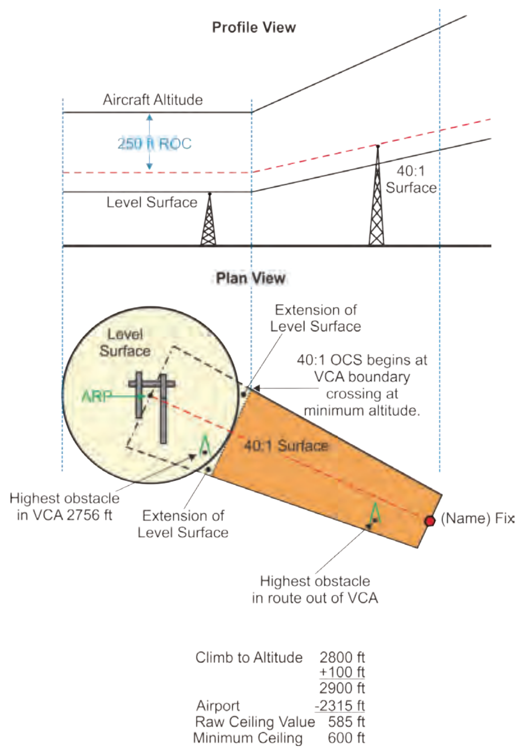
Calculate altitude (alt) that the CG may be discontinued:

$$alt = b + (d \times CG)$$

Example:

$$alt = 2100 + (5.34 \times 316) = 3787.44 \text{ round up to } 3800'$$

Figure 4-4. Route Out of VCA



4.2.3 Published Annotations.

The procedure must include instructions specifying an altitude to cross a fix/location over the airport, followed by routing and altitude instructions to the en route system. **Example**: "Climb in visual conditions to cross Wiley Post airport.

Chapter 5. Diverse Vector Area Evaluation (DVA)

5-1. General. DVA is utilized by ATC radar facilities pursuant to Order JO 7210.3, Facility Operation and Administration, 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 departure runway where the utilization of applicable departure criteria has 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. Evaluate a 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. No obstacle (except low, close-in) may penetrate the OCS of the DVA unless isolated in accordance with paragraph 5-3a. See also paragraph 5-4.

c. The OEA must not extend beyond the diverse departure evaluation distance.

d. A DVA is only applicable to the facility that requested it.

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

5-2. Initial Departure Assessment. Assess the runway from which ATC desires to vector departing aircraft below the MVA/MIA using paragraphs 2.0 and 2.1 of this volume 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. 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 Department of the Navy).

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 (DoD option only); or (e) uses a combination of these methods.

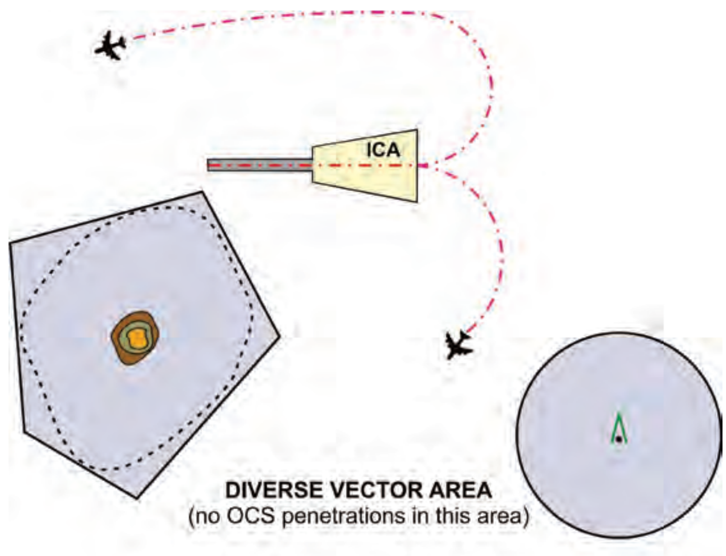
a. Isolate Penetrating Obstacles. This method is generally suitable for isolating single obstacles, or a group of obstacles in proximity to each other. Boundaries surrounding obstacles that penetrate a departure runway's OCS are established that define an area where vectors below the MVA/MIA are prohibited. 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 penetrating obstacles using the MVA sector construction specified in volume 1, chapter 10, paragraph 10.2.4b, 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 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.

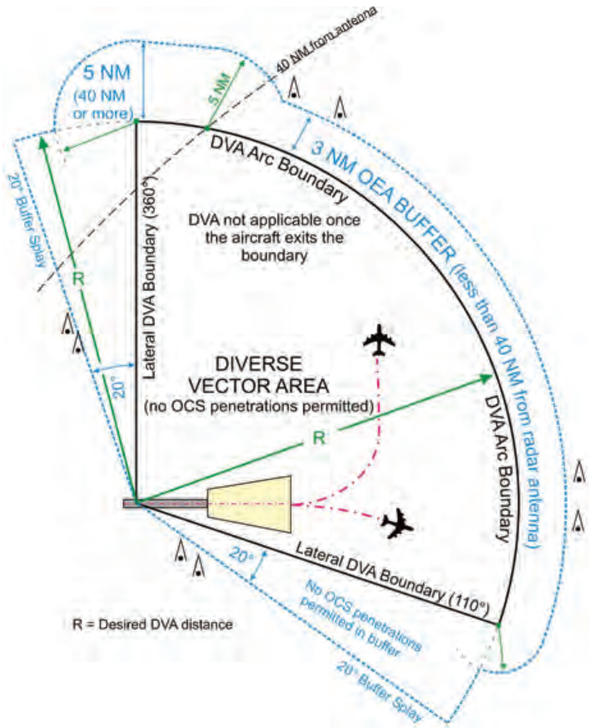
(3) Isolation areas must be located so that sufficient room to vector departing aircraft is provided which would allow ATC to issue vectors as necessary to avoid the areas. This determination must be made in collaboration with the air traffic facility.

Figure 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 5-2).

Figure 5-2. Range of Headings Sector



(1) Construct lateral sector boundaries from the DRP which correspond to the desired headings using the Departure Sector criteria of paragraph 2.2.

(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.

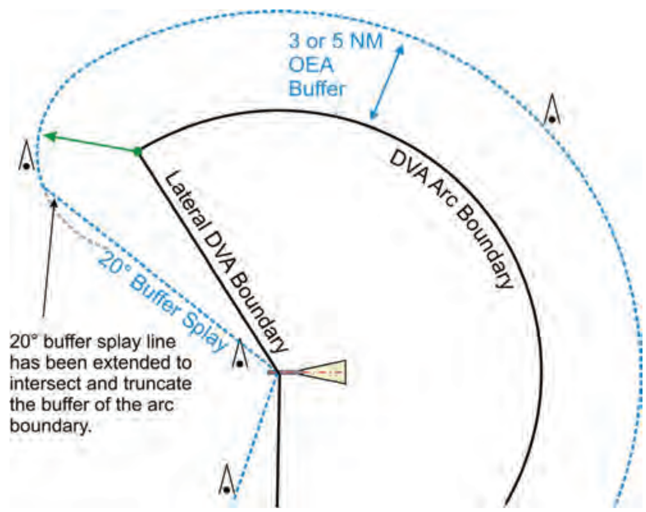
(3) An OEA buffer expands outward from the DVA boundaries. The buffer of the DVA arc boundary must meet the distance requirements of volume 1, chapter 10, paragraph 10.2.4a, except a 5 NM buffer always applies to a DVA that will be used by an ARTCC. The lateral buffers begin at DRP and splay outward 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 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 5-3).

Figure 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 e.g., "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 figures 5-4 through 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) * 40

(b) R_B = (Initial MVA/MIA – Airport Elevation – 951 – 400) * 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:

$$R_A = (3500 - 618 - 951 - 304) * 40$$
$$= 1627 * 40$$
$$= 65080$$

(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 (figure 5-5). Complete the search area with a line that connects point Y to point Z (see figures 5-4 and 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 5-4).

(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 volume 1, chapter 10, or 5 NM for an MIA) beyond the next higher MVA/MIA sector boundary, whichever is encountered first (see figures 5-6 and 5-7).

(5) Establish lateral boundaries and associated buffers that avoid the 40:1 penetrations using the Departure Sector criteria of paragraph 2.2. The maximum range of permitted headings (e.g., 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 5-8).

Figure 5-4. Preliminary Search Area Boundary

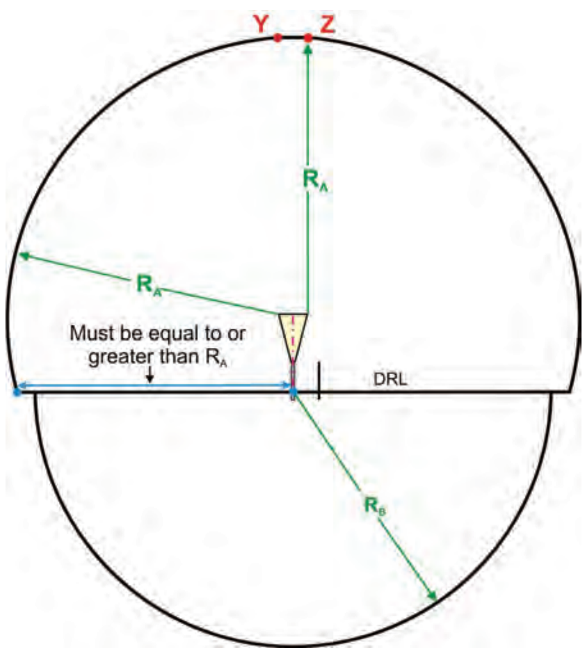


Figure 5-5. Construction with Points W and X

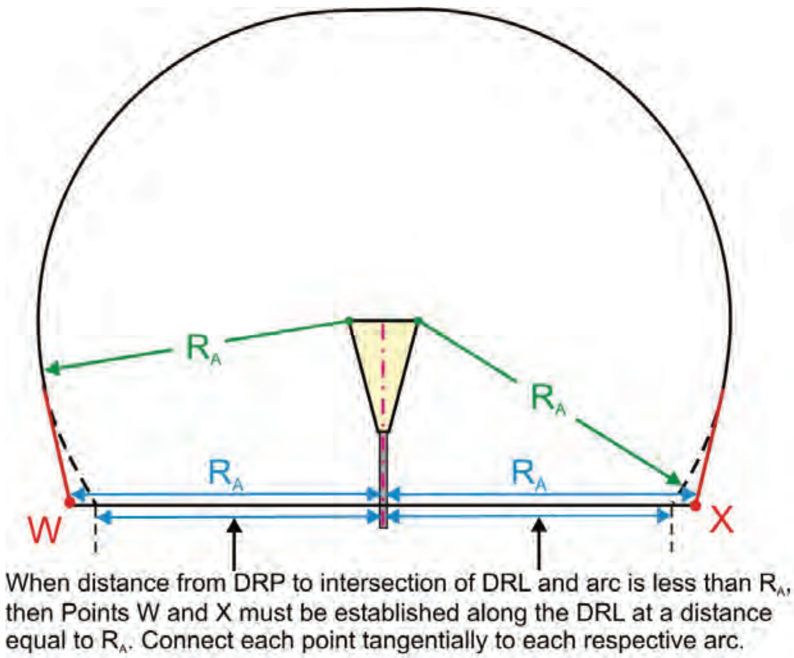


Figure 5-6. MVA Chart With Applicable Buffer Areas

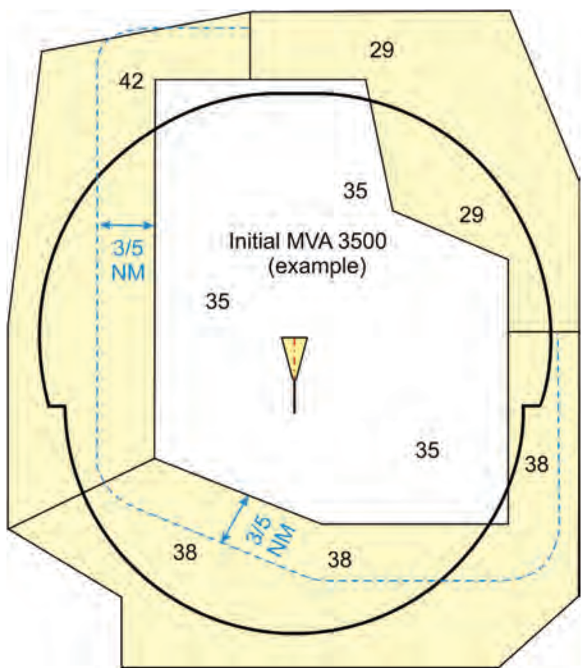


Figure 5-7. Obstacle Search Area

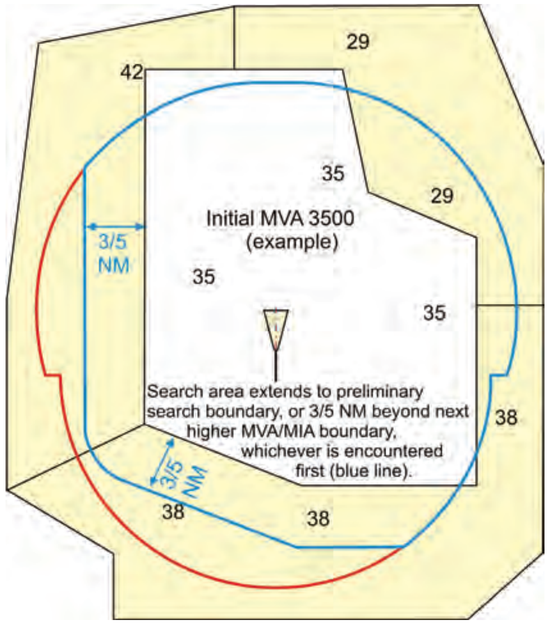
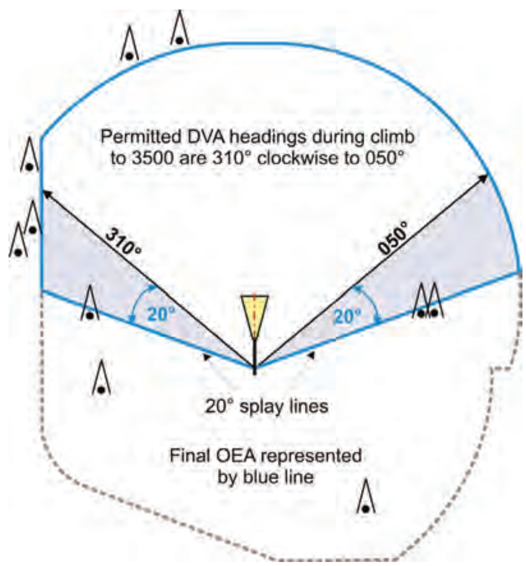


Figure 5-8. Permitted DVA Headings Based on Obstacles

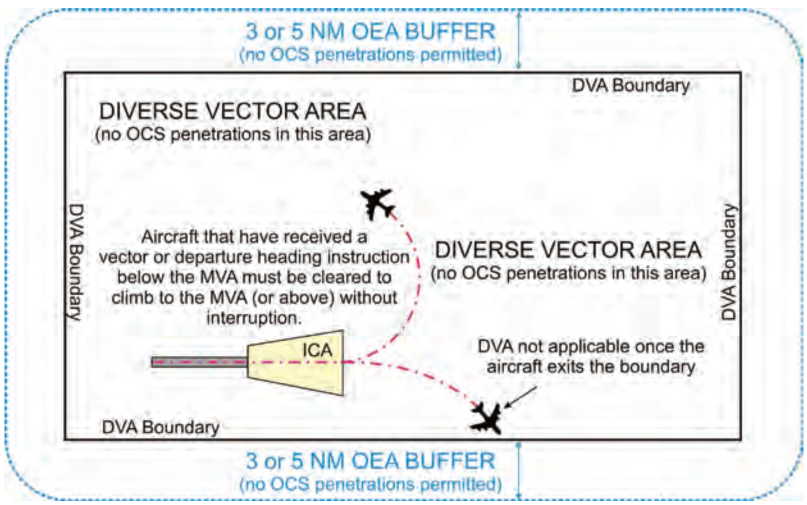


d. Define an Area (DoD Option). An area may be defined which excludes all obstacles (low, close-in obstacles are permitted) that penetrate the departure OCS (see figure 5-9).

(1) Construct the area boundary and an OEA buffer using the MVA sector construction specified in volume 1, chapter 10, section 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 5-9. Defined Area



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 1.4.1 of this volume.

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