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."

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

(23) 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

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CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B
CHG 25

National Policy

Effective Date:
03/09/2012

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

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

2. Who this change affects. The audience for this Order is the FAA organization responsible for instrument flight procedure (IFP) development. The secondary audience includes third party service providers, Air Traffic Organization (ATO) Service Area offices, Flight Standards headquarters and Regional office Divisions/Branches, and the applicable elements in the United States Army, Navy, Air Force, and Coast Guard (hereafter referred to as the U.S. Military or Military).

3. Where You Can 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. Explanation of changes.

a. Volume 3, Appendix 2. Updated paragraphs 1 and 2 for consistency with revisions to Air Traffic Directives based on study DOT-FAA-AFS-450-73, Comparative Evaluation of Lateral Flight Technical Error for Instrument Landing System and Localizer Only Approaches, which allows for the conditional use of localizer approach during a temporary glideslope outage.

5. Distribution. We will distribute this Order 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.

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John M. Allen
Director, Flight Standards Service

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

1. Purpose. Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS), contains the criteria used to formulate, review, approve, and publish procedures for instrument flight operations to and from civil and military airports. The purpose of this change is to incorporate Notice 8260.68 and 8260.69 into the order.

2. Audience. The audience for this Order is the FAA organization responsible for instrument flight procedure (IFP) development. The secondary audience includes third party service providers, Air Traffic Organization (ATO) Service Area offices, Flight Standards headquarters and Regional office Divisions/Branches, and the applicable elements in the United States Army, Navy, Air Force, and Coast Guard (hereafter referred to as the U.S. Military or Military).

3. What this Order Cancels.

a. Notice 8260.68, Publication of Circling Minima on Vertically-Guided Instrument Approaches.

b. Notice 8260.69, Simultaneous Independent Parallel Instrument Approaches [SIPIA] – Widely Spaced Runways.

c. AFS-400 January 26, 2005 Memorandum, Standard for Decision Altitude (DA) Rounding Convention

4. Distribution. We will distribute this Order 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.

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John M. Allen
Director, Flight Standards Service

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B
CHG 23

National Policy

Effective Date:
08/17/2011

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

1. Purpose. Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS), contains the criteria used to formulate, review, approve, and publish procedures for instrument flight operations to and from civil and military airports. The purpose of this change is to incorporate Notice 8260.70 and the June 27, 2009 AFS-400 policy memorandum and to revise/reformat to clarify policies relating to the establishment of takeoff/landing minimums introduced by Change 20. This revision is not intended to modify or rescind any previous agreements relating to implementation.

2. Audience. The audience for this Order is the FAA organization responsible for instrument flight procedure (IFP) development. The secondary audience includes third party service providers, Air Traffic Organization (ATO) Service Area offices, Flight Standards headquarters and Regional office Divisions/Branches, and the applicable elements in the United States Army, Navy, Air Force, and Coast Guard (hereafter referred to as the U.S. Military or Military).

3. What this Order Cancels.

a. AFS-400 Memorandum dated June 27, 2009, "Establishing Straight-in and Circling Visibility Minimums; Clarification of Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS), Volume 1, chapter 3, paragraph 3.3.2, 3.3.3, and Table 3-5a as clarified in AFS-400 Policy Memo dated March 14, 2008."

b. Notice 8260.70, Change to the FAA Order 8260.3, Vol. 1, chapter 3, table 3-5a.

4. Explanation of Changes. Significant areas of new direction, guidance, policy, and criteria as follows:

a. Volume 1, Chapter 2, paragraph 210. This paragraph has been revised to delete reference to calculating nautical mile (NM) visibility in overseas locations.

b. Volume 1, Chapter 3, Section 3, Visibility Minimums. This section has been revised to address inconsistencies with other FAA guidance.

c. Volume 1, Chapter 3, Section 4, Alternate Minimums. This section has been revised to clarify policies and incorporate guidance from Order 8260.19, Flight Procedures and Airspace.

d. Volume 1, Chapter 3, Section 5, Takeoff Minimums. This section has been revised to add helicopter values to table 3-12.

5. Distribution. We will distribute this Order 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.

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John M. Allen
Director, Flight Standards Service

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B
CHG 22

National Policy

Effective Date:
04/01/2011

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

1. Purpose. Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS), contains criteria that must be used to formulate, review, approve, and publish procedures for instrument approach and departure of aircraft to and from civil and military airports. These criteria are for application at any location over which the Federal Aviation Administration (FAA) or Department of Defense (DoD) exercises jurisdiction.

2. Audience. The primary audience for this notice is Department of Defense (DoD), Federal Aviation Administration (FAA), and designated third party designers of instrument procedures. The secondary audience includes other Air Traffic Organization (ATO) Service Area offices and Flight Standards headquarters and regional office Divisions/Branches.

3. Explanation of Changes. Significant areas of new direction, guidance, policy, and criteria as follows:

a. Volume 1, Chapter 10, Radar Approach Procedures and Vectoring Charts. This chapter has been revised to incorporate guidance from the Flight Systems Laboratory (AFS-450) safety analysis report, Technical Memorandum on Risk Associated with Minimum Vectoring Altitude/Minimum Instrument Altitude (MVA/MIA) Rounding Methods, dated October 6, 2010 with December 15, 2010 addendum. This report concluded that under certain conditions there is no appreciable increase in risk when the final result of altitude calculations is rounded to the nearest 100-ft increment. This change rescinds and replaces all previous draft guidance related to the referenced safety analysis report and has intentionally limited applicability to ATC radar Vectoring Charts. This guidance does not support altitude selection for any other TERPS application

4. Distribution. We will distribute this Order 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); to special mailing list ZVN-826; and Special Military and Public Addressees.

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John M. Allen
Director, Flight Standards Service

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

1. Purpose. Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS), contains criteria that must be used to formulate, review, approve, and publish procedures for instrument approach and departure of aircraft to and from civil and military airports. These criteria are for application at any location over which the Federal Aviation Administration (FAA) or Department of Defense (DoD) exercises jurisdiction.

> **Note:** This change revises criteria in Volume 1, chapter 2 regarding final approach segment descent angles and circling maneuvering areas, updates table 3-5a in Volume 1, Chapter 3, replaces criteria in Volume 1, chapter 10 for Radar approaches and Minimum Vectoring Altitude Charts (MVAC), and revises Volume 3, chapter 3 criteria relating to the Glideslope Qualification Surface (GQS).

2. Distribution. This change is distributed in Washington Headquarters to the branch level in the Offices of Aviation Research and Airport Safety and Standards, the Air Traffic Organization (Safety, En Route and Oceanic Services, Terminal Services, and Technical Operation Services), and Flight Standards Service; to the National Flight Procedures Office and the Regulatory Standards Division at the Mike Monroney Aeronautical Center; to the branch level in the regional Flight Standards and Airports Divisions; to the Technical Operations Service Areas and Air Traffic Service Areas; special mailing list ZVS-827, and to special military and public addressees.

3. Effective Date. August 27, 2009.

4. Explanation of Changes. Significant areas of new direction, guidance, policy, and criteria as follows:

a. Volume 1, Chapter 2, General Criteria. The chapter has been revised to incorporate guidance from TERPS Instruction Letters (TILs) 99-014 and 00-012A which are rescinded. Additionally, it revises circling approach area criteria to resolve Government/Industry Aeronautical Charting Forum (ACF) issue #92-02-105. The criteria also includes the recommendations of the United States Instrument Flight Procedures Panel (US-IFPP) Change 21 Working Group to improve internal consistency and coherence.

(1) Section 5, Final Approach.

(a) Provides clarification of intent related to vertical descent angle (VDA) and removes redundant requirements related to final approach segment descent gradient.

(b) Provides updated guidance related to the range of acceptable VDAs and revises/clarifies criteria and figures for VDA calculations in straight-in and circling aligned approach cases (with and without stepdown fix) incorporating updated terminology and formulas.

(c) Updates guidance for establishing, calculating, and marking the Visual Descent Point (VDP), with consideration to procedures with multiple lines of NPA minima.

(2) Section 6, Circling Approach.

(a) Updates requirements related to the Circling Approach Area, revising the method of determining the size of the Obstacle Evaluation Area (OEA) to more closely align with ICAO methodology based ACF issue #92-02-105.

(b) Clarifies intent related to OEA evaluation when circling area restrictions are established based on ACF issue #92-02-105 and US-IFPP Change 21 Working Group recommendations.

(3) Section 7, Missed Approach. Updates terminology and clarifies design elements specified in the missed approach.

b. Volume 1, Chapter 3, Takeoff and Landing Minimums. The chapter has been revised to incorporate guidance from the March 14, 2008 memorandum subject: Equivalent Meter Runway Visual Range (RVR) and Visibility with RVR less than 2400 Authorized, which is rescinded. The revision replaces table 3-5a (including footnotes) in its entirety.

c. Volume 3, Chapter 10, Radar Procedures. The chapter has been revised in its entirety to incorporate guidance from the canceled Notice 8260.64, Radar Approaches and Minimum Vectoring Altitudes - Current Guidance and Criteria. It also includes guidance from the July 21, 2008 AFS-400 memorandum subject: Use of Automated Precipitous Terrain Algorithms for Minimum Vectoring Altitude (MVA) and Minimum Instrument Flight Rules (IFR) Altitude (MIA) Required Obstacle Clearance (ROC) Reductions and the September 10, 2008 AFS-400 memorandum subject: Interim Criteria for Radar Approaches and Minimum Vectoring Altitudes and Guidelines for Application of Glidepath Qualification Surface. These memorandums are rescinded. The criteria also includes the recommendations of the United States Instrument Flight Procedures Panel (US-IFPP) Change 21 Working Group to improve internal consistency and coherence.

d. Volume 3, Chapter 2, General Criteria. The chapter has been revised to incorporate guidance from the canceled Notice 8260.65, Guidelines for Application of Glidepath Qualification Surface (GQS) and the September 10, 2008 AFS-400 memorandum subject: Interim Criteria for Radar Approaches and Minimum Vectoring Altitudes and Guidelines for Application of Glidepath Qualification Surface which is rescinded. The criteria also includes the recommendations of the United States Instrument Flight Procedures Panel (US-IFPP) Change 21 Working Group to improve internal consistency and coherence.

(1) Paragraph 2.9.1, Distance Measure Equipment (DME) incorporates guidance from the December 12, 2005 AFS-420 memorandum subject: Clarification of Issues Related to Criteria Coordination Committee Agenda Items related to issue 04-CCC-010.

(2) Paragraph 2.11 , Clear Areas and Obstacle Free Zones (OFZ) has been intentionally deleted in its entirety.

(3) Paragraph 2.12, Glidepath Qualification Surface (GQS) has been renumbered paragraph 2.11, and:

(a) All criteria and figures revised to clarify that the GQS area originates at the runway threshold, even when the sloping OCS is offset (i.e., low TCH case).

(b) Paragraph 2.11.1 text and formulas updated to accommodate vertically guided RNAV procedures (especially those with multiple lines of minima). It specifies that the assessment(s) of a GQS sloping surface be consistent with the vertical characteristics of each glidepath associated with the procedure/line of minima.

(c) Paragraph 2.11.1d(2) and figure 2-5g clarifies intent regarding permitted obstacles (i.e., excluded from consideration during GQS evaluation).

(4) Paragraph 2.13, ILS/MLS Critical Areas was deemed irrelevant to TERPS evaluations and intentionally deleted.

PAGE CONTROL CHART

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Volume 1, Chapter 2		**Volume 1, Chapter 2**	
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22, 23	05/15/2002		
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Original Signed By

John H. Allen
Director, Flight Standards Service

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

National Policy

8260.3B
CHG 20

Effective Date:
12/07/07

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

1. Purpose. Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS), contains criteria that must be used to formulate, review, approve, and publish procedures for instrument approach and departure of aircraft to and from civil and military airports. These criteria are for application at any location over which the Federal Aviation Administration (FAA) or Department of Defense (DoD) exercises jurisdiction. *This change replaces criteria in Volume 1, chapter 3 with internationally harmonized minimums standards.*

2. Distribution. This change is distributed in Washington Headquarters to the branch level in the Offices of Aviation Research and Airport Safety and Standards, the Air Traffic Organization (Safety, En Route and Oceanic Services, Terminal Services, and Technical Operation Services), and Flight Standards Service; to the National Flight Procedures Office and the Regulatory Standards Division at the Mike Monroney Aeronautical Center; to the branch level in the regional Flight Standards and Airports Divisions; to the Technical Operations Service Areas and Air Traffic Service Areas; special mailing list ZVS-827, and to special military and public addressees.

3. Effective Date. December 21, 2007

4. Explanation of Changes. Significant areas of new direction, guidance, policy, and criteria as follows:

a. VOLUME 1, General Criteria. Chapter 3, Takeoff and Landing Minimums. The entire chapter has been revised to reflect the new standard for determining landing minima, the result of extensive coordination with European aviation authorities aimed at harmonizing landing minima affecting United States and European operators. The chapter has also been reformatted to improve clarity and ease of understanding. Highlights of the major changes in each section of the chapter are as follows:

(1) Section One, General Information.

(a) Added new groupings for approach lighting systems, aligned with international specifications;

Distribution: A-W(AR/AS/ND/FS/AT/AF)-3; AJW-32 (200 Cys); **Initiated By:** AFS-420
AMA-200 (12 Cys); A-X(FS/AF/AT/AS)-3; ZVS-827;
Special Military and Public Addressees

(b) Replaced the term Height Above Touchdown (HAT) with Height Above Threshold (HATh).
(c) Added a table establishing threshold crossing height (TCH) limits for allowing visibility credit for authorized lighting systems.

Note: Addition of this table rescinds table 2-6 of Order 8260.54A and table 2-2c of Order 8260.3. Volume 3.

(2) Section Two, Establishing Minimum Altitudes/Heights.

(a) Revised paragraphs on establishing Decision Altitudes/Heights and Minimum Descent Altitudes;

(b) Added a table prescribing the minimum height above threshold, based on glide-path angle.

(3) Section Three, Visibility Minimums.

(a) Developed completely new tables and methodology for establishing straight-in approach visibility minimums;

(b) Authorized minimums to 1800 runway visual range (RVR) to runways without touchdown zone or centerline lights; authorization is contingent upon the pilot's use of a flight director, coupled autopilot, or head-up display (HUD) system during the instrument approach;

(c) Revised requirements for authorizing "fly visual to airport" on approach charts;

(d) Expanded the HATh range within which minimums of 1800 RVR are authorized with operable touchdown zone and centerline lights;

(e) Expanded the methodology for establishing circling visibility minimums.

(4) Section Four, Alternate Minimums.

(a) Provided an expanded description of the process for establishing other-than-standard alternate minimums;

(b) Modified the alternate minimums table and added an example computation.

PAGE CONTROL CHART

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James J. Ballough
Director, Flight Standards Service

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 19

5/15/02

ARMY .... TM 95-226
NAVY .... OPNAV INST 3722.16C
USAF .... AFMAN 11-226(1)
USCG .... CG 318

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

1. PURPOSE. Change 19 divides Order 8260.3B into five volumes to aid in the efficiency of its use. The conversion from one volume in revision B to five volumes will be completed in four steps consisting of Changes 19 through 22. Change 22 will complete the conversion process, and the document will then be identified as revision "C." Cross referencing between volumes will be minimal. This change also transmits new and revised sections of this order (Volume 1).

2. DISTRIBUTION: This change is distributed in Washington Headquarters to the branch level in the Offices of Airport Safety and Standards; and Communications, Navigation, and Surveillance Systems; to Flight Standards, Air Traffic, and Airway Facilities Services; to the National Flight Procedures Office and the Regulatory Standards Division at the Mike Monroney Aeronautical Center; to the branch level in the regional Flight Standards, Airway Facilities, Air Traffic, and Airports Divisions; special mailing list ZVS-827, and to special Military and Public Addressees.

3. CANCELLATION. With the publication of Change 19, the following orders will be canceled: Orders 8260.36A, Civil Utilization of Microwave Landing System (MLS), dated January 19, 1996; 8260.39A, Close Parallel ILS/MLS Approaches, dated December 29, 1999; 8260.41, Obstacle Assessment Surface Evaluation for Independent Simultaneous Parallel Precision Operations, dated September 15, 1995; and 8260.47, Barometric Vertical Navigation (VNAV) Instrument Procedures Development, dated May 26, 1998.

4. EFFECTIVE DATE: June 14, 2002

5. EXPLANATION OF CHANGES. This is the first change to Order 8260.3B that contains volumes. The volume and paragraph numbers are identified on the inside bottom corner of the page and chapter and page numbers (example 1-1) are on the outside bottom corner of the page. Significant areas of new direction, guidance, and policy included in this change are as follows:

a. VOLUME 1, General Criteria (current TERPS order). Installs the current TERPS Manual as Volume 1 (insert all changes to this portion of the order before adding the other volumes). This volume contains information and criteria applicable to any instrument approach

Distribution: A-W(AS/ND/FS/AT/AF)-3; AVN-100(150CYS); AMA-200 (80 CYS) A-X(FS/AF/AT/AS)-3; ZVS-827; Special Military and Public Addressees

Initiated By: AFS-420

procedure; e.g. administrative, en route, initial, intermediate, terminal fixes, holding, etc. Volume 1 will be completed with the implementation of Change 21.

(1) Chapter 1.

(a) Paragraph 6a. Adds the word "must" to convey that application of the criteria is mandatory.

(b) Paragraph 122a. Includes appendix number to the reference.

(c) Paragraph 161a. Clarifies directions for adding the suffix "DME" and noting the chart accordingly.

(d) Paragraph 173. Adds guidance for TERPS mathematics.

(e) Paragragh 174. Includes information for providing directive feedback.

(2) Chapter 2.

(a) Paragraphs 201, 202, and 203. Adds information and drawings concerning the TERPS concept of primary required obstacle clearance (ROC) and sloping and level obstacle clearance surfaces (OCS).

(b) Paragraph 234e(1). Provides guidance for establishing the minimum published holding altitude.

(c) Table 3 in Paragraph 242b(2). Changes minimum intermediate course lengths.

(d) Paragraph 251a(2)(b). Corrects information in this paragraph.

(e) Paragraph 253. Changes application of the visual descent point (VDP).

(f) Paragraph 274d. Brings up to date figures 17 and 18.

(g) Paragraph 275. Adds requirement for construction of turning or combination straight and turning missed approach areas. Adds note for clarification.

(h) Paragraph 287b(4)(b). Deletes example and figure 30 which is no longer required.

(i) Paragraph 287c(2). Changes figure 31-2 to reflect the current fix displacement calculations.

(3) Chapter 3.

(a) Paragraph 324. Adds current guidance concerning decision altitude (DA).

(b) Paragraph 325. Explains decision height (DH) as it relates to DA.

(c) Paragraph 350. Changes the title of table 9. TERPS Volume 3 now contains information for PRECISION minimums.

(4) Chapter 8, paragraph 813c(1). Updates reference to paragraph 523b(3) as all charts and explanations for solving secondary area obstacle problems have been deleted from appendix 2.

(5) Chapter 9. This change deletes chapter 9 with the exception of section 5 which becomes chapter 9, Localizer and Localizer Type Directional Aids (LDA). Paragraphs 951 through 957 become paragraphs 900 through 907. Volume 3 replaces most of chapter 9.

(6) Chapter 10. Volume 3 provides guidance that supersedes information in sections 2 and 3 of this chapter.

(7) Chapter 11, Paragraph 1105. Clarifies procedure identification of helicopter-only procedures.

(8) Chapter 12. This chapter becomes Volume 4 with four chapters; therefore, chapter 12 in this volume is reserved.

(9) Chapter 15.

(a) Paragraph 1513d(2). Updates reference to 1413d(1) as the ROC applied for this circling approach should be the same as the criteria applied to other chapters.

(b) Paragraph 1513f. Updates reference to chapter 2, section 8 as section 2 no longer contains criteria for the use of radio fixes.

(10) Chapter 17, paragraph 1731b. Updates reference to paragraph 1721 as all charts and explanations for solving secondary area obstacle problems have been deleted from appendix 2.

(11) Appendix 1. Adds title to appendix and an alphabetical listing of all the acronyms and abbreviations for old and new aviation terms used frequently throughout this order.

(12) Appendix 2. Deletes appendix 2 as this information is now in Volume 3, appendix 5.

(13) This change also provides guidance that supersedes chapter 3, section 1 of Order 8260.48, Area Navigation (RNAV) Approach Construction Criteria, dated April 8, 1999. The direction and guidance published in this change supersedes RELATED information in Order 8260.48. A major portion of Order 8260.48 remains in effect.

b. **VOLUME 2, Nonprecision Approach Procedure (NPA) Construction**, is reserved for Change 21. It will contain criteria central to nonprecision final approach segment construction. VHF omnidirectional range (VOR), VOR/distance measuring equipment (DME), nondirectional beacon (NDB), tactical air navigation (TACAN), airport surveillance radar (ASR), airborne radar approaches (ARA), localizer, simplified directional facility (SDF), localizer directional aid (LDA), direction finder (DF), area navigation (RNAV), and lateral navigation (LNAV) systems are supported. Criteria applicable to the initial missed approach climb unique to nonprecision approaches will be included in this volume.

c. VOLUME 3, Precision Approach (PA) and Barometric Vertical Navigation (Baro VNAV) Approach Procedure Construction. Replaces criteria originally located in chapter 9 and guidance from Orders 8260.36A, 8260.39A, 8260.41, and 8260.48, chapter 2, paragraphs 2.1, 2.3, 2.5-2.10, 2.12, and chapter 3, sections 1 and 2. This volume contains the final segment construction criteria for navigational systems that provide vertical guidance, instrument landing system (ILS), microwave landing system (MLS), transponder landing system (TLS), precision approach radar (PAR), Global Navigation Satellite landing system (GLS), wide area augmentation system (WAAS), local area augmentation system (LAAS), and Baro-VNAV. Obstruction clearance criteria applicable to simultaneous parallel, simultaneous converging, and Category II/III operations are included. Intermediate segment requirements and initial missed approach climb criteria unique to precision and Baro VNAV approaches are also contained in this volume.

d. VOLUME 4, Departure Procedure Construction. Replaces criteria originally located in chapter 12 of the TERPS order. This volume contains criteria departure obstruction supporting VOR, NDB, TACAN, ASR, localizer, and RNAV (in Change 21) navigation systems. Diverse departure, climb visually over the airport, and Air Traffic Control diverse vector areas are also covered. These criteria will be amended for use in the missed approach segment in Change 21.

e. VOLUME 5, Helicopter and Powered Lift Instrument Procedure Construction, is reserved for Change 21. It will contain all guidance for instrument procedure construction (en route, departure, approach) criteria.

6. PUBLICATION FORMAT. The double column, traditional paragraph numbering scheme of the TERPS document is changing to a single column, decimal number system more consistent with RTCA and the International Civil Aviation Organization (ICAO). The print is clear and illustrations are larger.

7. DISPOSITION OF TRANSMITTAL. The transmittal must be RETAINED AND FILED IN THE BACK OF THIS MANUAL until it is superseded by a revised order.

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James J. Ballough
Director, Flight Standards Service

CHANGE

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 18

11/12/99

ARMY .... TM 95-226
NAVY .... OPNAVINST 3722.16C
USAF .... AFMAN 11-226(1)
USCG .... CG 318

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

1. PURPOSE. This change transmits revised pages to Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS).

2. DISTRIBUTION. This change is distributed in Washington Headquarters to the branch level in the Offices of Airport Safety and Standards; and Communications, Navigation, and Surveillance Systems; to Flight Standards, Air Traffic, and Airway Facilities Services; the National Flight Procedures Office and the Regulatory Standards Division at the Mike Monroney Aeronautical Center; to the branch level in the regional Flight Standards, Airway Facilities, and Air Traffic Divisions; special mailing list ZVS-827, and to special Military and Public Addressees.

3. EFFECTIVE DATE. January 20, 2000.

4. EXPLANATION OF CHANGES. Significant areas of new direction, guidance, and policy included in this change are as follows:

a. Paragraph 122a adds wording to ensure requirements in AC-150/5340-1, Marking of Paved Areas on Airports, and AC 150/5300-13, Airport Design, are met during instrument procedure design and review. The changes in these AC's will impact instrument procedures.

b. Paragraph 161 changes the approach procedure naming convention. Instrument landing system (ILS) procedures utilizing distance measuring equipment (DME) will no longer have DME in the procedure name. If DME is required to support ILS localizer minimums, the chart will be noted to indicate DME is required for localizer (LOC) final. The naming scheme for multiple approaches of the same type to the same runway is changed to use alphabetical suffixes. The procedure title "area navigation (RNAV)" indicates wide area augmentation system (WAAS), lateral navigation (LNAV)/ vertical navigation (VNAV), Flight Management System (FMS), or global positioning system (GPS) approach systems define the final segment. The title for these procedures is RNAV RWY.XX, etc.

c. Paragraph 234b changes the procedure turn protected airspace to allow it to vary according to the entry altitude. As the altitude increases, so does true airspeed. This change ensures the obstruction area will contain the PT maneuver regardless of initiation altitude.

d. Paragraph 251 increases the visual segment obstacle clearance surface (OCS) starting width associated with straight-in approaches from a total width of 400 feet (± 200 feet) to 800 feet (± 400 feet).

Distribution: A-W(AS/ND/FS/AT/AF)-3; AVN-100(150CYS); AMA-200 (80 CYS); A-X(FS/AF/AT)-3; ZVS-827; Special Military and Public Addressees

Initiated By: AFS-420

e. Paragraph 252 publishes actual descent gradient to threshold crossing height (TCH) where straight-in minimums are prohibited because of excessive descent gradient. Publishing this value aids pilots in determining whether or not to attempt a straight-in landing and provides methodology for accommodating S/D fix altitudes above the final approach fix (FAF) to TCH descent.

f. Paragraph 253 adds requirement for the visual descent point (VDP) DME to be collocated with the facility providing final approach course guidance (U.S. Navy/U.S. Army/U.S. Air Force/U.S. Coast Guard NA). Wording is changed to clarify the requirement, but the meaning is not changed.

g. Paragraph 277b provides the "appropriate final required obstacle clearance (ROC)." Previous version required 250 feet of ROC regardless of facility type.

h. Paragraph 282c adds guidance to ensure marker beacons are used as fixes ONLY when associated with the facility providing course instructions.

i. Paragraph 334c adds the new guidance in AC 150/5300-13 that requires precision instrument runway markings for visibility minimums less than 3/4 statute mile, and requires touchdown zone lighting and runway centerline (TDZ/CL) for runway visual range (RVR) less than 2,400 feet.

j. Paragraph 1028 changes the wording to allow military operations with 100-foot category I height above touchdown (HAT) on precision approach radar (PAR) procedures.

5. INFORMATION CURRENCY.

a. Forward for consideration any deficiencies found, clarification needed, or suggested improvements regarding the contents of this order to:

DOT/FAA
Flight Procedure Standards Branch, AFS-420
P.O. Box 25082
Oklahoma City, OK 73125

b. Your assistance is welcome. FAA Form 1320-9, Directive Feedback Information, is included at the end of this change for your convenience. If an interpretation is needed immediately, you may call the originating office for guidance. However, you should use FAA Form 1320-9 as a follow-up to the verbal conversation.

c. **Use the "Other Comments" block** of this form to provide a complete explanation of why the suggested change is necessary.

6. DISPOSITION OF TRANSMITTAL. This change transmittal should be retained after changed pages are filed.

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L. Nicholas Lacey
Director, Flight Standards Service

CHANGE

U. S. DEP ARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 17

2/13/98

ARMY .... TM 95-226
NAVY .... OPNAVINST 3722.16C
USAF .... AFJMAN 11-226
USCG .... CG 318

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

1. PURPOSE. This change incorporates criteria contained in AVN Supplements to TERPS. It also corrects and updates criteria for evaluating the visual portion of an instrument approach, computing descent gradient, descent angle, and Visual Descent Point (VDP). Area navigation (RNAV) criteria are updated.

2. DISTRIBUTION. This change is distributed in Washington Headquarters to the division level of Flight Standards Service; Air Traffic Service; the Offices of Airport Safety and Standards; and Communications, Navigation, and Surveillance Systems; to the National Flight Procedures Office; the Regulatory Standards and Compliance Division at the Mike Monroney Aeronautical Center; to the regional Flight Standards divisions; and to special Military and Public Addressees.

3. EFFECTIVE DATE. April 20, 1998.

4. EXPLANATION OF CHANGES. This change incorporates all AVN Supplements to TERPS, provides a method for evaluating the visual portion of an instrument approach, and introduces criteria for determining final segment length based on descent angle. It revises ILS and PAR obstacle clearance calculations; adds criteria contained in FAA Order 8260.34, Glide Slope Threshold Crossing Height Requirements, to chapter 9; and updates chapter 15.

5. DISPOSITION OF TRANSMITTAL. After filing, this change transmittal should be retained.

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Initiated By: AFS-420

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55 (thru 57 and 58)	7/76	55 (thru 57 and 58)	2/13/98
59 (thru 63 and 64)	7/76	59 (thru 63 and 64)	2/13/98
67 (and 68)	4/1/83	67 (and 68)	2/13/98
77 (and 78)	9/10/93		
79 (thru 82)	2/79		
83	7/76		
84 (and 85)	3/12/93	77 (thru 85)	2/13/98
86	9/10/93	86	9/10/93
87 (thru 89)	4/1/83		
90	12/6/84	87 (thru 89 and 90)	2/13/98
15-1 (thru 15-3)	7/26/90	15-1 (thru 15-3)	2/13/98
15-4 (and 5)	7/26/90	15-4 (and 5)	7/26/90
15-6 (thru 15-32)	7/26/90	15-6 (thru 15-27)	2/13/98
APPENDIX 2		APPENDIX 2	
1 (and 2)	2/79		
3 (and 4)	4/1/83		
5	2/79		
6 (thru 8)	7/76		

PAGE CONTROL CHART (Continued)

REMOVE PAGES	DATED	INSERT PAGES	DATED
APPENDIX 2		APPENDIX 2	
9	9/10/93		
10 (thru 12)	4/1/83		
12-1 (and 12-2)	3/12/93		
13	4/1/83		
14	9/10/93		
15	4/1/83		
16	9/10/93		
17 (and 18)	4/1/83	1 (thru 6)	2/13/98

Thomas E. Stuckey
Acting Director, Flight Standards Service

CHANGE

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 16

2/18/94

ARMY.......................................TM 95-226
NAVY..............................OPNAV INST 3722.16C
USAF..AFM 55-9
USCG..CG 318

SUBJ: **UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)**

1. PURPOSE. This change further refines criteria in Order 8260.3B, chapter 3, section 2, paragraph 323b, Remote Altimeter Setting Source (RASS). This change also incorporates any editorial requirements occurring in chapter 9 from previous changes.

2. DISTRIBUTION. This change is distributed to all addressees on special distribution list ZVS-827.

3. EXPLANATION OF CHANGES. This change provides relief to the stringent requirements published in change 11 to this order while still meeting the basic tenants of safety in the RASS study on which this change is based. The concept of nonhomogeneous weather and terrain differentials is absorbed within the computational formula, and further adjustments for those situations are not required in the application of RASS adjustments. This change also updates the U.S. Navy addressees for Department of Defense distribution.

4. DISPOSITION OF TRANSMITTAL. Retain this page after changed pages have been filed.

PAGE CONTROL CHART

REMOVE PAGES	DATED	INSERT PAGES	DATED
v	12/6/84	v	2/18/94
vi	12/6/84	vi	12/6/84
37	4/1/83	37	4/1/83
38	5/7/92	38	2/18/94
38-1	5/7/92	38-1	2/18/94
38-2	5/7/92	38-2	2/18/94
75	9/10/93	75	2/18/94
76	2/79	76	2/79

William J. White
Deputy Director, Flight Standards Service

Distribution: ZVS-827 Initiated By: AVN-210/AFS-420

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 15

ARMY .. ..TM 95-226
NAVY..................... ......OPNAV INST 3722.16C
USAF.......... ....AFM 55-9
USCG............. ....CG 318

9/10/93

SUBJ: UNITED STATES STANDARDS TERMINAL INSTRUMENT PROCEDURES (TERPS)

1. PURPOSE. This change deletes the TERPS requirement for middle markers for precision ILS approaches, thereby, removing the 50-foot penalty for all users of this instrument landing system.

2. DISPOSITION OF TRANSMITTAL: Retain this page after changed pages have been filed.

PAGE CONTROL CHART

REMOVE PAGES	DATED	INSERT PAGES	DATED
ix	7/26/90	ix	7/26/90
x	7/26/90	x	9/10/93
xiii	7/26/90	xiii	7/26/90
xiv	7/26/90	xiv	9/10/93
xxi	7/26/90	xxi	7/26/90
xxii	7/26/90	xxii	9/10/93
xxiii	3/12/93	xxiii	9/10/93
xxiv	3/12/93	xxiv	3/12/93
xxv	5/7/92	xxv	5/7/92
xxvi	3/12/93	xxvi	9/10/93
xxix (and xxx)	3/12/93	xxix	9/10/93
		xxx	9/10/93
29	4/1/83	29	9/10/93
30	4/1/83	30	4/1/83
43	12/4/90	43	9/10/93
44	5/21/92	44	5/21/92
75	2/79	75	9/10/93
76	2/79	76	2/79
77	4/1/83	77	9/10/93
78	4/1/83	78	9/10/93
85	3/12/93	85	3/12/93
86	3/12/93	86	9/10/93
87 (and 88)	3/12/93	86-1 (and 86-2)	9/10/93
9, Appendix 2	4/1/83	9, Appendix 2	9/10/93
10, Appendix 2	4/1/83	10, Appendix 2	4/1/83
13, Appendix 2	4/1/83	13, Appendix 2	4/1/83
14, Appendix 2	4/1/83	14, Appendix 2	9/10/93
15, Appendix 2	4/1/83	15, Appendix 2	4/1/83
16, Appendix 2	4/1/83	16, Appendix 2	9/10/93

Thomas C. Accardi
Director, Flight Standards Service

Distribution: ZVS-827

Initiated By: AFS-420

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 14

3/12/93

ARMY .... TM 95-226
NAVY ...... OPNAV INST 3722.16C
USAF .... AFM 55-9
USCG .... CG 318

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

1. PURPOSE. This change refines criteria in chapter 11, section 3, Takeoff and Landing Minimums, to more closely align with FAR 97.3(d.1) and applicable military regulations. Separate criteria have been developed for computing visibility for "copter-to-runway" approaches to minimum visibility values of one-half the corresponding Cat "A" fixed-wing value.

2. DISPOSITION OF TRANSMITTAL. Retain this page after changed page has been filed.

PAGE CONTROL CHART

REMOVE PAGES	DATED	INSERT PAGES	DATED
101	2/79	101	2/79
102	2/79	102	3/12/93
103	7/76	103	3/12/93
104	7/76	104	3/12/93

Thomas C. Accardi
Director, Flight Standards Service

Distribution: ZVS-827

Initiated By: AVN-540/ AFS-420

*U.S. G.P.O.:1993-343-273:80151

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 13

3/12/93

ARMY .... TM 95-226
NAVY ...... OPNAV INST 3722.16C
USAF .... AFM 55-9
USCG .... UNNUMBERED

SUBJ: **UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)**

1. PURPOSE. This change adds criteria to chapter 9, section 9, for triple simultaneous ILS procedures. Previously, this section covered only dual simultaneous ILS procedures. Existing figure 96 becomes figure 96A. Figure 96B is new. Existing figure 97 becomes figure 97A. In figure 97A, coverage of normal operating zones has been increased for clarity. Figure 97B is new. This change also includes corrections to change 12, published 5/21/92.

2. DISPOSITION OF TRANSMITTAL. Retain this page after changed page has been filed.

PAGE CONTROL CHART

REMOVE PAGES	DATED	INSERT PAGES	DATED
xv	7/26/90	xv	3/12/93
xvi	7/26/90	xvi	7/26/90
xxiii	7/26/90	xxiii	3/12/93
xxiv	7/26/90	xxiv	3/12/93
xxv	5/7/92	xxv	5/7/92
xxvi	7/26/90	xxvi	3/12/93
xxix (and xxx)	7/26/90	xxix (and xxx)	3/12/93
11	5/21/92	11	3/12/93
12	5/21/92	12	5/21/92
12-1 (and 12-2)	12/6/84	12-1 (and 12-2)	5/21/92
13	12/6/84	13	12/6/84
14	12/6/84	14	3/12/93
83	7/76	83	7/76
84-85 (and 86)	2/79	84-87 (and 88)	3/12/93
Appendix 2		Appendix 2	
11	4/1/83	11	4/1/83
12	5/21/92	12	4/1/83
		12-1 (and 12-2)	3/12/93

Thomas C. Accardi
Director, Flight Standards Service

Distribution: ZVS-827 Initiated By: AVN-540/AFS-420

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 12

ARMY . . . . TM 11-2557-26
NAVY . . OPNAV INST 3722.16B
USAF . . . . AFM 55-9
USCG . . . . UNNUMBERED

5/21/92

SUBJ: **UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)**

1. <u>PURPOSE</u>. This change provides a descent gradient table for high altitude jet penetrations using arcs of less than 15 miles (par 232a). Table 10 is changed to provide 1/4 mile credit for ODALS on a precision straight-in. Appendix 2 is changed to provide specific guidance to computed required procedural parameters for some military PAR systems.

2. <u>DISPOSITION OF TRANSMITTAL</u>. Retain this page after changed page has been filed.

PAGE CONTROL CHART

REMOVE PAGES	DATED	INSERT PAGES	DATED
11-12	12/6/84	11	5/21/92
		12	12/6/84
		12-1 (and 12-2)	12/6/84
43-44	12/4/90	43	12/4/90
	4/1/83	44	5/21/92
Appendix 2 11-12	4/1/83	Appendix 2 11	4/1/83
		12	5/21/92

Thomas C. Accardi
Director, Flight Standards Service

Distribution: **ZVS-827**

Initiated By: **AVN-540/AFS-420**

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 11

ARMY . . . . TM 11-2557-26
NAVY . . OPNAV INST 3722.16B
USAF . . . . AFM 55-9
USCG . . . . UNNUMBERED

5/7/92

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

1. PURPOSE. This change refines criteria in paragraph 323b for adjustments to minimums required for obstacle clearance necessary when utilizing a remote altimeter setting source (RASS). The method in which procedures specialists apply required adjustments is changed. The concepts of non-homogeneous weather and precipitous terrain are absorbed within the computational formula and further adjustments for those situations are not required. Figure 37B on page 41 was renumbered 37D to accommodate two new figures, 37B and 37C, page 38-2.

2. DISPOSITION OF TRANSMITTAL. Retain this page after changed page has been filed.

PAGE CONTROL CHART

REMOVE PAGES	DATED	INSERT PAGES	DATED
xxv-xxvi	7/26/90	xxv	
		xxvi	7/26/90
37	4/1/83	37	4/1/83
38	1/27/84	38	
		38-1	
		38-2	
41	12/6/84	41	
42	12/6/84	42	12/6/84

Thomas C. Accardi
Director, Flight Standards Service

Distribution: ZVS-827

Initiated By: AVN-540/AFS-420

CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 10

ARMY . . . . TM 11-2557-26
NAVY . . OPNAV INST 3722.16B
USAF . . . . AFM 55-9
USCG . . . . UNNUMBERED

12/4/90

SUBJ: **UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)**

1. PURPOSE. This change makes minor changes to table 9, chapter 3, Civil Straight-in Minimums, as a follow-up to Action Notice A8260.6. The change removes reference to middle marker (MM) in note 3 under nonprecision minimums; references operations specifications regarding MM under precision approach (line 14); and reduces "D" category runway visual range (RVR) in line 13, precision approach.

2. DISPOSITION OF TRANSMITTAL. Retain this page after changed page has been filed.

PAGE CONTROL CHART

REMOVE PAGES	DATED	INSERT PAGES	DATED
43-44	4/1/83	43	12/4/90
		44	4/1/83

William C. Withycombe
Acting Director, Flight Standards Service

Distribution: ZVS-827 Initiated By: AVN-540/AFS-420

CHANGE

U S DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 9

ARMY . . . . TM 11-2557-26
NAVY . . OPNAV INST 3722.16B
USAF . . . . AFM 55-9
USCG . . . . UNNUMBERED

7/26/90

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

1. PURPOSE. This change transmits Chapter 15, Area Navigation (RNAV), to the United States Standard for Terminal Instrument Procedures (TERPS), Order 8260.3B; Department of the Army Technical Manual, TM 11-2557-26; Department of the Navy, OPNAV INST 3722.16B; Department of the Air Force Manual, AFM 55-9; and the United States Coast Guard manual, unnumbered.

2. SUMMARY OF CHANGES. Chapter 15, Area Navigation (RNAV), is a major change and addition of criteria. Appendix 6 is revised to include additional terminology. The Table of Contents is revised to include chapter 15 with additional figures and tables.

3. DISPOSITION OF TRANSMITTAL. Retain this page after changed pages have been filed.

PAGE CONTROL CHART

REMOVE PAGES	DATED	INSERT PAGES	DATED
vii	4/1/83	vii thru xxix (and xxx)	7/26/90
viii	3/24/86		
ix thru xx	4/1/82		
xxi, xxii	3/24/86		
xxiii	4/1/83		
xxiv thru xxv (and xxvi)	12/6/84		
		15-1 thru 15-32	7/26/90
Appendix 6 1 thru 19 (and 20)	4/1/83	Appendix 6 1 thru 21 (and 22)	7/26/90

Daniel C. Beaudette
Director, Flight Standards Service

Distribution: ZVS-827 Initiated By: AVN-540/AFS-420

CHANGE

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 8

Army. . . . . TM 95-226
Navy. . . . . OPNAV Inst 3722.16C
Air Force. . . . . AFM 55-9
Coast Guard. . . . . CG 318

3/24/86

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

PURPOSE. This change adds new criteria to TERPS to permit course reversal using non-collocated navigational aids and procedure turn criteria where the turn fix is other than the facility or final approach fix (FAF).

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
vii	4/1/83	vii	4/1/83
viii	12/6/84	viii	3/24/86
xxi and xxii	12/6/84	xxi and xxii	3/24/86
15 and 16	4/1/83	15 and 16	3/24/86
		16-1	3/24/86
		16-2	3/24/86
17	11/15/83	17	3/24/86
18	4/1/83	18	3/24/86
19 and 20	4/1/83	19 and 20	3/24/86
		20-1	3/24/86
		20-2	3/24/86
21 and 22	4/1/83	21	3/24/86
		22	4/1/83

William T. Brennan
Acting Director of Flight Standards

Distribution: ZVS-827

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CHANGE

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 7

Army	TM 95-226	12/6/84
Navy	OPNAV Inst 3722 16C	
Air Force	AFM 55-9	
Coast Guard	. . . . .CG 318	

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

PURPOSE. This change updates Navy distribution requirements, updates portions of the Table of Contents, revises reference to aircraft categories, provides easier to follow instructions on dead reckoning (DR) initial segments, gives revised criteria on step-down fixes, revised holding areas/obstacle clearance, revised standard alternate minimums, a revised Section 1 for PAR straight missed approach, and corrects several typographical errors in references in Chapter 17.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
v	11/15/83	v	12/6/84
vi	4/1/83	vi	12/6/84
vii	4/1/83	vii	4/1/83
viii	4/1/83	viii	12/6/84
xxi & xxii	4/1/83	xxi & xxii	12/6/84
xxiii	4/1/83	xxiii	4/1/83
xxiv	4/1/83	xxiv	12/6/84
xxv (and xxvi)	4/1/83	xxv (and xxvi)	12/6/84
7	4/1/83	7	12/6/84
8	4/1/83	8	4/1/83
11 through 14	4/1/83	11 through 14	12/6/84
33	11/15/83	33	12/6/84
34	11/15/83	34	12/6/84
35 & 36	7/76	35 & 36	12/6/84
41 & 42	4/1/83	41 & 42	12/6/84
89	4/1/83	89	4/1/83
90	4/1/83	90	12/6/84
173	6/80	173	12/6/84
174	6/80	174	6/80
177	6/80	177	12/6/84
178	6/80	178	6/80
179	6/80	179	12/6/84
180	6/80	180	6/80

Kenneth S. Hunt

Kenneth S. Hunt
Director of Flight Operations

Distribution: ZVS-827

Initiated By: AVN-200/AFO-200

CHANGE

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 6

1/27/84

Army. . . . . TM 95-226
Navy. . . . . OPNAV Inst 3722.16C
Air Force. . . . . AFM 55-9
Coast Guard. . . . . CG 318

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

PURPOSE. This change corrects three errors included in previous changes. It deletes the requirement to apply excessive length of final penalty to circling procedures, includes the formula for one-half the width of the primary area in figure 65, and replaces incorrect NATO STANDARD (C) lighting figure with figures showing the two systems being used.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
37 and 38	4/1/83	37	4/1/83
		38	1/27/84
65 and 66	4/1/83	65	4/1/83
		66	1/27/84
APPENDIX 5 1 and 2	4/1/83	APPENDIX 5 1 and 2	1/27/84

William T. Brennan
Acting Director of Flight Operations

Distribution: ZVS-827 Initiated By: AFO-230

CHANGE

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 5

11/15/83

Army. . . . . TM 95-226
Navy. . . . . OPNAV Inst 3722.16C
Air Force. . . . . AFM 55-9
Coast Guard. . . . . CG 318

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

PURPOSE. This change updates references to Federal agencies, corrects distribution lists, and makes minor changes to criteria references which were made necessary by the automation of procedures development. Several minor typographical errors are also corrected.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
iii - iv	2/79	iii - iv	11/15/83
v - vi	4/1/83	v	11/15/83
		vi	4/1/83
5 (and 6)	4/1/83	5 (and 6)	11/15/83
17 and 18	4/1/83	17	11/15/83
		18	4/1/83
23 and 24	4/1/83	23	4/1/83
		24	11/15/83
27 and 28	2/79	27	11/15/83
		28	2/79
31 and 32	4/1/83	31	11/15/83
		32	4/1/83
33 and 34	4/1/83	33 through 34-2	11/15/83
181 and 182	4/1/83	181	4/1/83
		182	11/15/83

William T. Brennan
·ting Director of Flight Operations

Distribution: ZVS-827 **Initiated By:** AVN-200/AFO-200

CHANGE

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 4

4/1/83

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

PURPOSE. This change updates references to responsible FAA organizations; defines the use of shall, should, and may; removes reference to L/MFR; adds Chapter 14 SDF Procedures; adds Figure 129B PAR, corrects minor typographical errors; and completely updates Appendix 5, Approach Lighting Systems and Appendix 6, Alphabetical Index.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
v thru xvi	7/76	v thru xxv	4/1/83
xvii thru xxiii	6/80		
1	7/76	1 thru 26	4/1/83
2 and 3	2/79	29 thru 34	4/1/83
4	7/76	37 and 38	4/1/83
5(and 6)	2/79	39 thru 44-1(and 44-2)	4/1/83
7	2/79	65 thru 68	4/1/83
8	10/79	77 and 78	4/1/83
9 thru 11	7/76	87 thru 90	4/1/83
12	2/79	99 and 100	4/1/83
13	7/76	137 and 138	4/1/83
14 thru 16	2/79	175 and 176	4/1/83
17 and 18	7/76	181 and 182	4/1/83
19 and 20	2/79		
21 and 22	7/76		
23 thru 26	2/79		
29	2/79		
30 thru 32	7/76		
33	2/79		
34	7/76		
37 and 38	7/76		
39 thru 44	2/79		
65 thru 68	7/76		
77	7/76		
78	2/79		
87	2/79		
88	7/76		
89 and 90	2/79		
99	7/76		
100	2/79		
175 and 176	6/80		
181 and 182	6/80		

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PAGE CONTROL CHART CONTINUED

Remove Pages	Dated	Insert Pages	Dated
APPENDIX 2		APPENDIX 2	
3 and 4	7/76	3 and 4	4/1/83
9 and 10	7/76	9 thru 17(and 18)	4/1/83
11	2/79		
12	7/76		
13 thru 16	7/76		
APPENDIX 5		APPENDIX 5	
1 thru 10	7/76	1 thru 8	4/1/83
APPENDIX 6		APPENDIX 6	
1 thru 20	6/80	1 thru 19(and 20)	4/1/83

Kenneth S. Hunt
Kenneth S. Hunt
Director of Flight Operations

CHANGE

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 3

6/3/80

Army ....TM 95-226
Navy ... OPNAV Inst 3722.16C
Air Force .... AFM 55-9
Coast Guard .... CG 318

Cancellation Date: Retain

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

PURPOSE. This change incorporates a new Chapter 17, Enroute Criteria into the TERPs handbook and is concurred in by the TERPs signatories. These criteria formerly were contained in FAA Handbook 8260.19, Flight Procedures and Airspace, Chapter 8, Criteria. This administrative action focalizes all instrument procedures related criteria into the TERPs handbook for reasons of homogeneity. A change to 8260.19 will be issued to withdraw Chapter 8. TERPS Chapters 13, 14, 15, and 16 are reserved for future use.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
xvii thru xviii	2/79	xvii thru xxiii	6/80
xix	7/76	Chapter 17	
xx thru xxi	2/79	Pages 173 thru 187	6/80
Appendix 6		Appendix 6	
Pages 1 thru 11	7/76	Pages 1 thru 20	6/80
12	2/79		
13 thru 20	7/76		

Kenneth S. Hunt

KENNETH S. HUNT
Director of Flight Operations

Distribution: ZFS-827 **Initiated By:** AFO-700/500

CHANGE

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 2

Army .... TM 95-226
Navy ..... OPNAV Inst 3722.16C
Air Force................. AFM 55-9
Coast Guard .... CG 318

10/22/79

Cancellation Date: Retain

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

PURPOSE. Provide artwork for Figure 101 and related page revisions inadvertently omitted in the initial printing process of Change 1.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
7 and 8	2/79	7	2/79
		8	10/79
91 thru 94	7/76	91	7/76
		92 and 93	10/79
		94	7/76

Kenneth S. Hunt

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Director of Flight Operations

Distribution: ZFS-827 **Initiated By:** AFO-700

BACK

CHANGE

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 1

2/6/79

Army .... TM 95-226
Navy .... OPNAV Inst 3722.16C
Air Force .... AFM 55-9
Coast Guard .... CG 318

Cancellation Date: RETAIN

SUBJ: UNITED STATES STANDARD FOR TERMINAL INSTRUMENT PROCEDURES (TERPS)

PURPOSE. In addition to minor revisions, clarifications, and editorial corrections, this change transmits a new Table 6, Effect of HAT/HAA on Visibility Minimums (chapter 2), and adds new Chapter 12, Departure Procedures.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
iii thru vi	7/76	iii thru vi	2/79
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J. A. Ferrarese

J. A. FERRARESE, Acting Director, Flight Standards Service

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
National Policy

ORDER 8260.3B

Effective Date:
07/07/76

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

This order prescribes standardized methods for use in designing instrument flight procedures. It is to be used by all personnel charged with the responsibility for the preparation, approval, and promulgation of terminal instrument procedures. Compliance with criteria contained herein is not a substitute for sound judgment and common sense. These criteria do not relieve procedures specialists and supervisory personnel from exercising initiative or taking appropriate action in recognizing both the capabilities and limitations of aircraft and navigational aid performance. These criteria are predicated on normal aircraft operations for considering obstacle clearance requirements.

These criteria have been officially adopted and contained as a joint publication between the Federal Aviation Administration (FAA), the United States Army (USA), the United States Navy (USN), the United States Air Force (USAF), and the United States Coast Guard (USCG).

For reference, below are the applicable official document numbers.

USA	TM 95-226
USAF	AFMAN 11-226(I)
USCG	CG 318
USN	OPNAV Inst 3722.16C
FAA	FAAO 8260.3B

Note: This is a CONSOLIDATED REPRINT including Changes 1 through 26.

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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

BY ORDER OF THE SECRETARIES OF THE ARMY, AIR FORCE, AND TRANSPORTATION

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The Adjutant General

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Federal Aviation Administration

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Submit requisition to:
USAASO
Cameron Station
Alexandria, VA 22314

U.S. Air Force

Submit requisition to:
DMAODS/DDCP
Washington, DC 20315

U.S. Coast Guard:

In accordance with COMDTNOTE 5600.
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Washington, DC 20002

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FAA ORDER **8260.3B**

Army TM 95-226
Navy OPNAV Inst. 3722.16C
Coast Guard CG 318
Air Force AFMAN 11-226(I)

UNITED STATES STANDARD
FOR
TERMINAL
INSTRUMENT
PROCEDURES
(TERPS)

VOLUME 1

GENERAL CRITERIA

U. S. DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

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.

CHAPTER 2. GENERAL CRITERIA

200. SCOPE. This chapter contains only that information common to all types of TERPS. Criteria, which do not have general application, are located in the individual chapters concerned with the specific types of facilities.

SECTION 1. COMMON INFORMATION

201. TERPS. Concept of Primary Required Obstacle Clearance (ROC). The title of this order, United States Standard for Terminal Instrument Procedures (TERPS), contains a key word in defining the order's content. The word is "STANDARD;" something set up and established by authority as a rule for the measure of quantity, weight, extent, value, or quality.

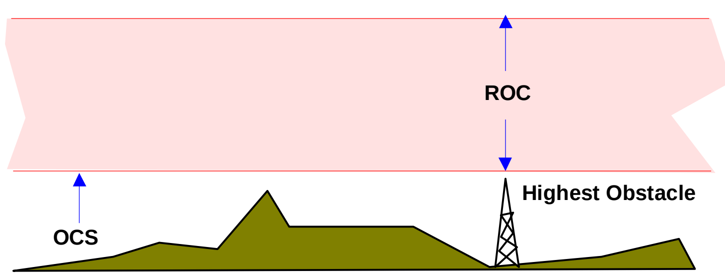
a. **The TERPS document specifies the minimum measure of obstacle clearance** that is considered by the FAA (the Federal authority) to supply a satisfactory level of vertical protection. The validity of the protection is dependent, in part, on assumed aircraft performance. In the case of TERPS, it is assumed that aircraft will perform within certification requirements.

b. **The following is an excerpt from the foreword of this order:** "These criteria are predicated on normal aircraft operations for considering obstacle clearance requirements." Normal aircraft operation means all aircraft systems are functioning normally, all required navigational aids (NAVAID's) are performing within flight inspection parameters, and the pilot is conducting instrument operations utilizing instrument procedures based on the TERPS standard to provide ROC. While the application of TERPS criteria indirectly addresses issues of flyability and efficient use of NAVAID's, the major safety contribution is the provision of obstacle clearance standards. This facet of TERPS allows aeronautical navigation in instrument meteorological conditions (IMC) without fear of collision with unseen obstacles. ROC is provided through application of level and sloping OCS.

202. Level OCS. The level OCS concept is applicable to "level flight" segments. These segments are level flight operations intended for en route, initial, intermediate segments, and nonprecision final approaches. A single ROC value is applied over the length of the segment. These values were determined through testing and observation of aircraft and pilot performance in various flight conditions. Typical ROC values are: for en route procedure segments, 1,000 feet (2,000 over designated mountainous terrain); and for initial segments, 1,000 feet, 500 feet in intermediate segments, and 350/300/250 feet in final segments.

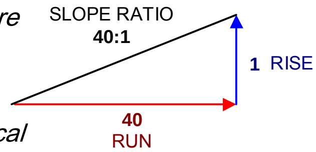
a. **This method of applying ROC** results in a horizontal band of airspace that cannot be penetrated by obstacles. Since obstacles always extend upward from the ground, the bottom surface of the ROC band is mathematically placed on top of the highest obstacle within the segment. The depth (ROC value) of the band is added to the obstacle height to determine the minimum altitude authorized for the segment. The bottom surface of the ROC band is referred to as the level OCS. Therefore, level flight segments are evaluated by the level OCS application standard (see figure 1-1).

Figure 1-1. Minimum Segment Altitude. Par 202a



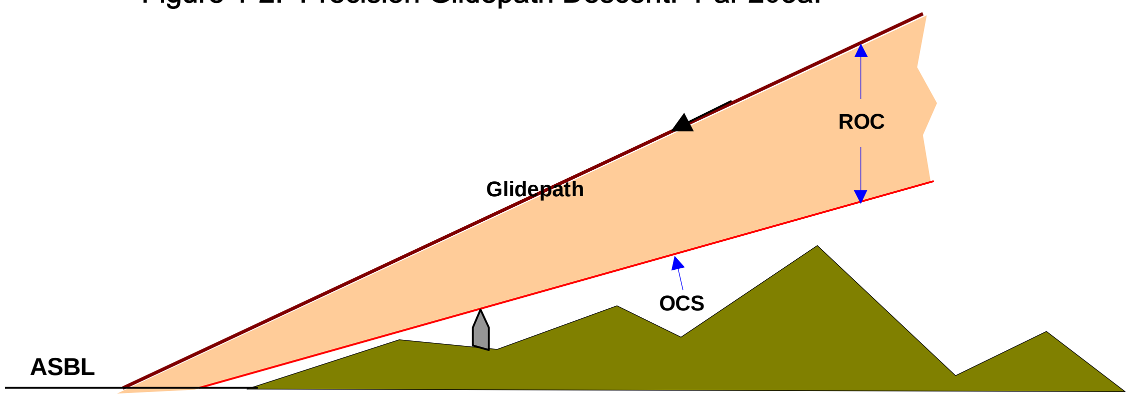
203. Sloping Obstacle Clearance Surfaces (OCS). The method of applying ROC, in segments dedicated to descending on a glidepath or climbing in a departure or missed approach segment, requires a different obstacle clearance concept than the level OCS because the ROC value must vary throughout the segment. The value of ROC near the runway is relatively small, and the value at the opposite end of the segment is sufficient to satisfy one of the level surface standards above. It follows then, that a sloping OCS is a more appropriate method of ROC application.

NOTE: Slope ratios are normally expressed in terms of rise over run in engineering and professional technical jargon. However, TERPS has traditionally expressed slope ratios in terms of run over rise; e.g., 34:1, 40:1.



a. **Descending on a Precision Glidepath.** The obstacle evaluation method for descent on a glidepath is the application of a descending OCS below the glidepath. The vertical distance between the glidepath and the OCS is ROC; i.e., ROC = (glidepath height) - (OCS height). The ROC decreases with distance from the final approach fix as the OCS and glidepath converge on the approach surface baseline (ASBL) height (see figure 1-2). The OCS slope and glidepath angle values are interdependent: OCS Slope = 102 ÷ glidepath angle; or glidepath angle = 102 ÷ OCS slope. This relationship is the standard that determines the ROC value since $ROC = (\text{glidepath height}) - (\text{OCS height})$.

Figure 1-2. Precision Glidepath Descent. Par 203a.



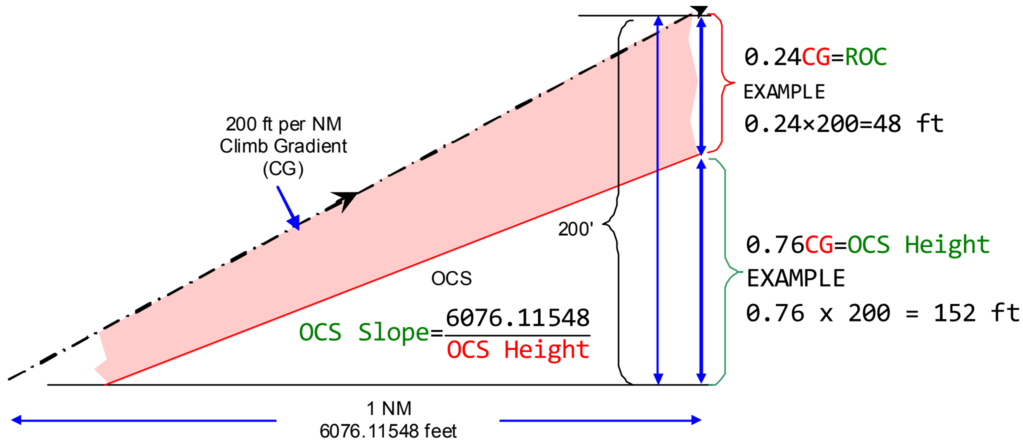
(1) **If the OCS is penetrated**, the OCS slope may be adjusted upward, thereby increasing the glidepath angle. The glidepath angle would increase because it is dependent on the required slope.

(2) **Descent on a glidepath** generated by systems that do not meet the system precision requirements of ICAO PANS-OPs, Annex 10, such as barometric vertical navigation (Baro-VNAV), provide ROC through application of a descending sloping surface based on standards using differing formulas, but the concept is the same.

b. **Climbing on departure or missed approach.** The concept of providing obstacle clearance in the climb segment, in instrument procedures, is based on the aircraft maintaining a minimum climb gradient. The climb gradient must be sufficient to increase obstacle clearance along the flightpath so that the minimum ROC for the subsequent segment is achieved prior to leaving the climb segment (see figure 1-3). For TERPS purposes, the MINIMUM climb gradient that will provide adequate ROC in the climb segment is 200 ft/NM.

(1) **The obstacle evaluation method** for a climb segment is the application of a rising OCS below the minimum climbing flightpath. Whether the climb is for departure or missed approach is immaterial. The vertical distance between the climbing flightpath and the OCS is ROC. ROC for a climbing segment is defined as $ROC = 0.24\,CG$. This concept is often called the 24% rule. Altitude gained is dependent on climb gradient (CG) expressed in feet per NM. The minimum ROC supplied by the 200 ft/NM CG is 48 ft/NM $(0.24 \times 200 = 48)$. Since 48 of the 200 feet gained in 1 NM is ROC, the OCS height at that point must be 152 feet $(200 - 48 = 152)$, or 76% of the CG $(152 \div 200 = 0.76)$. The slope of a surface that rises 152 over 1 NM is 40 (6076.11548 ÷ 152 = 39.97 = 40).

Figure 1-3. Climb Segment. Par 202b.



(2) Where an obstruction penetrates the OCS, a nonstandard climb gradient (greater than 200 ft/NM) is required to provide adequate ROC. Since the climb gradient will be greater than 200 ft/NM, ROC will be greater than 48 ft/NM $(0.24 \times CG > 200 = ROC > 48)$. The nonstandard ROC expressed in ft/NM can be calculated using the formula: $(0.24\,h) \div (0.76\,d)$ where "h" is the height of the obstacle above the altitude from which the climb is initiated, and "d" is the distance in NM from the initiation of climb to the obstacle. Normally, instead of calculating the nonstandard ROC value, the required climb gradient is calculated directly using the formula: $h \div (0.76d)$.

c. In the case of an instrument departure, the OCS is applied during the climb until at least the minimum en route value of ROC is attained. The OCS begins at the departure end of runway, at the elevation of the runway end. It is assumed aircraft will cross the departure end-of-runway at a height of at least 35 ft. However, for TERPS purposes, aircraft are assumed to lift off at the runway end (unless the procedures state otherwise). The ROC value is zero at the runway end, and increases along the departure route until the appropriate ROC value is attained to allow en route flight to commence.

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

e. Extraordinary circumstances, such as a mechanical or electrical malfunction, may prevent an aircraft from achieving the 200 ft/NM minimum climb gradient assumed by TERPS. In these cases, adequate obstacle clearance may not be provided by published instrument procedures. Operational procedures contained outside TERPS guidelines are required to cope with these abnormal scenarios.

204.-209. RESERVED.

210. UNITS OF MEASUREMENT. Units of measurement shall be expressed as set forth below:

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

b. Altitudes. The unit of measure for altitude in this publication is feet. Published heights below the transition level (18,000 ft) shall be expressed in feet above mean sea level (MSL); e.g. 17,900 ft. Published heights at and above the transition level (18,000 ft) shall be expressed as flight levels (FL); e.g., FL 180, FL 190, etc. See Title 14 of the Code of Federal Regulations (14 CFR) Part 91.121.

c. Distances. Develop all distances in nautical miles (NM) (6076.11548 ft or 1852 m per NM) and hundredths thereof, except where feet are required. Use the following formulas for feet and meter conversions:

$$feet = \frac{meters}{0.3048} \qquad meters = feet \times 0.3048$$

When applied to visibilities, distances shall be expressed in statute miles (SM) (5280 ft per SM) and the appropriate fractions thereof. (1/8 SM = 660 ft; 1/4 SM = 1320 ft; 3/8 SM = 1980 ft; 1/2 SM = 2640 ft; 5/8 SM = 3300 ft; 3/4 SM = 3960; 7/8 SM = 4620 ft). Runway visual range (RVR) must be expressed in feet.

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

e. Determination of Correct ness of Distance and Bearing Information. The approving agency is the authority for correctness of distance and bearing information, except that within the United States, its territories, and possessions, the National Oceanic and Atmospheric Administration is the authority for measurements between all civil navigation aids and between those facilities incorporated as part of the National Airspace System (NAS).

211. POSITIVE COURSE GUIDANCE (PCG). PCG must be provided for feeder routes, initial (except as provided for in paragraph 233b), intermediate, and final approach segments. The segments of a procedure wherein PCG is provided must be within the service volume of the facility(ies) used, except where Expanded Service Volume (ESV) has been authorized. PCG may be provided by one or more of the navigation systems for which criteria has been published.

212. APPROACH CATEGORIES (CAT). Aircraft performance differences have an effect on the airspace and visibility needed to perform certain maneuvers. Because of these differences, aircraft manufacturer/operational directives assign an alphabetical category to each aircraft so that the appropriate obstacle clearance areas and landing and departure minimums can be established in accordance with the criteria in this order. The categories used and referenced throughout this order are Category A; B; C; D, and/or E. Aircraft categories are defined in Part 97.

213. APPROACH CATEGORY APPLICATION. The approach category operating characteristics must be used to determine turning radii minimums and obstacle clearance areas for circling and missed approaches.

214. PROCEDURE CONSTRUCTION. An IAP may have four separate segments. They are the initial, intermediate, final, and missed approach segments. In addition, an area for circling the airport under visual conditions shall be considered. An approach segment begins and ends at the plotted position of the fix; however, under some circumstances certain segments may begin at specified points where no fixes are available. The fixes are named to coincide with the associated segment. For example, the intermediate segment begins at the intermediate fix (IF) and ends at the precise final approach fix (PFAF). The order in which this chapter discusses the segments is the same order in which the pilot would fly them in a completed procedure; that is from an initial, through an intermediate, to a final approach. In constructing the procedure, the FAC should be identified first because it is the least flexible and most critical of all the segments. Then establish the other segments to produce an orderly maneuvering pattern responsive to the local traffic flow and to conserve controlled airspace to the extent possible (see figure 1-4).

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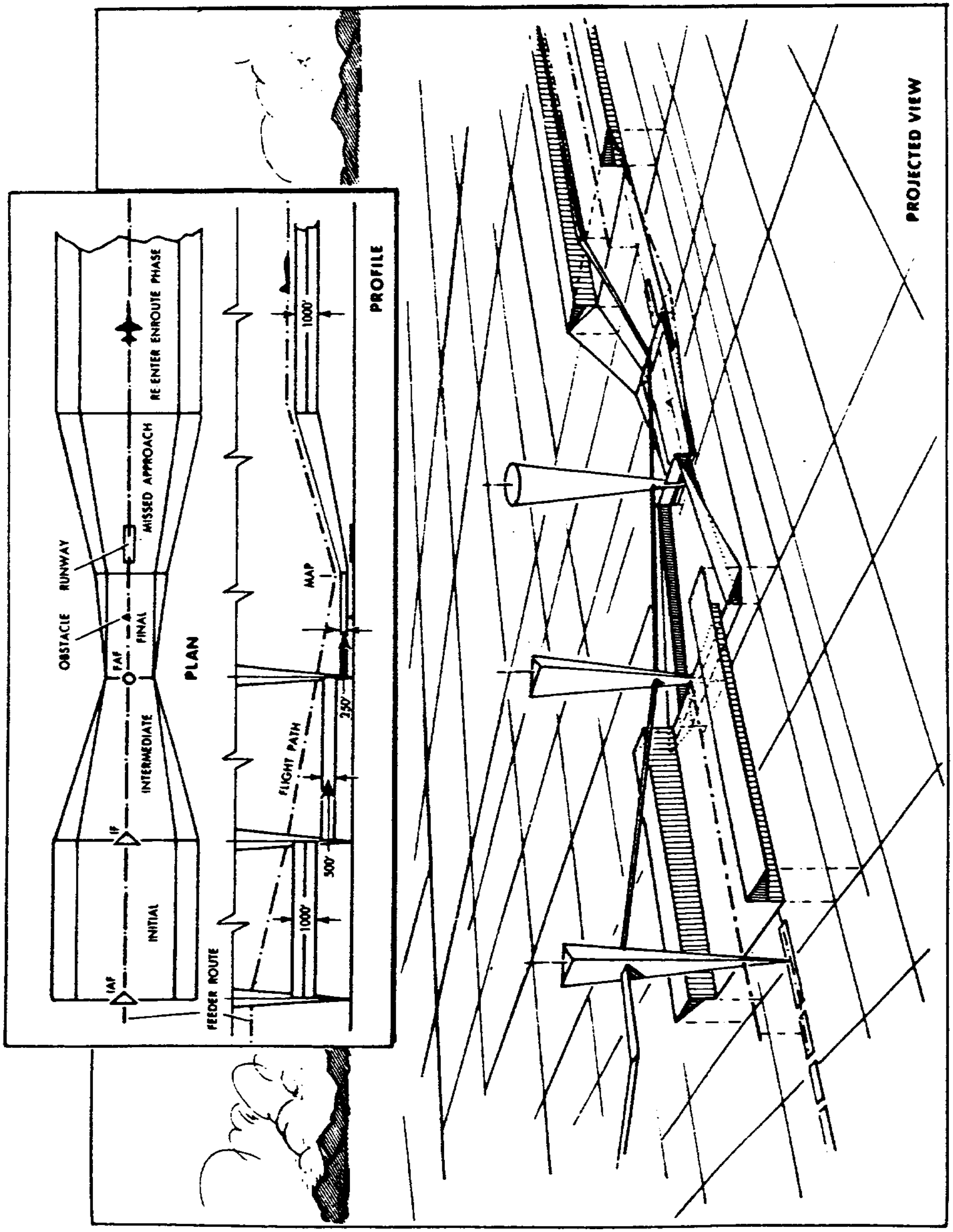
Figure 1-4. SEGMENTS OF AN APPROACH PROCEDURE. Par 214.



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).

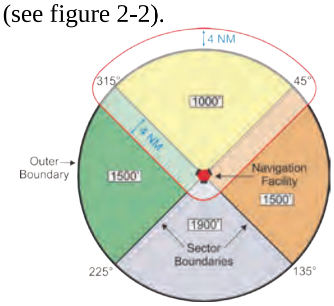


Figure 2-1. Non-RNAV MSA. Par 221.

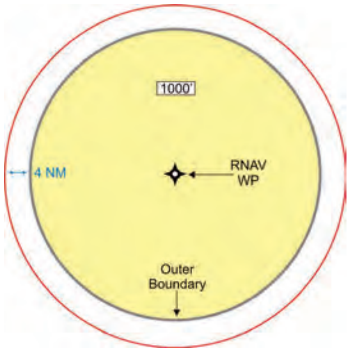


Figure 2-2. RNAV MSA. Par 221.

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).

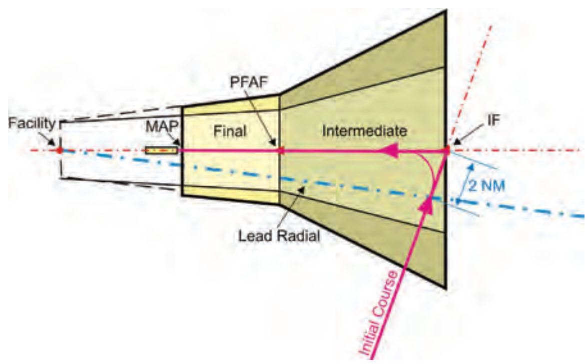


Figure 2-3. INITIAL APPROACH INTERCEPTION ANGLE GREATER THAN 90°. Par 232a(1).

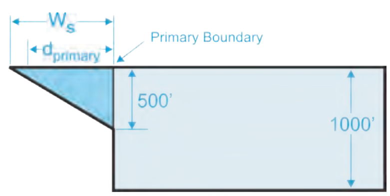
(2) Arcs. An arc may provide course guidance for all or a portion of an initial approach. The minimum arc radius must be seven miles, except for high altitude jet penetration procedures, in which the minimum radius should be at least 15 miles. When an arc of less than 15 miles is used in high altitude 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.

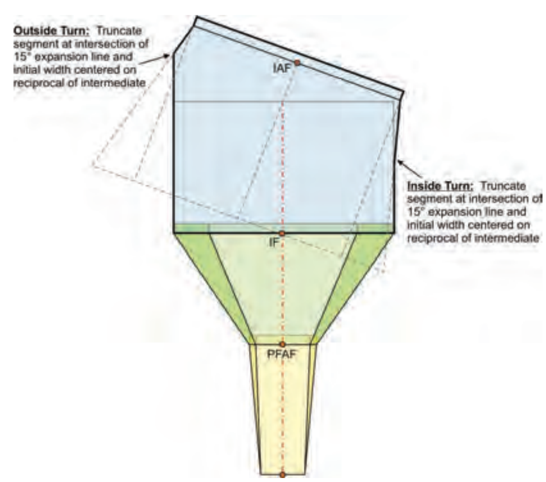


Figure 4-1. EXAMPLE DR SEGMENT. Par 233b.

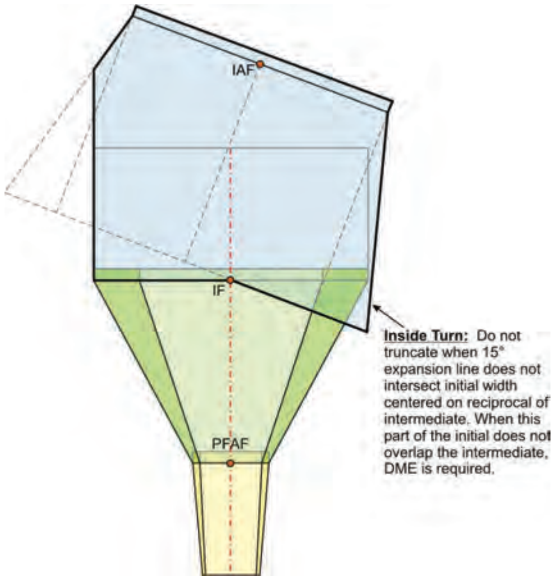


Figure 4-2. EXAMPLE DR SEGMENT. Par 233b.

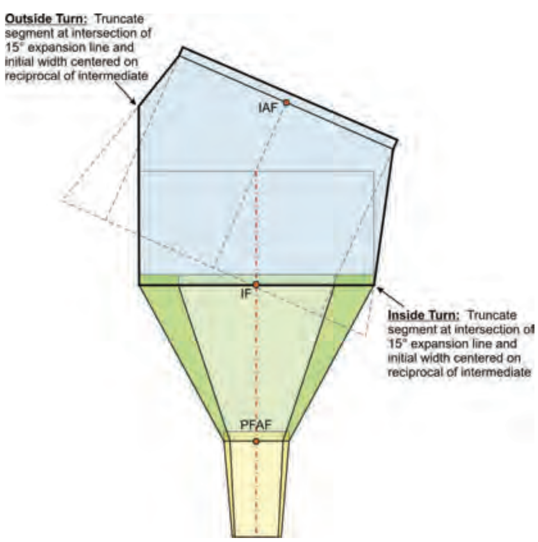


Figure 4-3. EXAMPLE DR SEGMENT. Par 233b.

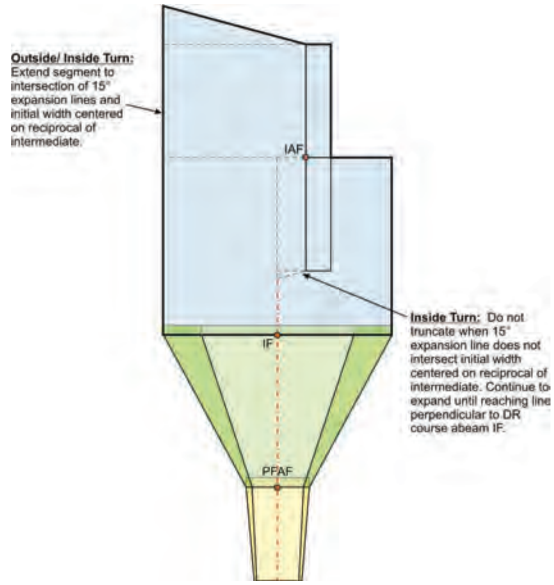


Figure 4-4. EXAMPLE DR SEGMENT. Par 233b.

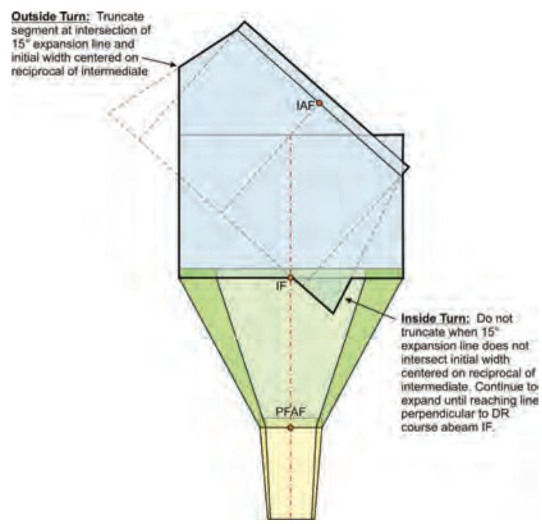


Figure 4-5. EXAMPLE DR SEGMENT. Par 233b.

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.

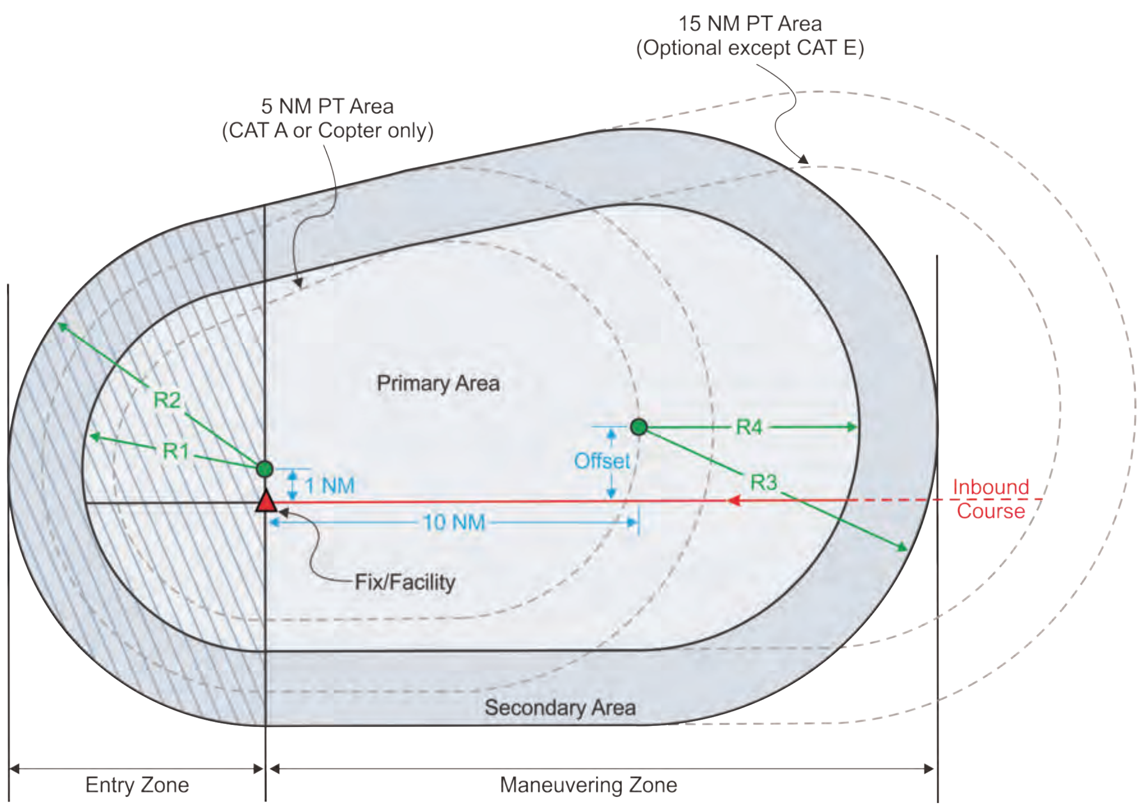


Figure 5. PROCEDURE TURN AREA, Par 234b.
(See Table 1A to determine radius values.)

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

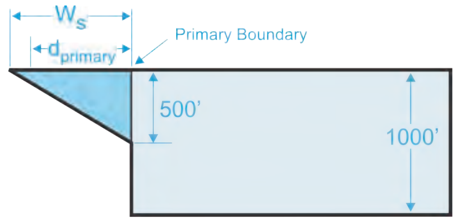
>10,000

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.

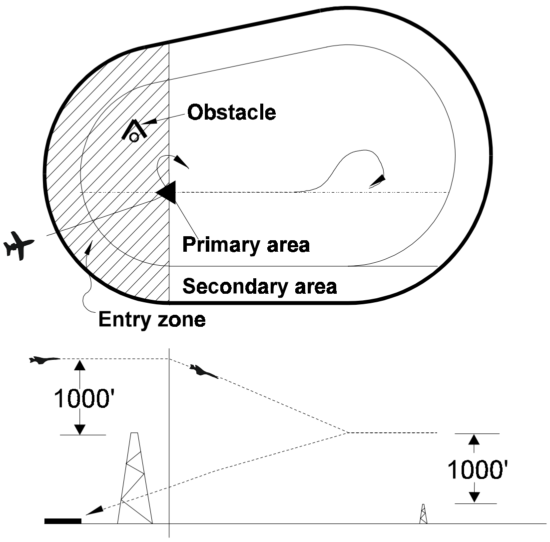


Figure 6. PT INITIAL APPROACH AREA. Par 234c.

e. Elimination of PT. A PT is NOT required when an approach can be made direct from a specified IF to the FAF. A PT NEED NOT be established when an approach can be made from a properly aligned holding pattern. See paragraph 291. In this case, the holding pattern in lieu of a PT, shall be established over a final or intermediate approach fix and the following conditions apply:

(1) If the holding pattern is established over the FAF (not applicable to RNAV procedures), an intermediate segment is not constructed. Ideally, establish the minimum holding altitude at the FAF altitude. In any case, the published holding altitude shall not be more than 300 feet above the FAF altitude.

(2) If the holding pattern is established over the IF, the MHA shall permit descent to the FAF altitude within the descent gradient tolerances prescribed for the intermediate segment (see paragraph 242d).

Table 1B. PT COMPLETION ALTITUDE DIFFERENCE. Par 234d.

TYPE OF PT	ALTITUDE DIFFERENCE
15 Mile PT from FAF	Within 3,000 Ft of Alt. over FAF
10 Mile PT from FAF	Within 2,000 Ft of Alt. over FAF
5 Mile PT from FAF	Within 1,000 Ft of Alt. over FAF
15 Mile PT, no FAF	Not Authorized
10 Mile PT, no FAF	Within 1,500 Ft of MDA on Final
5 Mile PT, no FAF	Within 1,000 Ft of MDA on Final

235. INITIAL APPROACH BASED ON HIGH ALTITUDE TEARDROP PENETRATION. A teardrop penetration consists of departure from an IAF on an outbound course, followed by a turn toward and intercepting the inbound course at or prior to the IF or point. Its purpose is to permit an aircraft to reverse direction and lose considerable altitude within reasonably limited airspace. Where no IF is available to mark the beginning of the intermediate segment, it shall be assumed to commence at a point 10 miles prior to the FAF. When the facility is located on the airport, and no fix is available to mark the beginning of the final approach segment, the criteria in paragraph 423 apply.

a. Alignment. The outbound penetration course shall be between 18° and 26° to the left or right of the reciprocal of the inbound course. The actual angular divergence between the courses will vary inversely with the distance from the facility at which the turn is made (see table 2).

b. Area.

(1) Size. The size of the penetration turn area must be sufficient to accommodate both the turn and the altitude loss required by the procedure. The penetration turn distance shall not be less than 20 miles from the facility. The penetration turn distance depends on the altitude to be lost in the procedure and the point at which the descent is started (see table 2). The aircraft should lose half the total altitude or 5,000 feet, whichever is greater, outbound prior to starting the turn. The penetration turn area has a width of 6 miles on both sides of the flight track up to the IF or point, and shall encompass all the areas within the turn (see figure 7).

Table 2. PENETRATION TURN DISTANCE/DIVERGENCE. Par 235a.

ALT TO BE LOST PRIOR TO COM-MENCING TURN	DISTANCE TURN COM-MENCES (NM)	COURSE DIVER-GENCE (DEGREES)	SPECIFIED PENETRA-TION TURN DIST-ANCE (NM)
12,000 Ft	24	18	28
11,000 Ft	23	19	27
10,000 Ft	22	20	26
9,000 Ft	21	21	25
8,000 Ft	20	22	24
7,000 Ft	19	23	23
6,000 Ft	18	24	22
5,000 Ft	17	25	21
5,000 Ft	16	26	20

(2) Penetration Turn Table. Table 2 should be used to compute the desired course divergence and penetration turn distances which apply when a specific

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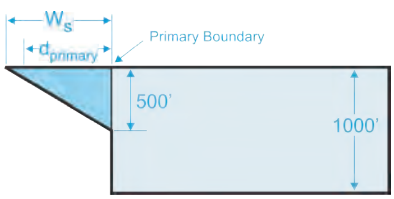
altitude loss outbound is required. It is assumed that the descent begins at the plotted position of fix. When the procedure requires a delay before descent of more than five miles, the distance in excess of five miles should be added to the distance the turn commences. The course divergence and penetration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

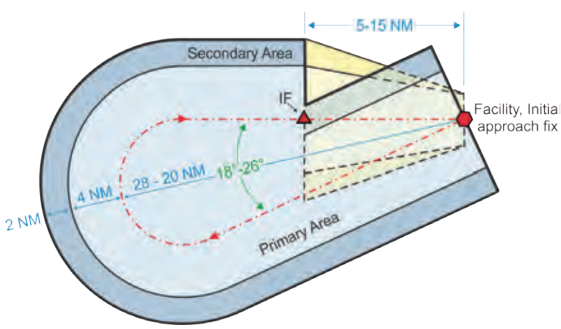


Figure 7. TYPICAL PENETRATION TURN INITIAL APPROACH AREA. Par 235.

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.

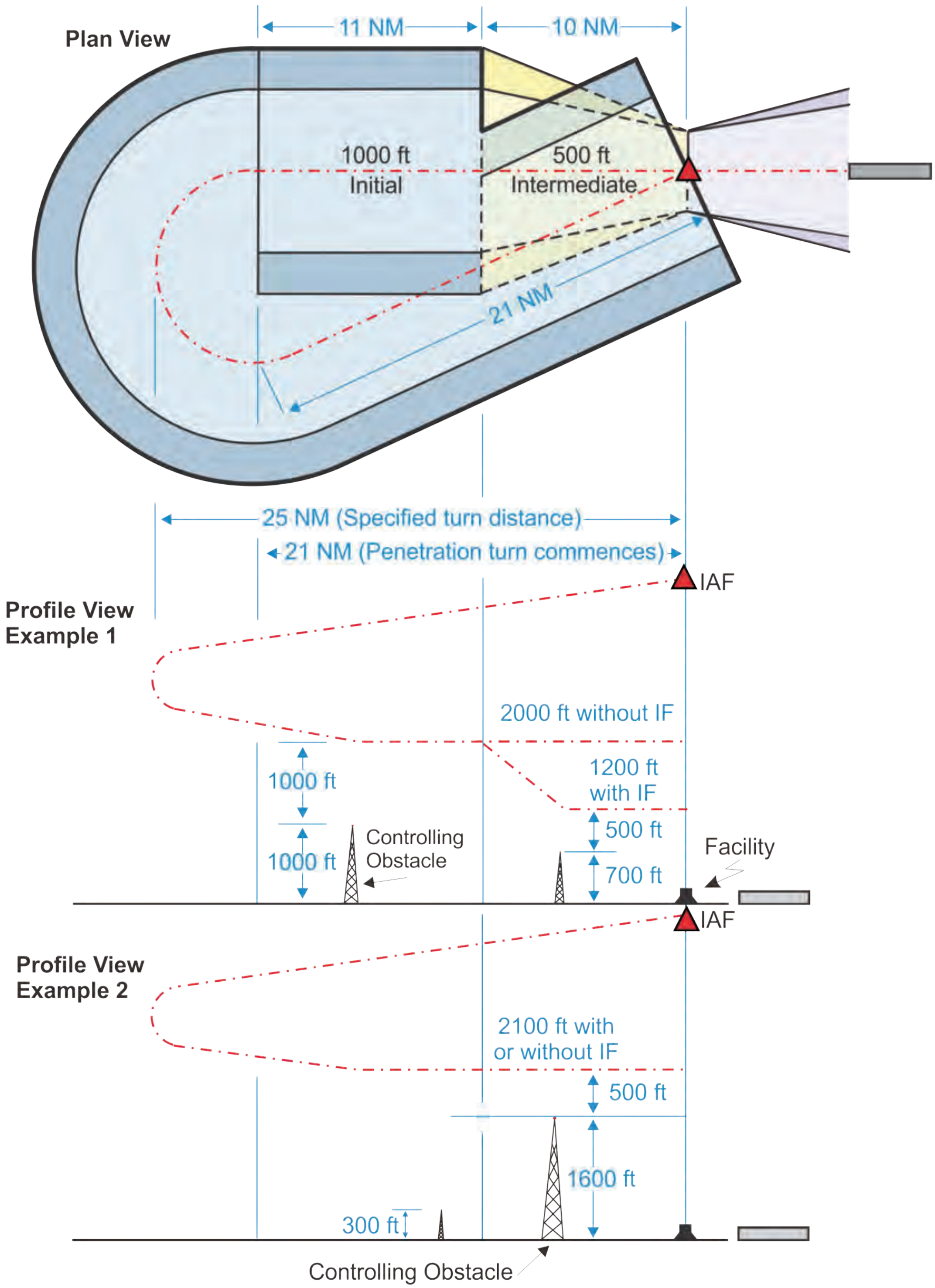
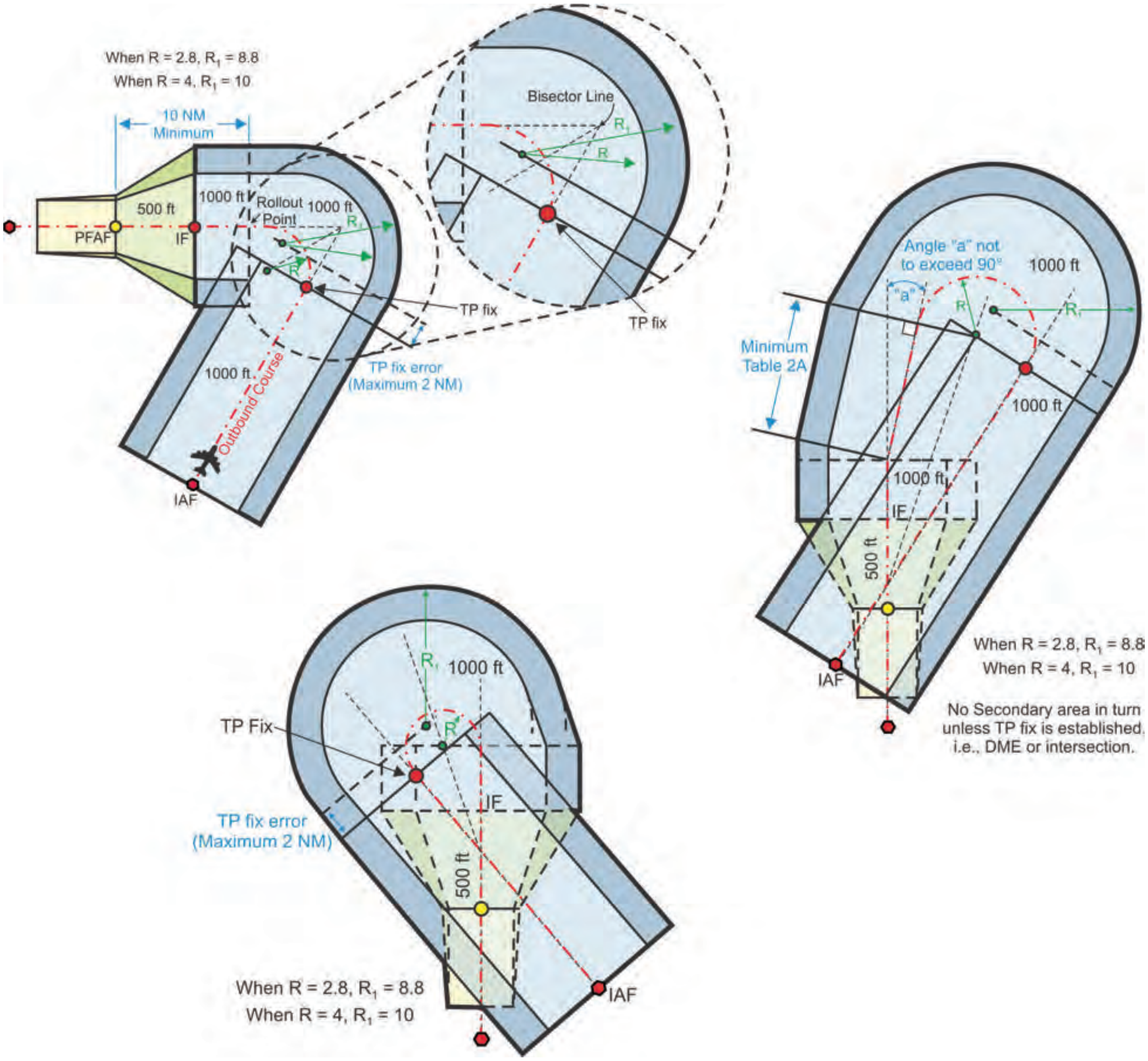


Figure 8. PENETRATION TURN INITIAL APPROACH OBSTACLE CLEARANCE. Par 235c.



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).

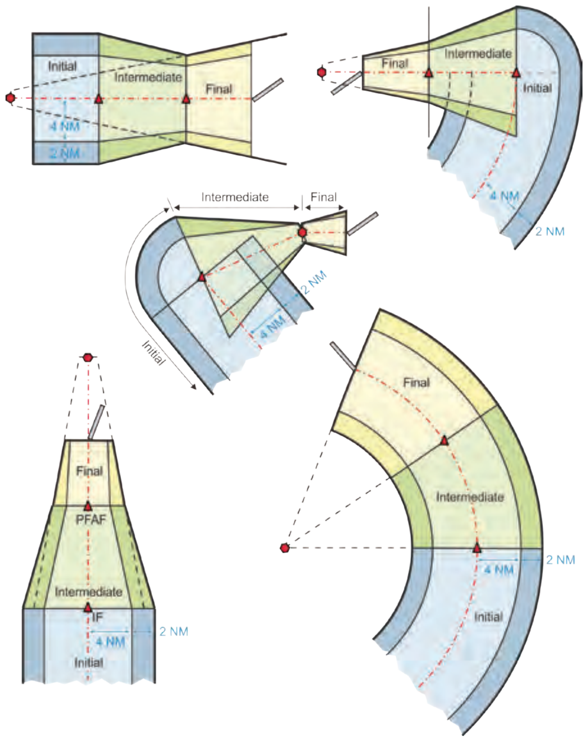


Figure 10. TYPICAL APPROACH SEGMENTS.
Par 232b and 240.

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.

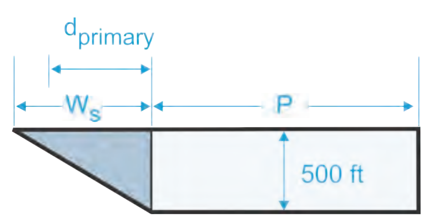
(1) Length. The length of the intermediate segment is measured along the course to be flown. Where the initial segment joins the intermediate segment at angles up to 90 degrees, the MINIMUM length is 5 NM for CAT A/B, and 6 NM for CAT C/D/E (except as specified in volume 1, chapters 9 and 10, and volume 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.

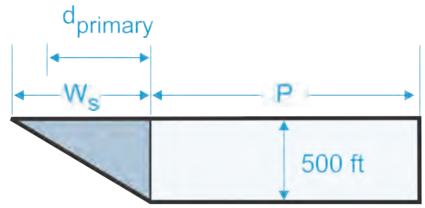
a. Alignment. The same arc must be used for the intermediate and the final approach segments. Turns are not permitted over the PFAF.

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.

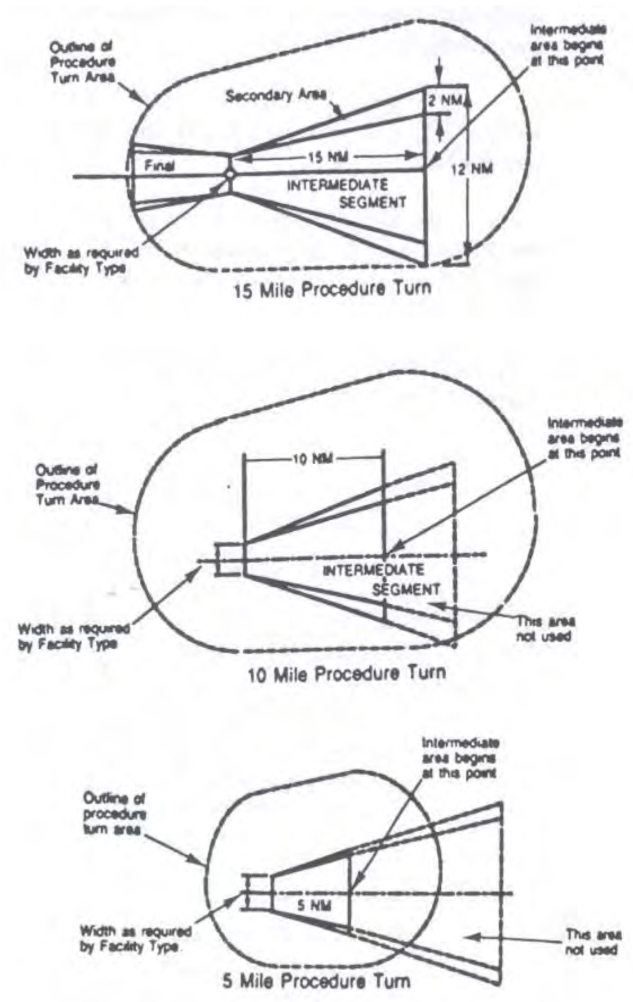


Figure 11. INTERMEDIATE AREA WITHIN A PT AREA. FAF is the Facility. Par 244a.

b. PT Over a FAF when the FAF is NOT a Facility (See figure 12).

(1) The intermediate segment shall be 6 NM wide each side of the interm ediate course at the PT distance.

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

(a) Table 1A shall be applied.

(b) Only one stepdown fix is authorized within the interm ediate segm ent that underlies the PT maneuvering area.

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

(d) The MAXIMUM descent gr adient f rom the IF point to the stepdown fix is 200 feet/NM. The MAXIMUM descent gradient from the stepdown fix to the FAF is 318 feet/NM.

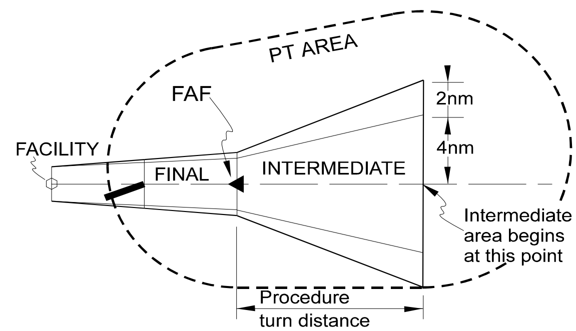


Figure 12. INTERMEDIATE AREA WITHIN THE PT AREA. FAF is not the Facility. Par 244b.

c. PT Over a Facility/Fix AFT ER the FAF. See figure 13.

(1) The PT facility/fix to FAF distance shall not exceed 4 NM.

(2) The MAXIMUM PT distance is 15 NM.

(3) The length of the intermediate segment is from the start of the PT distance to the FAF and the MINIMUM length shall be 5 NM.

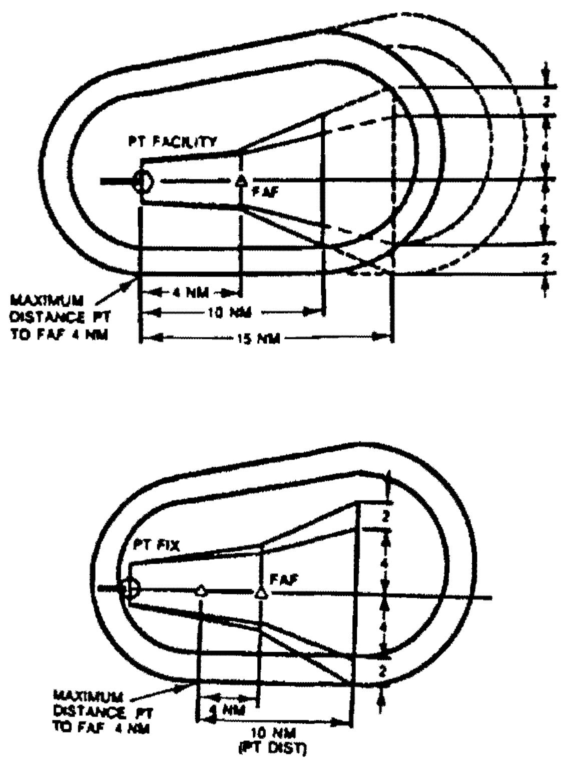


Figure 13. INTERMEDIATE AREA WITHIN THE PT AREA. PT Over the Facility/Fix After the FAF. Par 244c.

(4) 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.

(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.

(5) The MAXIMUM descent gradient in the intermediate segment is 200 feet/NM. The PT distance may be increased in 1 NM increments up to 15 NM to meet descent limitations.

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

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

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

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

d. PT Over a Facility/Fix PRIOR to the FAF. See figures 14-1 and 14-2.

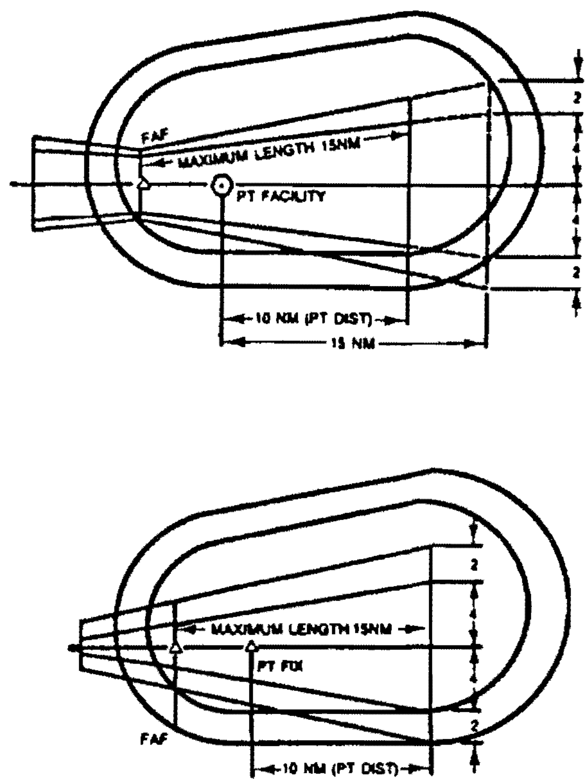


Figure 14-1. INTERMEDIATE AREA WITHIN THE PT AREA. PT Over the Facility/Fix Prior to the FAF. Par 244d.

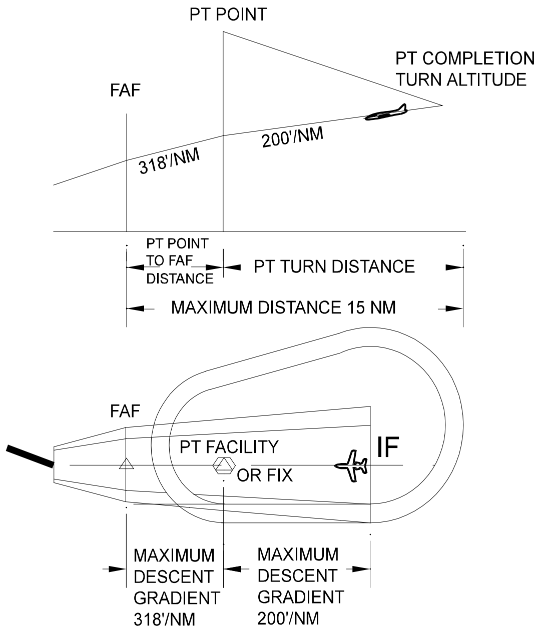
(1) The MINIMUM PT distance is 5 NM.

(2) The length of the intermediate segment is from the start of the PT distance to the FAF and the MAXIMUM length is 15 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:

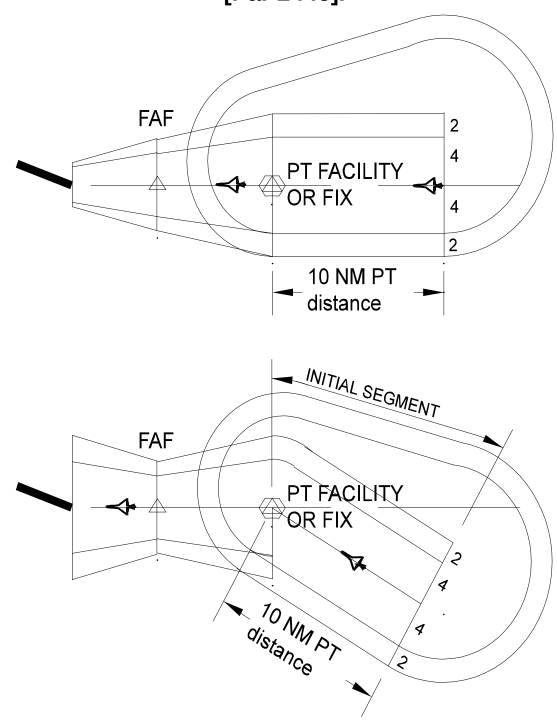
(a) When the PT fix is over a facility/fix prior to the FAF, the facility/fix is the stepdown fix in the intermediate/initial area, and another stepdown fix within this segment is not authorized.

(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>

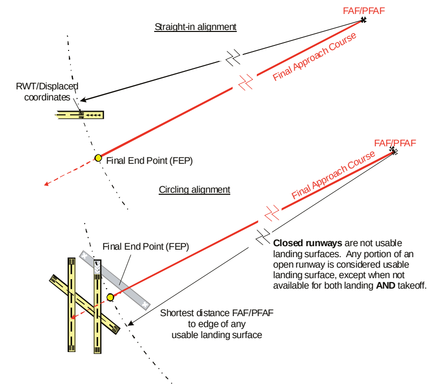
FAA	2.75°-3.77°	(IAPS w/ ≤ CAT C mins)
	2.75°-3.50°	(IAPS w/ CAT D/E mins)
USAF	2.50°-3.50°	(All IAPS)
USN	2.50°-3.77°	(All IAPS)

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):

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

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].

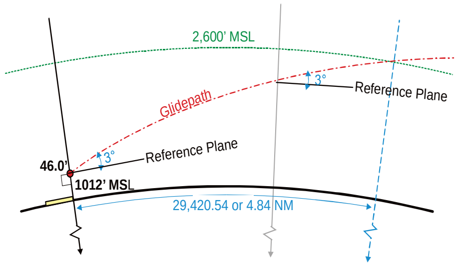
$$D_{PFAF} = \frac{\ln\left(\frac{r+alt}{r+THRe+TCH}\right)\cdot r}{\tan\left(\theta\cdot\frac{\pi}{180°}\right)}$$

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:

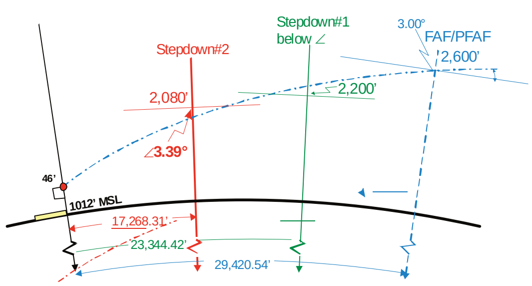
e = base of natural log. (Napier's constant)
D_Z = dist (ft) from FEP to fix
θ = angle calculated in accordance with Vol. 1, chapter 2, paragraph 252a/252b
r = 20890537
$base_{alt}$ = THRe + TCH (Vol. 1, chapter 2, paragraph 252a)
$base_{alt}$ = CMDA (Vol. 1, chapter 2, paragraph 252b)

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):

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

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.

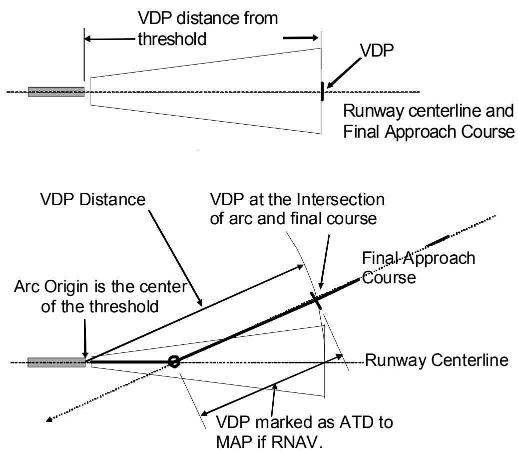
b. Marking VDP Location.

(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.

(2) For RNAV SIAPs, mark the VDP location with an Along Track Distance (ATD) fix to the MAP. Maximum fix error is ± 0.5 NM.

(3) If the final course is not aligned with the runway centerline, use the RWT coordinates as a vertex, swing an arc of a radius equal to the VDP distance across the final approach course (*see figure 14-7*). The point of intersection is the VDP. (For RNAV procedures, the distance from the point of intersection to the MAP is the ATD for the VDP.)

Figure 14-7. VDP Location [Par 253b(3)].



254.-259. RESERVED.

SECTION 6. CIRCLING APPROACH

260. CIRCLING APPROACH AREA. Where circling is authorized, evaluate the circling approach area for each CAT published on the procedure. The Circling Minimum Descent Altitude (CMDA) is based on the results of the circling area evaluation _and_ the evaluation of the final segment delivering the aircraft to the circling area. Also see Vol. 1, chapter 3, paragraph 3.2.1b.

a. Obstacle Evaluation Area (OEA). The area for each CAT is based on true airspeed (V_{KTAS}). The minimum altitude used for true airspeed conversion is 1,000 ft above airport elevation.

Use the following formula for converting indicated airspeed (V_{KIAS}) to true airspeed (V_{KTAS}) is:

$$V_{KTAS} = \frac{V_{KIAS} \cdot 171233 \cdot \sqrt{(288+15)-0.00198 \cdot (\mathbf{alt}+\mathbf{k})}}{\left(288 - 0.00198 \cdot (alt+k)\right)^{2.628}}$$

Where:

V_{KIAS} = indicated airspeed (from *table 4*)
alt = airport elevation (MSL)
k = height above airport (1,000 ft minimum)

Calculate the Circling Approach Radius (CAR) based on true airspeed, bank angle, and straight segment length using the following formula (radian calculations):

$$*CAR = 2 \cdot \frac{\left(V_{KTAS}+25\right)^2}{tan\left(bank_{angle} \cdot \frac{\pi}{180}\right) \cdot 68625.4} + S$$

Where:

V_{KTAS} = true airspeed
$bank_{angle}$ = bank angle (from *table 4*)
S = straight segment (from *table 4*)

**Minimum CAR = 1.30 NM*

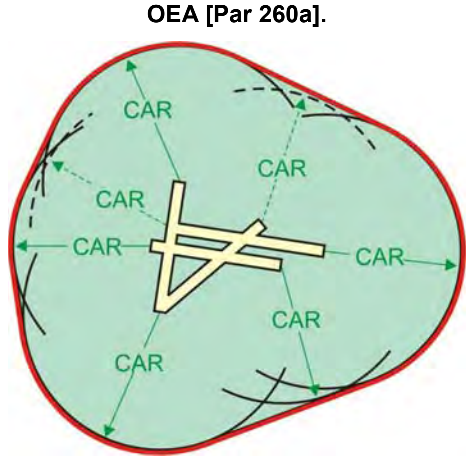
Table 4. Circling Approach Area Parameters [Par 260a].

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

The OEA is constructed by drawing arcs equal to the CAR for each CAT from the RWT coordinates (or displaced threshold coordinates when applicable) of each runway. Not applicable to permanently closed or other runways not authorized for circling. However, when only one end of the runway is not authorized for circling, the OEA is based on the CAR from both sets of RWT coordinates. Join the outermost arcs with tangential lines. The resulting enclosed area is the circling OEA [no secondary area].
See figure 15-1.

b. Obstacle Clearance. Provide 300 ft ROC plus adjustments over the highest obstacle in the OEA.

Figure 15-1. Circling Approach OEA [Par 260a].



c. CMDA. The published Circling Minimum Descent Altitude (CMDA) may not result in a Height

Above Airport (HAA) lower than permitted by Vol. 1, chapter 3, table 3-9.

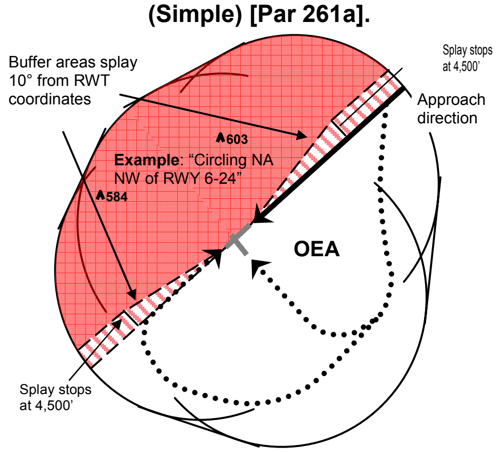
Where the CMDA results in a HAA greater than 1,000 ft, re-calculate CAR by increasing **k** to equal the actual HAA and re-evaluate the OEA. If the resulting HAA value increases, re-calculate and re-evaluate using the higher value.

Example
CAT A controlling obstacle = 623 ft
Airport Elevation = 600 ft
CAT A minimum HAA (Vol. 1, chap 3) = 350 ft
ROC = 300
CMDA based on ROC
623 + 300 = 923 (rounds to 940 ft)
CMDA based on min HAA
600 + 350 = 950 ft (rounds to 960 ft)
Published CMDA = 960 ft

261. RESTRICTED CIRCLING AREA. The circling OEA may be modified to gain relief from obstacles by establishing a restricted area. This option is only authorized where the restriction can clearly be described as a portion of the airspace where circling is not authorized and the chart is properly annotated. The OEA excludes the restricted area except the portion defined by a line originating at the RWT coordinates (or displaced threshold coordinates when applicable) of each runway used to define the area splaying 10 degrees relative to runway centerline towards the restricted area. Discontinue the splay when it reaches 4,500 ft in width from runway centerline extended (see figure 15-2a).

a. Simple restricted area. Establish the restricted area as the right or left half of the OEA relative to runway centerline(s) extended to the CAR boundary. The chart annotation must include the runway identification (both ends) and the area's magnetic direction from runway centerline described as a cardinal/inter-cardinal compass direction (N, NE, E, SE, S, SW, W, NW). *See Vol. 1, chapter 2, figures 15-2a through 15-2f and Order 8260.19, chapter 8.*

Figure 15-2a. Restricted Circling Area (Simple) [Par 261a].



b. Complex restricted area. Establish the restricted area as a single contiguous sector bounded by the centerlines of intersecting runways (or runways extended) continued outward to the OEA boundary, truncated (figures 15-2b through 15-2d) or expanded (figure 15-2f) by a direct line from each set of RWT coordinates (or displaced threshold coordinates when applicable). The chart annotation includes the runway number and the general orientation of the restricted area from each runway described as a cardinal/inter-cardinal compass direction. *See Vol. 1, chapter 2, figures 15-2b through 15-2g and Order 8260.19, chapter 8.*

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

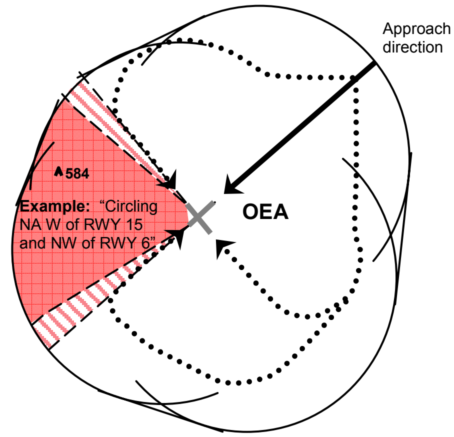


Figure 15-2c. Restricted Circling Area, Circling Aligned (Complex <180°) [Par 261b].

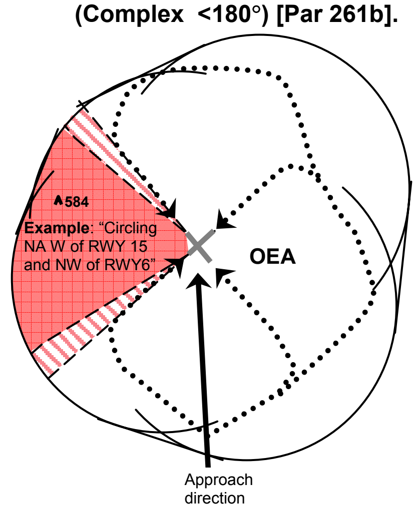


Figure 15-2d. Restricted Circling Area (Complex < 180°, Intersecting runways) [Par 261b].

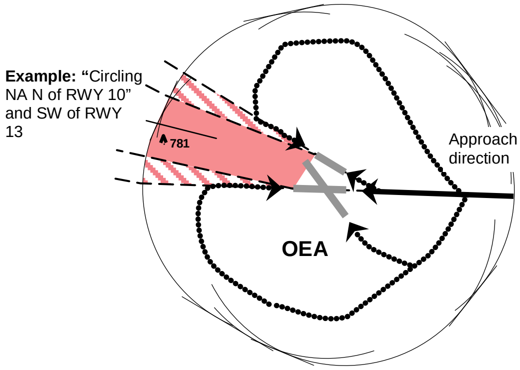


Figure 15-2e. Restricted Circling Area (Complex < 180°, Parallel runways) [Par 261b].

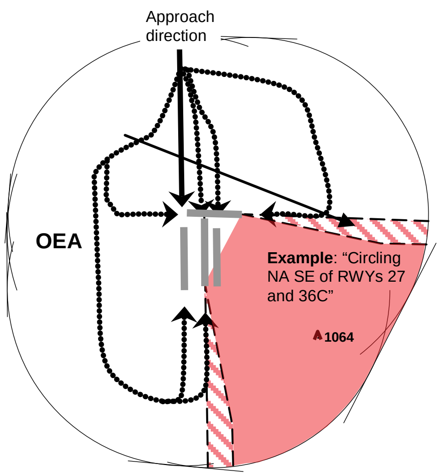
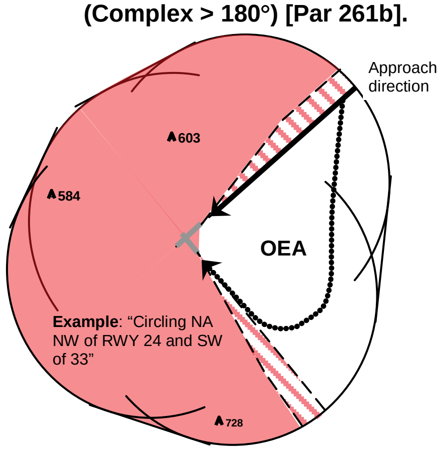


Figure 15-2f. Restricted Circling Area (Complex > 180°) [Par 261b].



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.

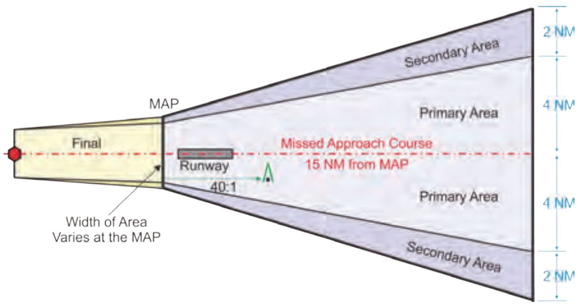


Figure 16. STRAIGHT MISSED APPROACH AREA. Par 270 and 273.

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).

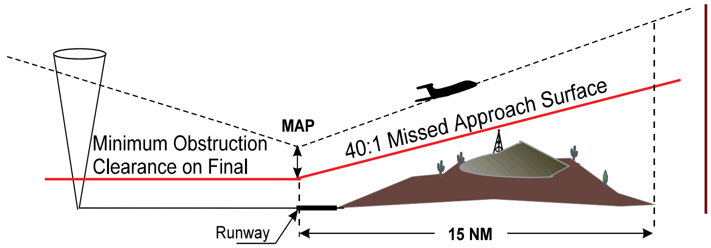
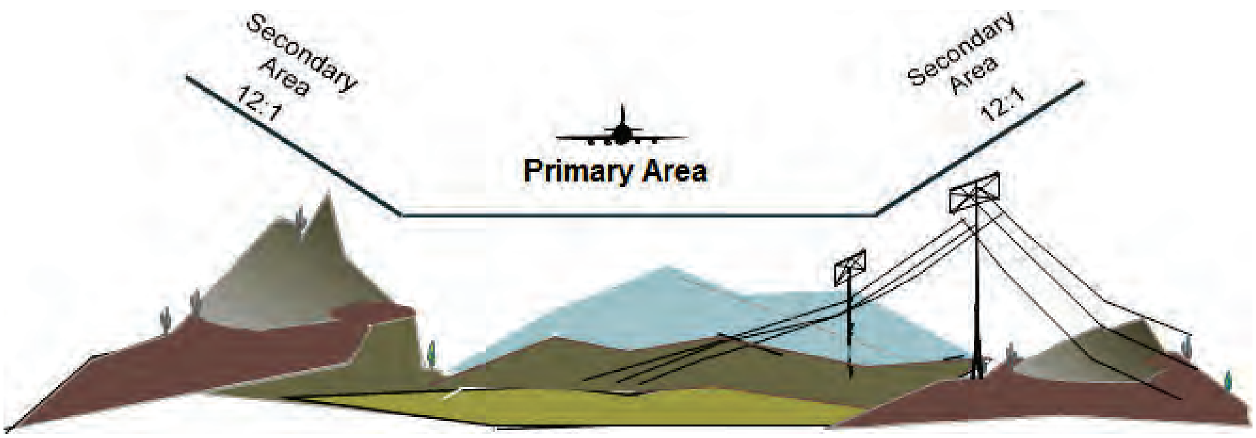


Figure 17. STRAIGHT MISSED APPROACH OBSTACLE CLEARANCE. Par 274.



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.

b. Secondary areas for the reduction of obstacle clearance are permitted when PCG is provided. The secondary area begins where a line perpendicular to the straight flightpath, originating at the point of completion of the turn, intersects the outer boundaries of the missed approach segment. The width of the secondary area expands uniformly from zero to 2 miles at 15 NM flight track point.

c. Primary areas. Figures 19, 20, 21, 22, 23, and 24 show the manner of construction of some typical turning missed approach areas. The following radii are used in the construction of these areas:

(1) 90° Turn or Less. Narrow Final Approach Area at MAP. See figure 19. To construct the area:

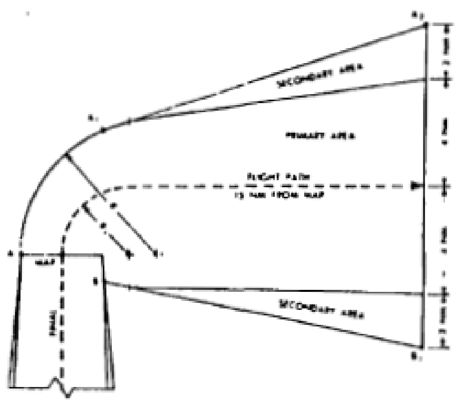


Figure 19. TURNING MISSED APPROACH AREA. 90° Turn or Less. Narrow Final Approach Area at MAP. Par 275c(1).

(a) Draw an arc with the radius (R_1) from the MAP. This line is then extended outward to a point 15 miles from the MAP, measured along the line. This is the assumed flightpath (see table 5).

Table 5. TURNING MISSED APPROACH RADII (Miles). Par 275.

Approach Category	Obstacle Clearance Radius (R)	Flightpath Radius (R_1)
A 2.6		1.30
B 2.8		1.40
C 3.0		1.50
D 3.5		1.75
E 5.0		2.50

(b) Establish points "A_2" and "B_1" measuring 6 miles perpendicular to the flightpath at the 15 mile point.

(c) Now connect "A_2" and "B_1" with a straight line.

(d) Draw an arc with the radius (R) from point "A" to "A_1". This is the edge of the obstacle clearance area.

(e) Establish point "B" by measuring backward on the edge of the final approach area a distance of 1 mile or a distance equal to the fix error PRIOR to the FAF, whichever is greater.

(f) Connect points "A_1" and "A_2", and points "B" and "B_1" with straight lines.

(2) 90 ° Turn or Less. Wide Final Approach Area at MAP. See figure 20. To construct the area:

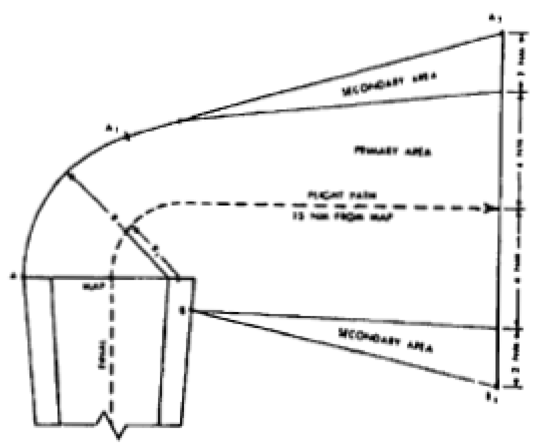


Figure 20. TURNING MISSED APPROACH AREA. 90° Turn or Less. Wide Final Approach Area at MAP. Par 275c(2)

(a) Draw an arc with the appropriate radius (R_1) from the MAP. This line is then extended outward to a point 15 miles from the MAP, measured along the line. This is the assumed flightpath.

(b) Establish points "A_2" and "B_1" by measuring 6 miles perpendicular to the flightpath at the 15-mile point.

(c) Now connect "A_2" and "B_1" with a straight line.

(d) Draw an arc with the appropriate radius (R) from point "A" to point "A_1". This is the edge of the obstacle clearance area.

(e) Establish point "B" by measuring backward on the edge of the final approach area a distance of 1 mile or a distance equal to the fix error PRIOR to the FAF, whichever is greater.

(f) Connect points "A_1" and "A_2", and points "B" and "B_1" with straight lines.

(3) More Than 90° Turn. Narrow Final Approach Area at MAP (see figure 21). To construct the area:

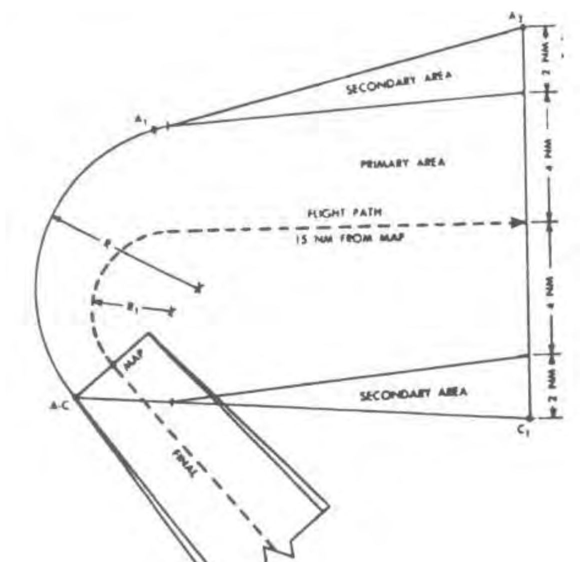


Figure 21. TURNING MISSED APPROACH AREA. More Than 90° Turn. Narrow Final Approach Area at MAP. Par 275c(3).

(a) Draw an arc with the radius (R_1) from the MAP through the required number of degrees and then continue outward to a point 15 miles from the MAP, measured along this line, which is the assumed flightpath.

(b) Establish points "A_2" and "C_1" by measuring 6 miles on each side of the assumed flightpath and perpendicular to it at the 15-mile point.

(c) Now connect points "A_2" and "C_1" with a straight line.

(d) Draw an arc with the radius (R) from point "A" to point "A_1" (figure 21 uses 135º). This is the outer edge of the obstacle clearance area.

(e) Locate point "C" at the inner edge of the final approach secondary area opposite the MAP. (Point "A" and point "C" will be coincident when the MAP is the facility.)

(f) Connect points "A_1" and "A_2", and points "C" and "C_1" with straight lines.

(4) More than 90 ° Turn. *Wide Final* Approach Area at MAP (see figure 22). To construct the area:

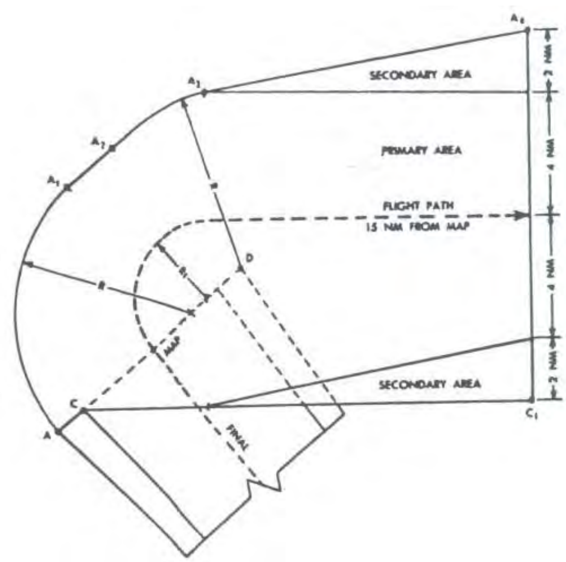


Figure 22. TURNING MISSED APPROACH AREA. More Than 90° Turn. Wide Final Approach Area at MAP. Par 275c(4).

(a) Draw the assumed flightpath arc with the radius (R_1) from the MAP the required number of degrees to the desired flightpath or course.

(b) Establish points "A_4" and "C_1" by measuring 6 miles on each side of the assumed flightpath and perpendicular to it at the 15-mile point.

(c) Connect points "A_4" and "C_1" with straight lines.

(d) Draw a 90° arc with the appropriate radius (R) from point "A" to "A_1". Note that when the width of the final approach area at the MAP is greater than the appropriate radius (R), the turn is made in two increments when constructing the obstacle clearance area.

(e) Draw an arc with the radius (R) from point "D" (edge of final approach secondary area opposite MAP) the required number of degrees from point "A_2" to point "A_3". Compute the number of degrees by subtracting 90° from the total turn magnitude.

(f) Connect points "A_1" and "A_2", with a straight line.

(g) Locate point "C" at the inner edge of the final approach secondary area opposite the MAP.

(h) Connect point "A_3" with point "A_4", and connect point "C" with point "C_1" using straight lines.

(5) 180° Turn. Narrow Final Approach Area at MAP (see figure 23). To construct the area:

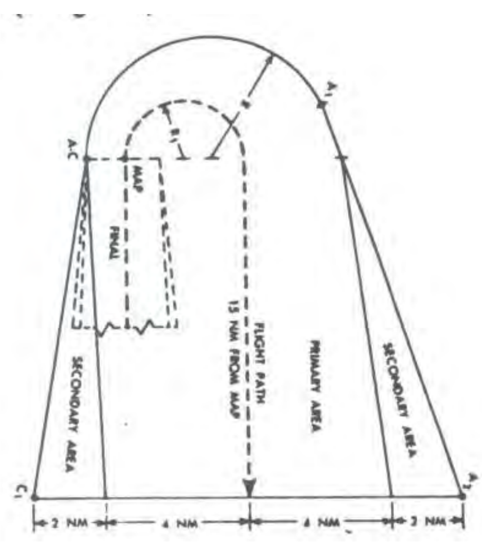


Figure 23. TURNING MISSED APPROACH AREA. 180° Turn. Narrow Final Approach Area at MAP. Par 275c(5).

(a) Draw an arc with the radius (R_1) from the MAP through 180°, and then continue outward to a point 15 miles from the MAP, measured along this line, which is the assumed flightpath.

(b) Establish points "A_2" and "C_2" by measuring 6 miles on each side of the assumed flightpath, and perpendicular to it at the 15-mile point.

(c) Now connect points "A_2" and "C_2" with a straight line.

(d) Locate point "C" at the inner edge of the final approach secondary area opposite the MAP. (Point "A" and point "C" will be coincident when the MAP is the facility.)

(e) Draw an arc with the radius (R) from point "A" to point "A_1" (180°). This is the outer edge of the obstacle clearance area.

(f) Connect points "A_1" and "A_2", and points "C" and "C_1" by straight lines. (The line "A_1-A_2" joins the arc tangentially).

(6) 180° Turn. Wide Final Approach Area at MAP (see figure 24). To construct the area:

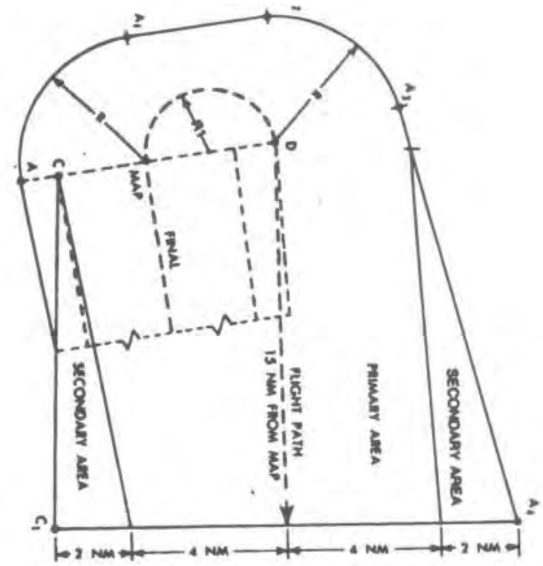


Figure 24. TURNING MISSED APPROACH AREA. 180° Turn. Wide Final Approach Area at MAP. Par 275c(6).

(a) Draw the flightpath arc with radius (R_1) from the MAP and then continue the line outward to a point 15 miles from the MAP, measured along the assumed flightpath.

(b) Establish points "A_4" and "C_1" by measuring 6 miles on each side of the flightpath and perpendicular to it at the 15-mile point.

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(c) Now connect "A_4" and "C_1" with a straight line.

(d) Draw a 90° arc with the appropriate radius (R) from point "A" to "A_1". Note that when the width of the final approach area at the MAP is greater than the appropriate radius (R), the turn is made in two increments when constructing the obstacle clearance area.

(e) Draw an arc with the radius (R) from point "D" (edge of final approach secondary area opposite MAP) the required number of degrees from point "A_2" to point "A_3". Compute the number of degrees by subtracting 90° from the total turn magnitude.

(f) Connect points "A_1" and "A_2", with a straight line.

(g) Locate point "C" at the inner edge of the final approach secondary area opposite the MAP.

(h) Connect points "A_3" and "A_4", and points "C" and "C_1" with straight lines. (The line "A_3-A_4" joins the arc tangentially).

276. TURNING MISSED APPROACH OBSTACLE CLEARANCE. The methods of determining the height of the 40:1 missed approach surface over obstacles in the turning missed approach area vary with the amount of turn involved. Evaluate the missed approach segment to ensure the 40:1 OIS is not penetrated.

a. 90° Turn or Less. See figure 25. Zone 1 is a 1.6 mile continuation of the final approach secondary area, and has identical obstacle clearance requirements. Zone 2 is the area in which the height of the missed approach surface over an obstacle must be determined. To do this, first identify line "A-D-B". Point "B" is located by measuring backward on the edge of the final approach area a distance of 1 mile or a distance equal to the fix error prior to the FAF, whichever is greater. This is to safeguard the short-turning aircraft. Thus, the height of the missed approach surface over an obstacle in zone 2 is determined by measuring the straight-line distance from the obstacle to the nearest point on line "A-D-B" and computing the height based on the 40:1 ratio. The height of the missed approach surface over the MAP is the same as specified in paragraph 274. When an obstacle is in a secondary area, measure the straight-line distance from the nearest point on the line "A-D-B" to the point on the inner edge of the secondary area which is nearest the obstacle. Compute the height of the missed approach surface at this point, using the 40:1 ratio. Then apply the 12:1 secondary area ratio from the height of the surface for the remaining distance to the obstacle.

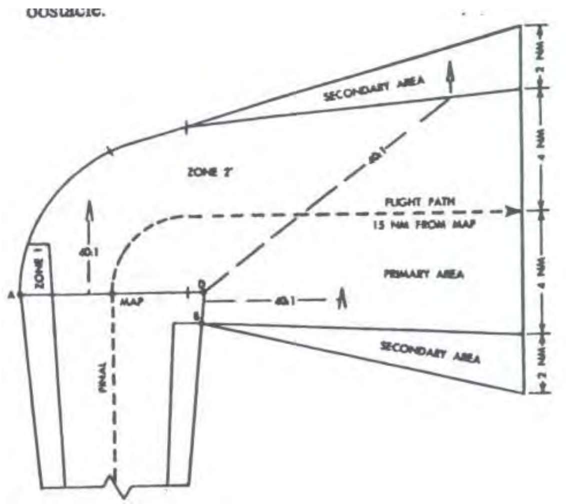


Figure 25. TURNING MISSED APPROACH OBSTACLE CLEARANCE. 90° Turn or Less. Par 276a.

b. More Than 90° Turn. See figure 26. In this case a third zone becomes necessary. Zone 3 is defined by extending a line from point "B" to the extremity of the missed approach area perpendicular to the FAC. Zone 3 will encompass all of the missed approach area not specifically within zones 1 and 2. All distance measurements in zone 3 are made from point "B". Thus the height of the missed approach surface over an obstacle in zone 3 is determined by measuring the distance from the obstacle to point "B" and computing the height based on the 40:1 ratio. The height of the missed approach surface over point "B" for zone 3 computations is the same as the height of the MDA. For an obstacle in the secondary area, use the same measuring method prescribed in paragraph 276a, except that the original measuring point shall be point "B."

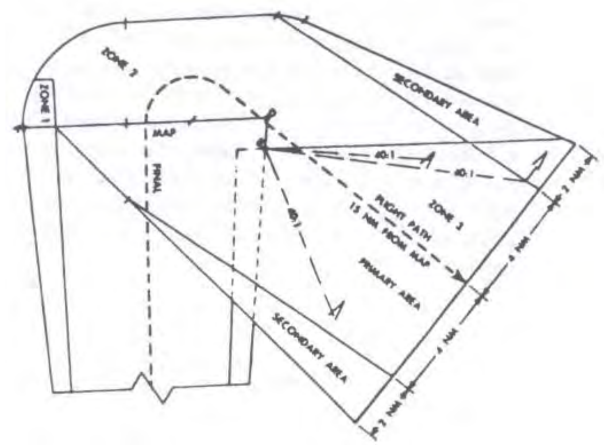


Figure 26. TURNING MISSED APPROACH OBSTACLE CLEARANCE. More Than a 90° Turn. Par 276b.

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

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

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

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

e. The preliminary charted missed approach altitude is the highest of the minimum missed approach obstruction altitude, MHA established IAW paragraph 293a, or the lowest airway MEA at the clearance limit. To determine the minimum missed approach obstruction altitude for the missed approach segment, identify the highest obstacle in the primary area; or if applicable, the highest equivalent obstacle in the secondary area. Then add the appropriate ROC (plus adjustments) for holding or en route to the highest obstacle elevation. Round the total value to the nearest hundred foot value.

f. Determine if a 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 "A-D-B" line in the shortest distance to the end-of-segment line at the clearance limit.

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

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

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

(b) If the computed 40:1 surface elevation is less than the ROC surface elevation, a climb-in-hold evaluation IS required. FAA 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 TERPS 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 shall be used until the MHA does not increase, then the 40:1 surface is re-evaluated. If obstacles penetrate the 40:1 surface, take action to eliminate the penetration.

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

277. COMBINATION STRAIGHT AND TURNING MISSED APPROACH AREA. If a straight climb to a specific altitude followed by a turn is necessary to avoid obstacles, a combination straight and turning missed approach area must be constructed. The straight portion of this missed approach area is section 1. The portion in which the turn is made is section 2. Evaluate the missed approach segment to ensure obstacle clearance is provided.

a. Straight Portion. Section 1 is a portion of the normal straight missed approach area and is constructed as specified in paragraph 273. Obstacle clearance is provided as specified in paragraph 274 except that secondary area reductions do not apply. The length of section 1 is determined as shown in figure 27 and relates to the need to climb to a specified altitude prior to commencing the turn. Point A_1 marks the end of section 1. Point B_1 is one mile from the end of section 1 (see figure 27).

section 1. Point B_1 is one mile from the end of section 1 (see figure 27).

b. Turning Portion. Section 2 is constructed as specified in paragraph 275 except that it begins at the end of section 1 instead of at the MAP. To determine the height which must be attained before commencing the missed approach turn, first identify the controlling obstacle on the side of section 1 to which the turn is to be made. Then measure the distance from this obstacle to the nearest edge of the section 1 area. Using this distance as illustrated in figure 27, determine the height of the 40:1 slope at the edge of section 1. This height, plus the appropriate final ROC, (the sum rounded up to the next higher 100-foot increment) is the height at which the turn should be started. Obstacle clearance requirements in section 2 are the same as those specified in paragraph 276 except that zone 1 is not considered and section 2 is expanded to start at point "B" if no fix exists at the end of section 1, or if no course guidance is provided in section 2 (see figure 27).

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

d. The preliminary charted missed approach altitude is the lowest of the minimum missed approach obstruction altitude, MHA established in accordance with paragraph 293a, or the lowest airway MEA at the clearance limit. To determine the minimum missed approach obstruction altitude for the missed approach segment, identify the highest obstacle in the primary area; or if applicable, the highest equivalent obstacle in the secondary area. Then add the appropriate ROC (plus adjustments) for holding or en route to the highest obstacle elevation. Round the total value to the nearest hundred foot value.

EXAMPLE

Given:

1. MDA 360′ MSL
2. Obstacle height: 1098′ MSL
3. Obstacle in section 2 = 3NM from near edge of section

Find:

1. Minimum altitude at which aircraft can start turn.
2. Required length of section 1.

Solution:

1. Find height MSL at near edge.
   a. A = 18,228′ (3 mi) ÷ 40 = 456′.
   b. 1098′ MSL − 456′ = 642′ MSL.
2. Add 250′ obstacle clearance.
   a. 250′ + 642′ = 892′ MSL.
3. Round up to next higher 20′.
   a. 892′ = 900′ MSL to start turn.
4. Find height to climb from MDA to 900′ MSL.
   a. 900′ − 360′ = 540′ to climb.
5. Find length of section 1.
   a. 540′ × 40 = 21,600′ − length of section 1.
6. Missed approach instructions.
   a. "Climb to 900′ before starting right turn to, etc."

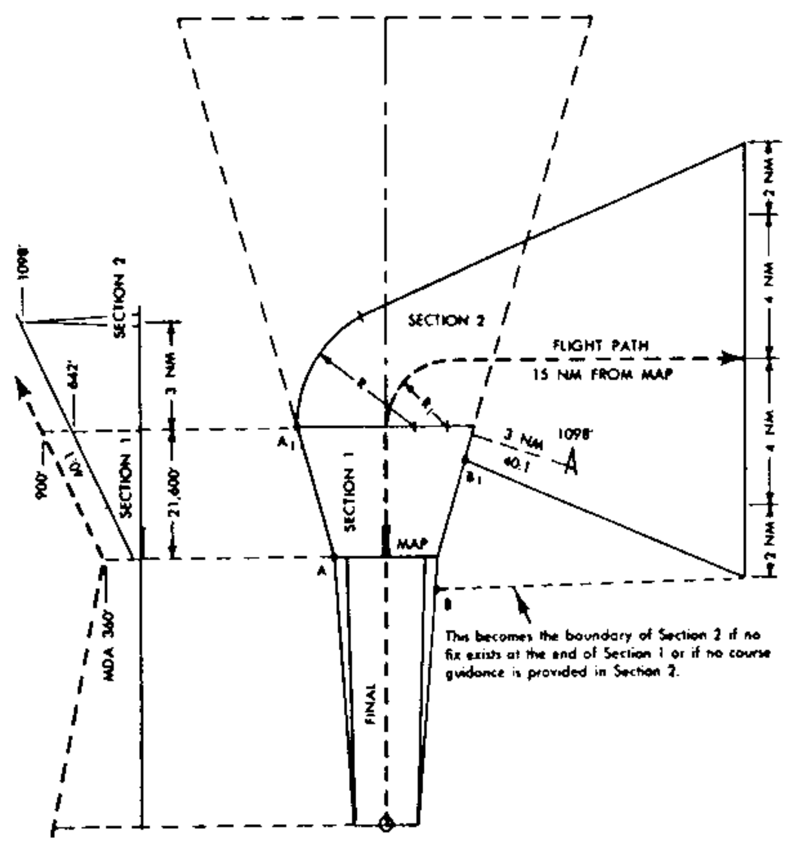


Figure 27. COMBINATION MISSED APPROACH AREA. Par 277(a).

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

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

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

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

(b) If the computed 40:1 surface elevation is less than the ROC surface elevation, a climb-in-hold evaluation IS required. FAA Order 7130.3, 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 TERPS 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 shall be used until the MHA does not increase, then the 40:1 surface is re-evaluated. If obstacles penetrate the 40:1 surface, take action to eliminate the penetration.

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

278. END OF MISSED APPROACH. Aircraft shall be assumed to be in the initial approach or en route environment upon reaching minimum obstacle clearance altitude (MOCA) or MEA. Thereafter, the initial approach or the en route clearance criteria apply.

279. RESERVED.

SECTION 8. TERMINAL AREA FIXES

280. GENERAL. Terminal area fixes include, but are not limited to the FAF, the IF, the IAF, the holding fix, and when possible, a fix to mark the MAP. Each fix is a geographical position on a defined course. Terminal area fixes should be based on similar navigation systems. For example, TACAN, omni-directional radio range tactical air navigation (VORTAC), and VOR/DME facilities provide radial/DME fixes. NDB facilities provide bearings. VOR facilities provide VOR radial. The use of integrated (VHF/NDB) fixes shall be limited to those intersection fixes where no satisfactory alternative exists.

281. FIXES FORMED BY INTERSECTION. A geographical position can be determined by the intersection of courses or radials from two stations. One station provides the course the aircraft is flying and the other provides a crossing indication which identifies a point along the course which is being flown. Because all stations have accuracy limitations, the geographical point which is identified is not precise, but may be anywhere within a quadrangle which surrounds the plotted point of intersection. Figure 28 illustrates the intersection of an arc and a radial from the same DME facility and the intersection of two radials or courses from different navigation facilities. The area encompassed by the sides of the quadrangle formed in these ways is referred to in this publication as the "fix displacement area".

282. COURSE/DISTANCE FIXES.

***a.* A DME fix is formed by a DME reading** on a positive navigational course. The information should be derived from a single facility with collocated azimuth and DME antennas. Collocation parameters are defined in FAA Order 6050.32, Spectrum Management Regulations and Procedures. However, when a unique operational requirement indicates a need for DME information from other than collocated facilities, an individual IAP which specifies DME may be approved, provided the angular divergence between the signal sources at the fix does not exceed 23° (see figure 28). For limitation on use of DME with ILS, see Volume 3, paragraph 2.9.1.

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

c. Fixes Formed by Marker Beacons. Marker beacons are installed to support certain NAVAID's that provide course guidance. A marker beacon is suitable to establish a fix only when it marks an along course distance from the NAVAID it is associated with; e.g. localizer and outer markers.

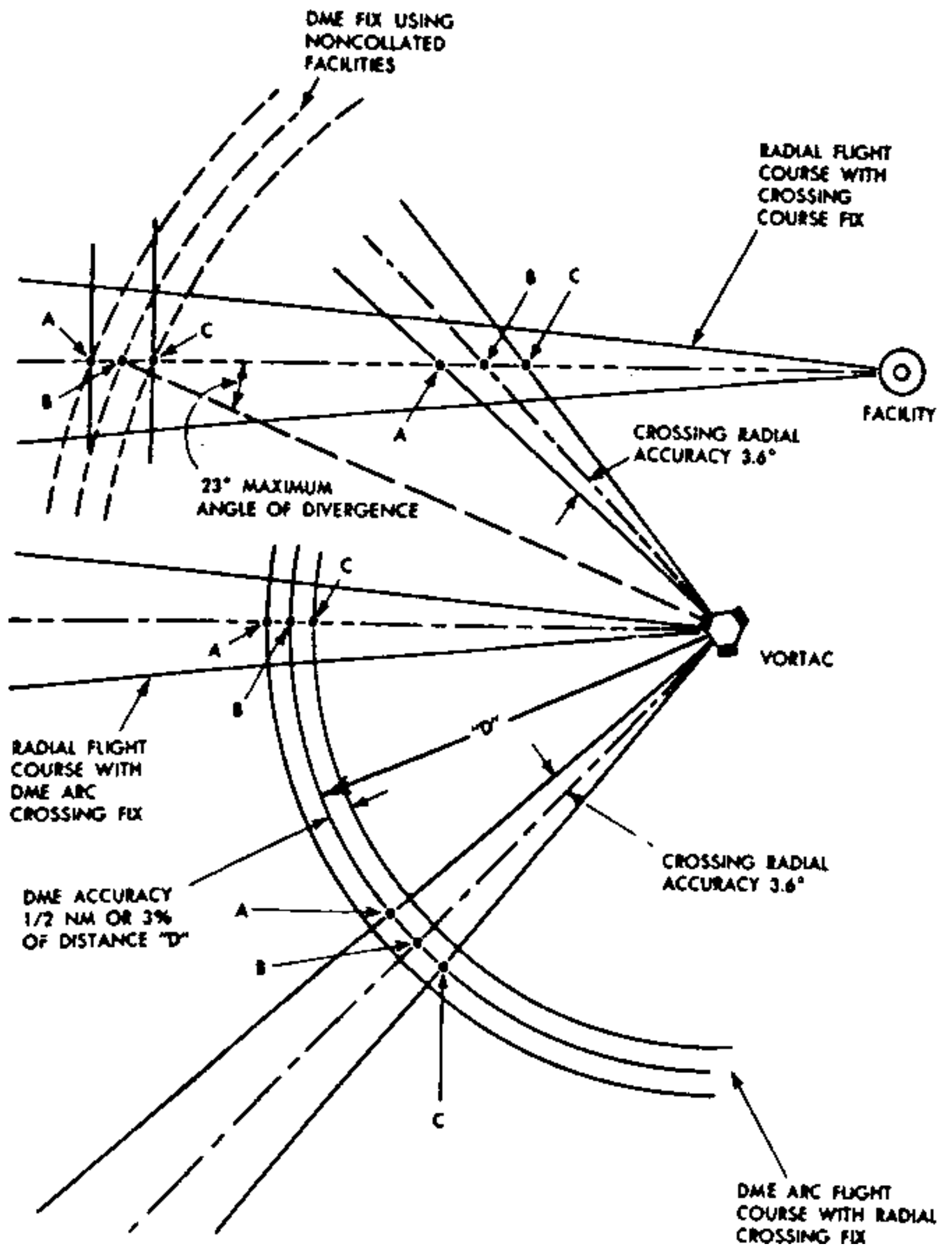


Figure 28. INTERSECTION FIX DISPLACEMENT. Par 281 and 282a.

283. FIXES FORMED BY RADAR. Where ATC can provide the service, Airport Surveillance Radar (ASR) may be used for any terminal area fix. PAR may be used to form any fix within the radar coverage of the PAR system. Air Route Surveillance Radar (ARSR) may be used for initial approach and intermediate approach fixes.

284. FIX DISPLACEMENT AREA. The areas portrayed in figure 28 extend along the flight course from point "A" to point "C". The fix error is a plus-or-minus value, and is represented by the lengths from "A" to "B" and "B" to "C". Each of these lengths is applied differently. The fix error may cause the fix to be received early (between "A" and "B"). Because the fix may be received early, protection against obstacles must be provided from a line perpendicular to the flight course at point "A".

285. INTERSECTION FIX DISPLACEMENT FACTORS. The intersection fix displacement area is determined by the system use accuracy of the navigation fixing systems (see figure 29). The system use accuracy in VOR and TACAN type systems is determined by the combination of ground station error, airborne receiving system error, and flight technical error (FTE). En route VOR data have shown that the VOR system accuracy along radial 4.5°, 95 percent of occasions, is a realistic, conservative figure. Thus, in normal use of VOR or TACAN intersections, fix displacement factors may conservatively be assessed as follows:

a. Along-Course Accuracy.

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

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

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

NOTE: The plus-or-minus 4.5° (95 percent) VOR/TACAN figure is achieved when the ground station course signal error, the FTE, and the VOR airborne equipment error are controlled to certain normal tolerances. Where it can be shown that any of the three error elements is consistently different from these assumptions (for example, if flight inspection shows a consistently better VOR signal accuracy or stability than the one assumed, or if it can be shown that airborne equipment error is consistently smaller than assumed), VOR fix displacement factors smaller than those shown above may be utilized under paragraph 141.

b. Crossing Course Accuracy.

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

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

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

NOTE: The plus-or-minus 3.6° (95 percent) VOR/TACAN figure is achieved when the ground station course signal error and the VOR airborne equipment error are controlled to certain normal tolerances. Since the crossing course is not flown, FTE is not a contributing element. Where it can be shown that either of the error elements is consistently different, VOR displacement factors smaller than those shown above may be utilized IAW paragraph 141.

286. OTHER FIX DISPLACEMENT FACTORS.

a. Radar. Plus-or-minus 500 feet or 3 percent of the distance to the antenna, whichever is greater.

b. DME. Plus-or-minus 1/2 (0.5) miles or 3 percent of the distance to the antenna, whichever is greater.

c. 75 MHz Marker Beacon.

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

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

(3) **Low powered fan marker,** plus-or-minus 1/2 mile.

(4) **"Z" marker, plus-or-minus** 1/2 mile.

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

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

287. SATISFACTORY FIXES.

a. Intermediate, Initial, or Feeder Fix. To be satisfactory as an intermediate, initial, or feeder approach fix, the fix error must not be larger than 50 percent of the appropriate segment distance that follows the fix. Measurements are made from the plotted fix position (see figure 29).

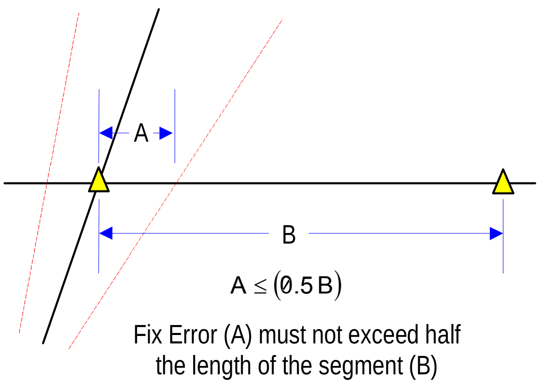


Figure 29. INTERMEDIATE, INITIAL, OR FEEDER APPROACH FIX ERRORS. Par 287.

b. Holding Fixes. Any terminal area fix except overheading a TACAN may be used for holding. The following conditions shall exist when the fix is an intersection formed by courses or radials:

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

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

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

(4) If distances stated in paragraphs 287b(2) or (3) are exceeded, the minimum angle of divergence of the intersecting courses must be increased at the following rate:

(a) If an NDB facility is involved, 1° for each mile over 30 miles.

(b) If an NDB facility is NOT involved, 1/2° for each mile over 45 miles.

FIGURE 30 DELETED BY CHG 19.

c. FAF. For a fix to be satisfactory for use as a FAF, the fix error should not exceed plus-or-minus 1 mile (see figures 31-1 and 31-2). It may be as large as plus-or-minus 2 miles when:

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

(2) A buffer of equal length to the excessive fix error is provided between the published MAP and the point where the missed approach surface begins (see figure 32).

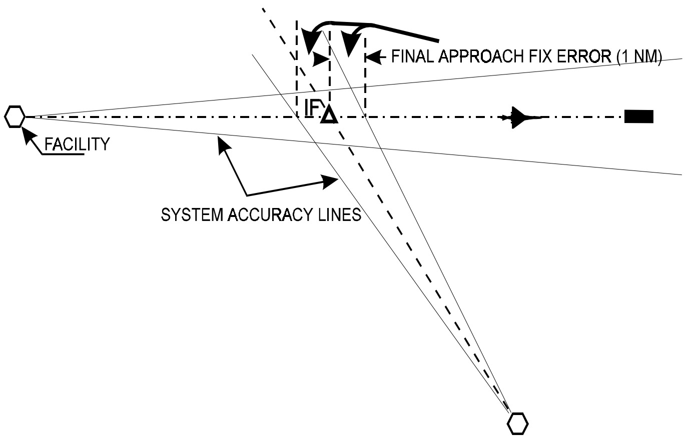


Figure 31-1. MEASUREMENT OF FAF ERROR. Par 287c.

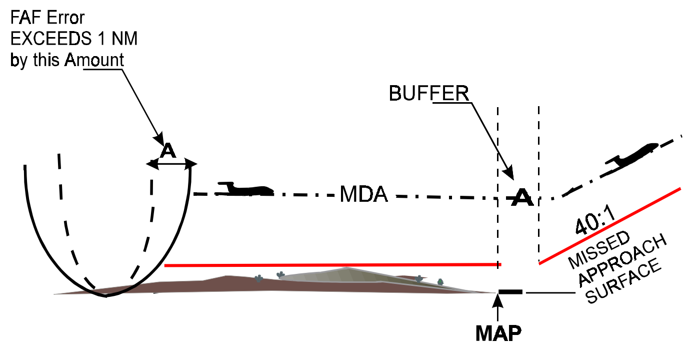
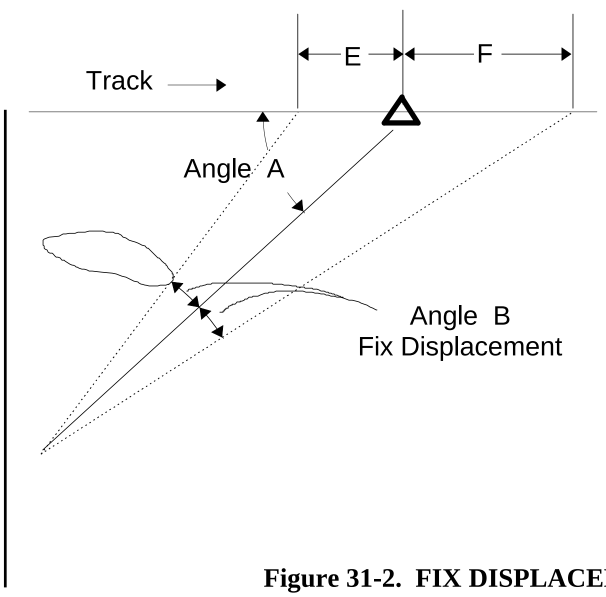


Figure 32. FAF ERROR BUFFER. Par 287c(2).

Calculate fix displacement using the following formulas:



Formula

$$E = \frac{6076.11548 \times D \times \text{Sin}\,B}{\text{Sin}\,(A + B)}$$

$$F = \frac{6076.11548 \times D \times \text{Sin}\,B}{\text{Sin}\,(A - B)}$$

Example

$$E = \frac{6076.11548 \times 30 \times \text{Sin}\,3.6°}{\text{Sin}\,(50 + 3.6°)}$$

$$E = 14220.10$$

$$F = \frac{6076.11548 \times 30 \times \text{Sin}\,3.6°}{\text{Sin}\,(50° - 3.6°)}$$

$$F = 15805.19$$

Figure 31-2. FIX DISPLACEMENT CALCULATIONS. Par 287c.

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).

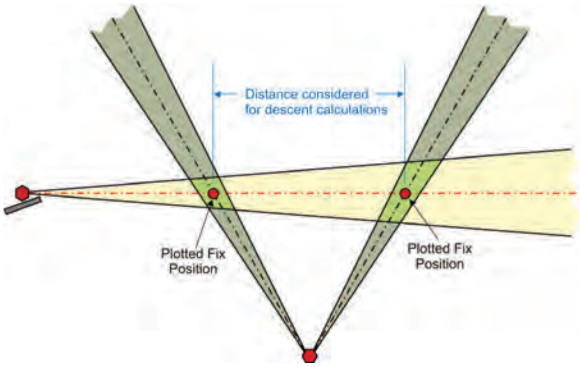


Figure 33. DISTANCE FOR DESCENT GRADIENT APPLICATION. Par 288a.

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).

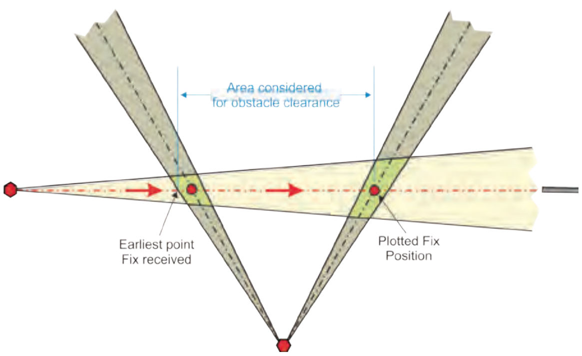


Figure 34-1. OBSTACLE CLEARANCE AREA BETWEEN FIXES. Par 288b.

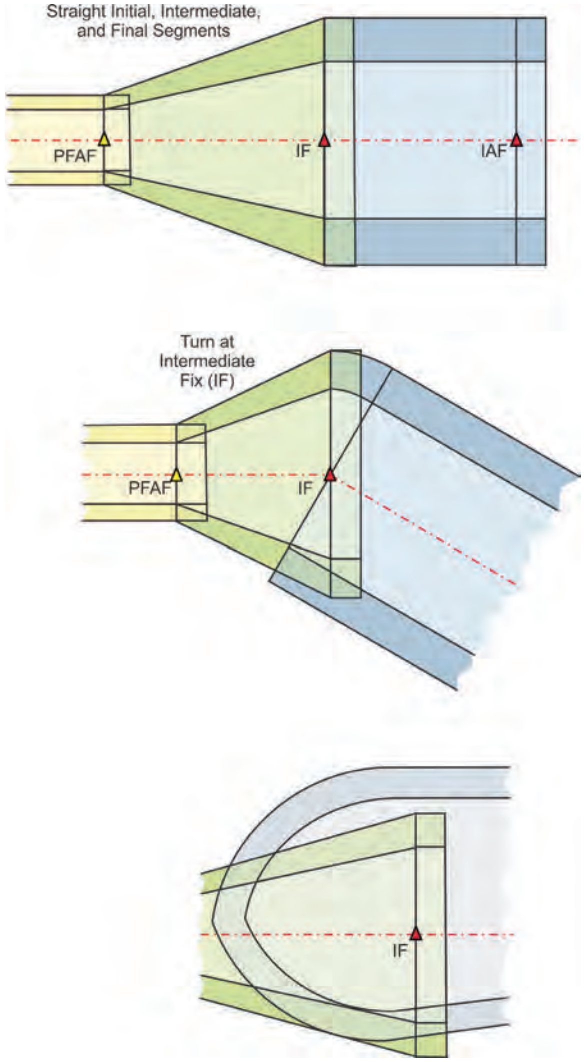


Figure 34-2. CONSTRUCTION OF FIX DISPLACEMENT AREA FOR OBSTACLE CLEARANCE. Par 288b.

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.

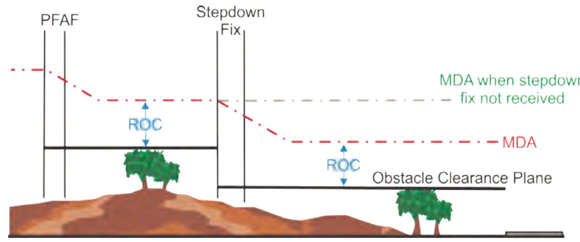


Figure 35. FINAL SEGMENT STEPDOWN FIX. Par 288c.

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)

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

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

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

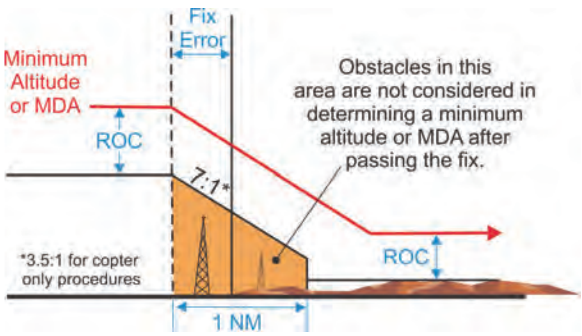


Figure 36. OBSTACLES CLOSE-IN TO A FIX. Par 289.

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

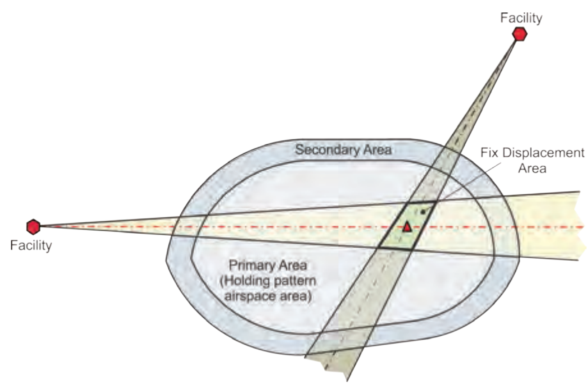


Figure 37-1. HOLDING PATTERN TEMPLATE APPLICATION. Par 292.

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.

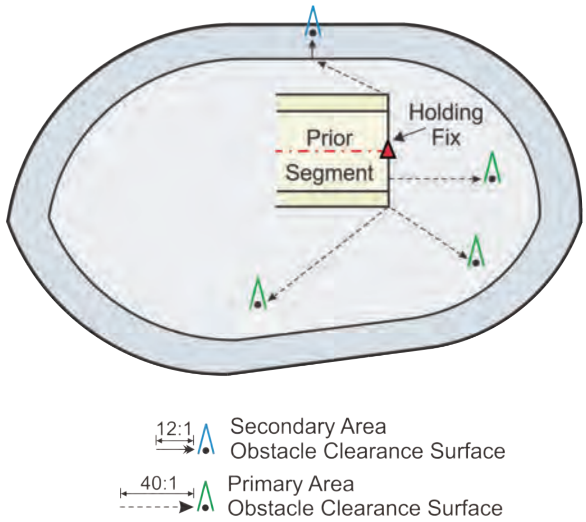


FIGURE 37-2. CLIMBING IN A HOLDING PATTERN. Par 293b.

294. - 299. RESERVED.

Paragraph 252a Formula *Calculating Straight-in Descent Angle*

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

Where:

- atan = arc tangent
- ln = Natural logarithm
- alt = FAF/PFAF or stepdown fix altitude
- THRe= Threshold elevation
- r = 20890537
- TCH = VGSI or Design TCH
- D_{FIX} = Distance (ft) from FAF/PFAF or stepdown fix to FEP

*atan(ln((r+alt)/(r+THRe+TCH))*r/D_{FIX})*180/π*

Calculator

alt	*2,400*	Click here to calculate
THRe	*85.00*	
r	*20890537*	
TCH	*47.00*	
D_{FIX}	*32,385.000*	
$\theta_{DESCENT}$	***4.006*** °	

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Figure 14.5 Formula *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
tan = tangent
r = 20890537
θ = VGSI or specified descent angle

*(ln((r+alt)/(r+THRe+TCH))*r)/tan(θ*π/180)*

Calculator

alt	*2,600*	Click here to calculate
THRe	*1,012.00*	
TCH	*46.00*	
r	*20890537*	
θ	*3°*	
D_{PFAF}	***29,420.537***	

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Paragraph 252b Formula *Calculating Circling Descent Angle*

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

Where:

atan = arc tangent
ln = Natural logarithm
r = 20890537
alt = FAF/PFAF or Stepdown fix altitude
CMDA = Lowest Published CMDA
D_{FIX} = Distance (ft) from FAF/PFAF or stepdown fix to FEP

$atan(ln((r+alt)/(r+CMDA))*r/D_{FIX})*180/\pi$

Calculator

alt		Click here to calculate
CMDA		
r	*20890537*	
D_{FIX}		
$\theta_{CIRCLEDESCENT}$	°	

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Paragraph 252c Formula *Determining Altitude of Vertical Path at a Stepdown Fix*

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

Where:

- e = base of the natural logarithm (Napier's constant)
- D_Z = dist (ft) from FEP to fix
- tan = tangent
- θ = angle calculated IAW 252a or 252b
- r = 20890537
- $base_{alt}$
  - (para. 252a) = THRe + TCH
  - (para. 252b) = CMDA

e^((DZ*tan(θ*π/180))/r)*(r+$base_{alt}$)-r

Calculator

D_Z	29,420.830	Click here to calculate
θ	3°	
r	20890537	
$base_{alt}$	1,058.00	
$Z_{vertpath}$	**2,600.015**	

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Paragraph 253 Formula *Calculating VDP distance*

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

Where:
- asin = arc sine
- cos = cosine
- θ = VGSI or specified descent angle
- r = 20890537
- THRe = Threshold elevation
- TCH = VGSI or Design TCH
- MDA = Minimum Descent altitude

r(π/2-θ*π/180-asin((cos(θ*π/180)*(r+THRe+TCH))/(r+MDA)))*

Calculator

MDA	*6,840*	Click here to calculate
THRe	*6,451.00*	
TCH	*50.00*	
r	*20890537*	
θ	*3°*	
D_{VDP}	***6,447.404***	

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Paragraph 260 Formula #1 *True Airspeed*

$$V_{KTAS} = \frac{V_{KIAS} \cdot 171233 \cdot \sqrt{(288+15)-0.00198 \cdot (alt+k)}}{\left(288 - 0.00198 \cdot (alt+k)\right)^{2.628}}$$

Where:

V_{KIAS} = indicated airspeed (from *table 4*)
alt = airport elevation (MSL)
k = height above airport (1,000 ft minimum)

*(VKIAS*171233*((288+15)-0.00198*(alt+k))^0.5)/(288-0.00198*(alt+k))^2.628*

Calculator

V_{KIAS}	*90*	Click here to calculate
alt	*0*	
k	*1,000*	
V_{KTAS}	***93.695***	

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Paragraph 260 Formula #2 *Circling Approach Area Radius*

$$CAR = 2 \cdot \frac{(V_{KTAS} + 25)^2}{\tan(bank_{angle} \cdot \frac{\pi}{180}) \cdot 68625.4} + S$$

Where:

V_{KTAS} = true airspeed
tan = tangent
$bank_{angle}$ = achieved bank angle (from *table 4*)
S = straight segment(from *table 4*)

2(VKTAS+25)^2/(tan(bankangle*π/180)*68625.4)+S*

Calculator		
V_{KTAS}	*93.695*	Click here to calculate
$Bank_{angle}$	*25°*	
S	*0.4*	
CAR	***1.281***	

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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.

Table 3-1. *Standard Lighting Systems.*			
	APPROACH LIGHTING SYSTEMS	**Operational Coverage (°)**	
		Lateral (±)	**Vertical (above horizon)**
ALSF-1	Standard Approach Lighting System with Sequenced Flashers	21.0* 12.5#	12.0* 12.5#
ALSF-2	Standard Approach Lighting System with Sequenced Flashers & CAT II Modification	21.0* 12.5#	12.0* 12.5#
SALS	Short Approach Lighting System	21.0* --	12.0* --
SALSF	Short Approach Lighting System with Sequenced Flashers	21.0* 12.5#	12.0* 12.5#
SSALS	Simplified Short Approach Lighting System	21.0* --	12.0* --
SSALF	Simplified Short Approach Lighting System with Sequenced Flashers	21.0* 12.5#	12.0* 12.5#
SSALR	Simplified Short Approach Lighting System with Runway Alignment Indicator Lights	21.0* 12.5#	12.0* 12.5#
MALS	Medium Intensity Approach Lighting System	10.0* --	10.0* --
MALSF	Medium Intensity Approach Lighting System with Sequenced Flashers	10.0* 12.5#	10.0* 12.5#
MALSR	Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights	10.0* 12.5#	10.0* 12.5#
ODALS	Omni-Directional Approach Lighting System	360#	2.0-10.0#

** Steady-burning # Sequenced flashers*

RUNWAY LIGHTING SYSTEMS	
HIRL	High Intensity Runway Lights
MIRL	Medium Intensity Runway Lights
LIRL	Low Intensity Runway Lights
TDZ/CL	Touchdown Zone and Centerline Lights

Note: See Order 8260.3B, Volume 3, appendix 5 for lighting system descriptions.

Table 3-2. *United States and International Approach Lighting Classifications*.		
Facility Class	**Approach Lighting Systems (ALS)**	**ALS Length (ft)**
Full (FALS)	**ALS length ≥ 720 m** **U.S.: ALSF-1, ALSF-2, SSALR, MALSR** High or medium intensity and/or flashing lights **ICAO:** Calvert or Barette Centre Line Lights, high intensity lights	≥ 2400
Intermediate (IALS)	**ALS length 420 - 719 m** **U.S.: MALSF, MALS, SSALF, SSALS, SALS/SALSF** High or medium intensity and/or flashing lights **ICAO:** Simplified Approach Light System, high intensity lights	≥ 1400 – 2399
Basic (BALS)	**ALS length 210 - 419 m** **U.S.: ODALS** High or medium intensity lights and/or flashing lights **JAA:** High, medium or low intensity lights, including one crossbar	≥700 – 1399
Nil (NALS)	**ALS length < 210 m**, or No approach lights	None or < 700

3.1.3 b. Operational Conditions.

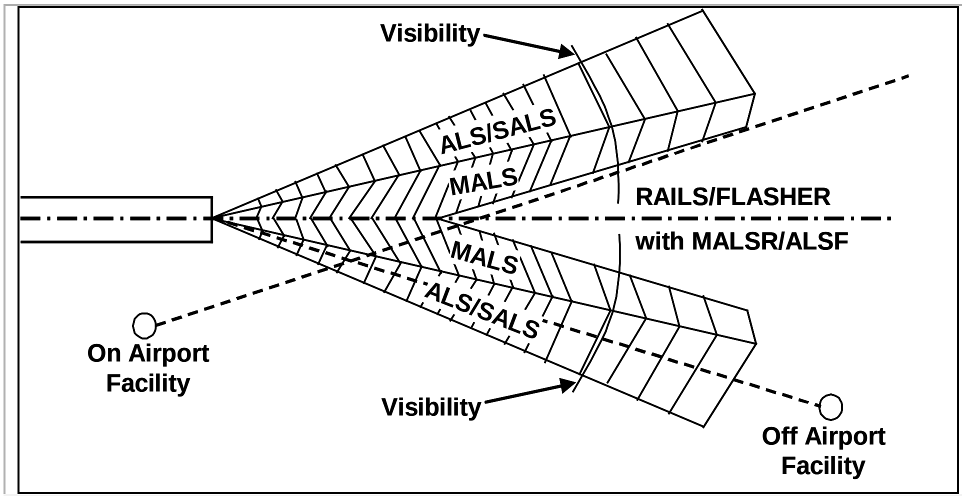
In order to apply approach light credit (e.g., publish visibility from the FALS, IALS, or BALS column from *table 3-5a, 3-6, or 3-7*), the following conditions must exist:

3.1.3 b. (1) The runway must have nonprecision instrument or precision instrument (all-weather) markings or TDZ/CLs as specified in directives of the appropriate approving authority. Unless otherwise authorized by Flight Standards, precision instrument runway markings are required in order to publish visibility less than 3/4 statute miles (SM). Runway marking effectiveness may be degraded when obscured by surface water, snow, ice, or tire marks. All procedures to the affected runway must revert to no-light minimums when required markings are removed, or when it is determined the markings are inadequate for reduced visibility credit. Operational TDZ/CL lights may be substituted for removed, deteriorated, or obscured runway markings to authorize a visibility minimum appropriate for the applicable approach light configuration.

3.1.3 b. (2) The final approach course (FAC) must place the aircraft within the lateral and vertical coverage of the approach lighting system at a distance from the landing threshold equal to the standard visibility required without lights (NALS column) **AND** the distance from MAP/DA to threshold must be less than or equal to 3 SM.

Note: The straight-in (SI) FAC to an "on-airport" facility typically transits all approach light operational areas within the visibility arc limits, but the FAC from *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)	HAT (Feet)	GLIDEPATH ANGLE (Degrees)	TCH UPPER LIMIT (Feet)
* 200 to 249	# 2.50 - 3.20	75	300 to 349	# 2.50 - 4.90	75
	3.21 - 3.30	70		4.91 - 5.00	71
	3.31 - 3.40	66		5.01 - 5.10	66
	3.41 - 3.50	63		5.11 - 5.20	61
	3.51 - 3.60	59		5.21 - 5.30	56
	3.61 - 3.70	55		5.31 - 5.40	52
	3.71 - 3.80	50		5.41 - 5.50	48
	3.81 - 3.90	47		5.51 - 5.60	43
	3.91 - 4.00	43		5.61 - 5.70	39
	4.01 - 4.10	39			
	4.11 - 4.20	35	350 and above	# 2.50 - 5.60	75
				5.61 - 5.70	70
250 to 269	# 2.50 - 4.10	75		5.71 - 5.80	65
	4.11 - 4.20	71		5.81 - 5.90	60
	4.21 - 4.30	67		5.91 - 6.00	55
	4.31 - 4.40	62		6.01 - 6.10	50
	4.41 - 4.50	58		6.11 - 6.20	45
	4.51 - 4.60	54		6.21 - 6.30	40
	4.61 - 4.70	50		6.31 - 6.40	35
	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			

* *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.

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

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).

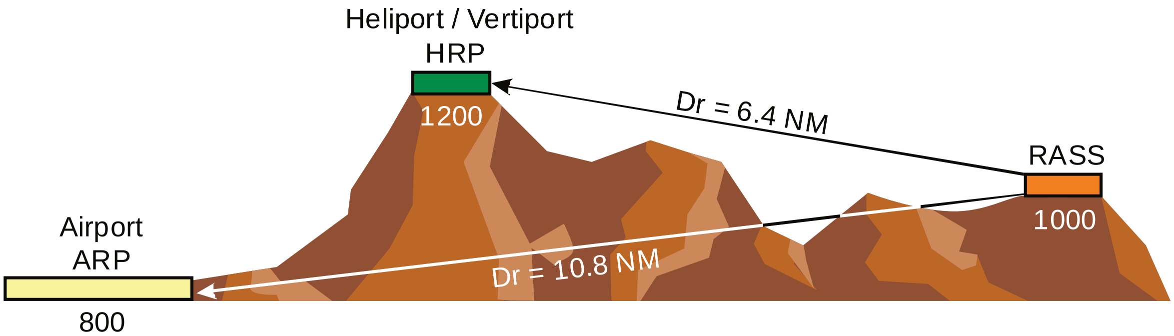
3.2.2 b. (4) Precipitous terrain identified in other segments. When the criteria applicable to the segment requires a precipitous terrain adjustment, increase ROC values by the amount specified by the software/algorithms. (USAF; by the amount deemed appropriate by the specialist/approving authority).

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:

Airport
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

Heliport
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

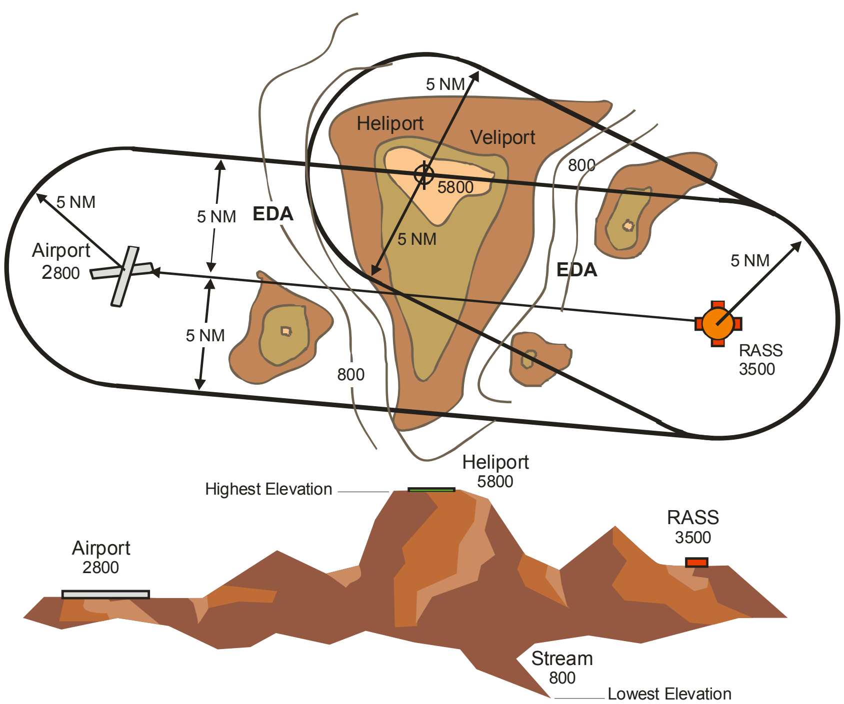
* Copter PinS Approaches. When annotated "Proceed Visually": D_r = Horizontal distance from altimeter source to HRP. When annotated "Proceed VFR": D_r = Horizontal distance from altimeter source to MAP

Examples:

Airport
D_r = 25 NM
E_2 = 5800 - 800 = 5000 ft
(2.30 * 25) + (0.14 * 5000) = 757.5 ft basic RASS adjustment
In intermediate segment 757.5 * 0.6 = 454.5 - 200 (254.5 ft ROC increase)
In PA/APV final segment: DH = 350 + 757.5 = increase DH to 1108
In NPA final segment: 3052.2 (Controlling obs) + 250 ROC + 757.5 = 4060 MDA

Heliport
D_r = 15 NM
E_2 = 5800 - 800 = 5000 ft
(2.30 * 15) + (0.14 * 5000) = 734.5 ft basic RASS adjustment
In intermediate segment 734.5 * 0.6 = 440.7 - 200 (240.7 ft ROC increase)
In PA/APV final segment: DH = 294 + 734.5 = increase DH to 1029
In NPA final segment: 6000 (Controlling obs) + 250 ROC + 734.5 = 7000 MDA

Figure 3-1b. Elevation Differential Area (EDA)
Intervening Terrain Influences Atmospheric Pressure Patterns



3.2.2 c. (3) NPA final segments (including the circling maneuvering area). Increase primary area ROC by the full basic RASS adjustment.

3.2.2 c. (4) PA/APV final segments. Increase the DA (prior to rounding) by the full basic RASS adjustment.

3.2.2 c. (5) For intermediate segments, use 60 percent of the basic RASS adjustment from formulas 3-1a or 3-1b and increase the intermediate segment primary area ROC by the amount this value exceeds 200 ft.

3.2.2 c. (6) When the missed approach design utilizes a turn at altitude prior to the clearance limit and a part-time altimeter source is specified, decrease the turning section Obstacle Clearance Surface (OCS) starting height by the difference between RASS adjustments for the two remote altimeter sources. (Where one altimeter source is local, subtract the full RASS adjustment.) Do not decrease these surface starting heights to less than the OCS at the missed approach point (MAP). If this results in an OCS penetration that cannot be resolved by other methods, provide a second climb-to-altitude determined by adding the difference between the RASS adjustments to the climb-to-altitude and rounding to the next higher appropriate increment. This application must not produce a turn altitude above the missed approach clearance-limit altitude.

Example: MISSED APPROACH: Climb to 6000 (6,100 when using Denver Intl altimeter setting) then…

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

3.2.2 c. (7) Helicopter Point in Space (PinS) Approach. When the MAP is more than 5 NM from the PinS approach altimeter-setting source for a PinS-VFR approach, or the HRP is more than 5 NM from altimeter-setting source for a PinS- Special IFR Approach to a VFR Heliport (IVH) approach, RASS adjustment must be applied. For application of the RASS formula, define “Dr” as the distance from the altimeter-setting source to the MAP/HRP accordingly, and define “E1”, or “E2, as specified by formulas 3-1a or 3-1b whereas E1 = the heliport elevation for both PinS-IVH and PinS-VFR.

3.2.2 c. (8) Minimum Reception Altitude (MRA). Where a minimum altitude is MRA based, increase the MRA using the RASS adjustment factor value.

3.2.2 c. (9) Where the altimeter is based on a remote source(s), annotate the procedure and/or publish the appropriate minima lines in accordance with Order 8260.19, Flight Procedures and Airspace.

3.2.2 d. Excessive Length, Nonprecision Final Approach. When a procedure incorporates a final approach fix (FAF), and the final approach segment (FAS) length FAF-to-MAP exceeds 6 NM (plotted positions), increase FAS primary area ROC 5 ft for each one-tenth NM over 6 NM.

EXCEPTION: If a stepdown fix exists and the remaining segment length is less than 6 NM, the basic FAS ROC may be applied between the stepdown fix and the MAP. See formula 3-2 (Excessive Length Adjustment).

Formula 3-2. Excessive Length Adjustment

$$Adjustment = 50(Length_{final} - 6)$$

Where $Length_{final}$ = horizontal distance in NM from plotted position of FAF to MAP

$$50*(Length_{final}-6)$$

Example

Distance FAF to MAP = 6.47

Adjustment = 50(6.47- 6) = 23.5

250 ROC + 23.5 = 273.5 adjusted ROC

Chapter 3. Takeoff and Landing Minimums
Section Three. Visibility Minimums

3.3 Visibility Minimums.

3.3.1 Authorization.

3.3.1 a. Straight-in visibility minimums are authorized when:

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

3.3.1 a. (2) The final approach segment vertical descent angle does not exceed tolerances [see paragraph 252].

3.3.1 b. Circling visibility minimums are authorized when:

3.3.1 b. (1) Straight-in alignment cannot be met (e.g., for "Circling-only" procedures not meeting straight-in alignment requirements) [see paragraph 162].

3.3.1 b. (2) Straight-in alignment requirements are met, but descent angle precludes publication of straight-in minimums [see paragraph 252].

3.3.1 b. (3) Published in conjunction with straight-in minimums.

Note: Do not establish circling minima when PA or APV procedures are established without accompanying SI NPA minima.

3.3.2 Establishing Straight-in Visibility Minimums. Establish as RVR where authorized. Otherwise, establish as a statute mile (SM) value. Meter (M) values are for locations outside the United States only.

3.3.2 a. Step 1. Find the visibility (RVR or SM) appropriate to the HATh and ALS from the applicable table(s). When more than one table applies, use the highest value.

3.3.2 a. (1) Table 3-5a specifies standard civil and military straight-in minimums except for CAT A and B NPA, Category II/III ILS, Special Authorization (SA) Category I/II ILS, and helicopter approaches.

3.3.2 a. (2) Use table 3-6 exclusively for CAT A straight-in NPA approaches. Use table 3-7 exclusively for CAT B straight-in NPA approaches.

3.3.2 a. (3) Use table 3-8 for CAT C/D/E straight-in NPA approaches after determining the visibility minimums prescribed by table 3-5a.

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).

			FALS			IALS			BALS			NALS		
HAT Range			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).

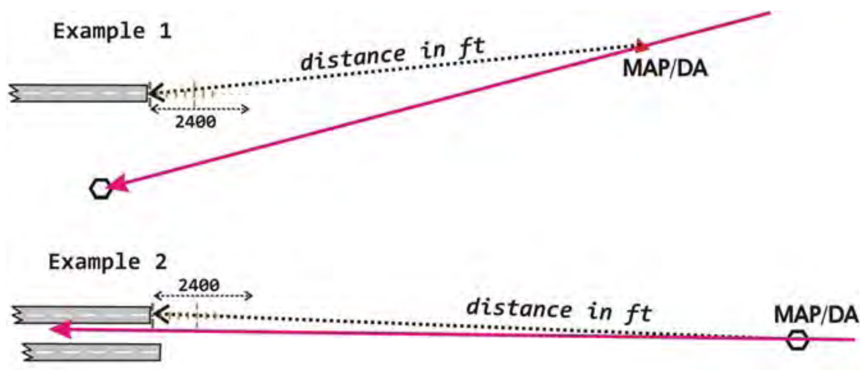
Table 3-8. Minimum Straight-in RVR/Visibility NPA Procedures CAT C/D/E

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.

Figure 3-2. MAP/DA to LTP distance Straight-in Aligned



3.3.2 c. Step 3. Determine visibility based on evaluation of the visual portion of the final approach segment. Apply the Standard visual area to runways to which an aircraft is authorized to circle (either in association with a SI procedure or a Circling only approach). Apply the Straight-In area to runways with approach procedures aligned with the runway centerline (less than or equal to ± 0.03°). Apply the Offset visual area to evaluate the visual portion of a straight-in approach that is not aligned with the runway centerline (more than ± 0.03°). These evaluations determine if night operations must be prohibited due to unlit obstacles or if visibility minimums must be restricted.

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

3.3.2 c. (1) Visual Area Types.

3.3.2 c. (1) (a) Standard [see figure 3-3a].

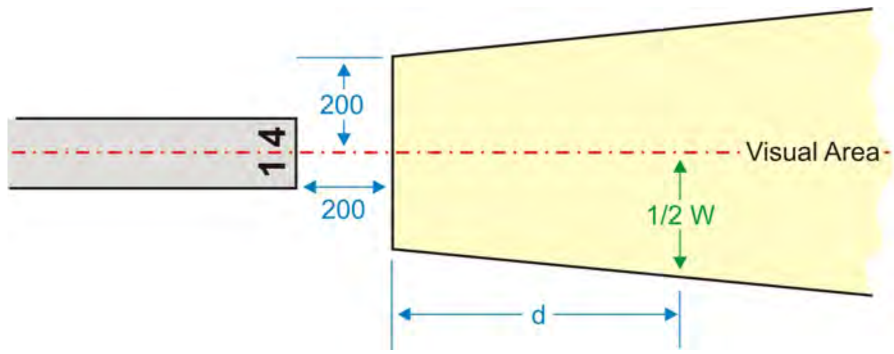
- Alignment. Align with the runway centerline extended (RCL).
- Length. The area begins 200 ft from LTP at LTP elevation and extends 10,000 ft out RCL
- Width. The beginning width is ± 200 ft either side of RCL. The sides splay outward relative to runway centerline. Calculate the half-width of the area at any distance "d" from its origin using formula 3-3a:

Formula 3-3a. Standard Visual Area 1/2 width

$$\frac{1}{2}W = (0.15 \times d) + 200$$

where *½W = perpendicular distance (feet) RCL to area edge*
d = distance (feet) from origin measured along RCL

Figure 3-3a. Standard Visual Area



3.3.2 c. (1) (b) Straight-in. (Procedure need not meet straight-in descent criteria) [see figure 3-3b].

- Alignment. Align with the RCL extended.
- Length. The area begins 200 ft from LTP at LTP elevation and extends to the calculated DA point for each PA or APV procedure and to the VDP location (even if one is not published for NPA procedures) [see Vol., para 253].
- Width. The beginning width is ± 200 ft for runways limited to CAT A/B minimums and ± 400 ft for all other runways. The sides splay outward relative to RCL Calculate the half-width of the area at any distance "d" from its origin using formula 3-3b:

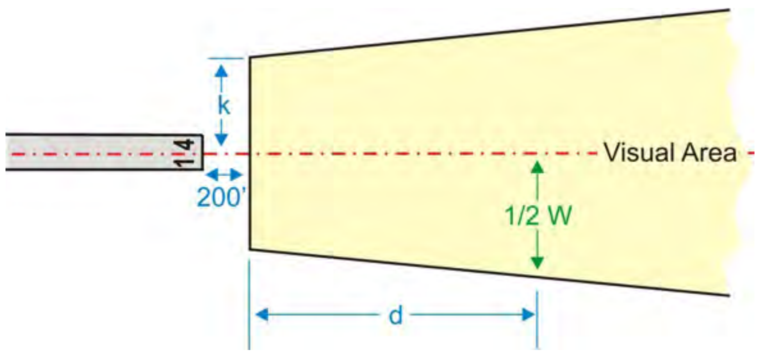
Note: When multiple NPA minimums are published on the same chart (i.e., dual minimums or applicable RNAV procedures) use the lowest MDA to determine VDP location and to determine the length of the visual area. For PA/APV approaches, calculate the DA point based on the primary altimeter source.

Formula 3-3b. Straight-in Visual Area 1/2 width

$$\frac{1}{2}W = (0.138 \times d) + k$$

where *$^{1/2}W$ = perpendicular distance (feet) RCL to area edge*
d = distance (feet) from origin measured along RCL
k = 200 for Cat A/B, 400 for Cat C/D/E

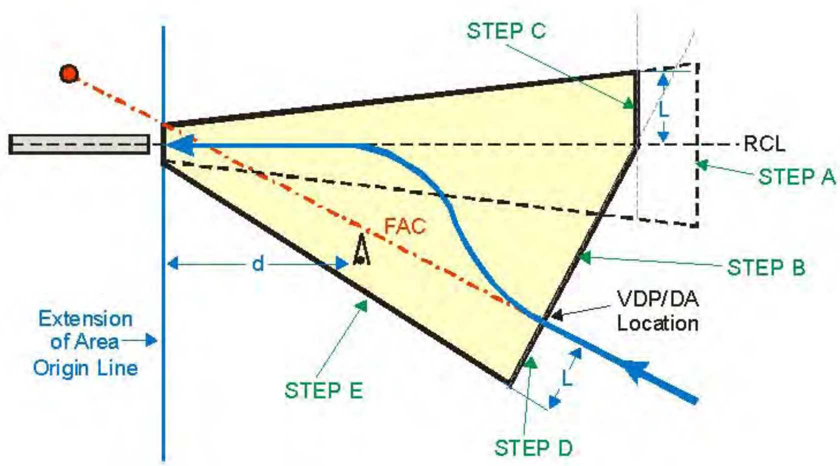
Figure 3-3b. Straight-in Visual Area



3.3.2 c. (1) (c) Offset [see figure 3-3c]: When the final course does not coincide with the RCL (± 0.03°), modify the straight-in visual area as follows:

- Step A. Draw the straight-in area aligned with the RCL as previously described.
- Step B. Extend a line perpendicular to the final approach course (FAC) from the DA point or VDP (even if one is not published) to the point it crosses the RCL.
- Step C. Extend a line from this point perpendicular to the RCL to the outer edge of the straight-in area, noting the length (L).
- Step D. Extend a line in the opposite direction of the line in Step B from the DA/VDP perpendicular to the FAC for distance (L).
- Step E. Connect the end of the line constructed in Step D to the end of the inner edge of the area origin line 200 ft from LTP.

Figure 3-3c. Offset Visual Area



3.3.2 c. (2) Obstacle Clearance. When evaluating a straight-in or offset visual area, apply both a 34:1 and a 20:1 surface. When evaluating the standard visual area, apply a 20:1 surface only. Calculate surface height above LTP elevation at any distance "d" from an extension of the area origin line using formula 3-3c:

Formula 3-3c. Visual Area OIS Height

$$20{:}1\ \text{Surface Height} = \frac{d}{20}$$

$$34{:}1\ \text{Surface Height} = \frac{d}{34}$$

where d = distance (feet) from origin line (extended) measured along RCL

3.3.2 c. (2) (a) 34:1 OIS. If penetrated, limit visibility to no lower than 4000 RVR or 3/4 SM.

3.3.2 c. (2) (b) 20:1 OIS. If penetrated, take the following action:

- Lighted Obstacles: Do not publish a VDP and limit visibility to no lower than 5000 RVR or 1 SM.
- Unlighted Obstacles: Do not publish a VDP, limit visibility to no lower than 5000 RVR or 1 SM, and annotate the chart denying the approach or applicable minimums at night.
    - o A Visual Glide Slope Indicator (VGSI) may be used in lieu of obstruction lighting with Flight Standards or Military authority approval. USAF not applicable.

3.3.2 d. Step 4. Establish the SI visibility as the highest value determined from Steps 1-3.

3.3.2 d. (1) Visibility greater than 3 SM. Where the HATh is 1000 ft or higher, 3 SM visibility may be established with Flight Standards approval when the procedure is annotated "Fly Visual to Airport."

Note 1: "Fly Visual to Airport" provides relief from visual reference requirements specified in Part 91.175, and related rules such as 121.651, 135.225, and 125.381. This option will only be approved where deemed safe and operationally beneficial.

Note 2: Not applicable to procedures developed under Order 8260.49, Simultaneous Offset Instrument Approaches (SOIA), Order 7110.98 Simultaneous Converging Instrument Approaches, or Order 7110.110 Dependent Converging Instrument Approaches (DCIA) With Converging Runway Display Aid (CRDA).

3.3.2 e. When authorized approach light credit, determine the applicability of the U.S Terminal Procedures Publication (TPP) "Inoperative Components or Visual Aids" (INOP Components) table. This step is not applicable to the USAF.

3.3.2 e. (1) Determine the visibility required without approach lights.

3.3.2 e. (1) (a) Follow Step 1, except use the visibility from the NALS column.

Figure 3-4. Example U.S. TPP Inoperative Components or Visual Aids Table

INOPERATIVE COMPONENTS OR VISUAL AIDS TABLE

Landing minimums published on instrument approach procedure charts are based upon full operation of all components and visual aids associated with the particular instrument approach chart being used. Higher minimums are required with inoperative components or visual aids as indicated below. If more than one component is inoperative, each minimum is raised to the highest minimum required by any single component that is inoperative. ILS glide slope inoperative minimums are published on the instrument approach charts as localizer minimums. This table may be amended by notes on the approach chart. Such notes apply only to the particular approach category(ies) as stated. See legend page for description of components indicated below.

(1) ILS, MLS, PAR and RNAV (LPV line of minima)

Inoperative Component or Aid	Approach Category	Increase Visibility
ALSF 1 & 2, MALSR, & SSALR	ABCD	¼ mile

(2) ILS with visibility minimum of 1,800 RVR

ALSF 1 & 2, MALSR, & SSALR	ABCD	To 4000 RVR
TDZL RCLS	ABCD	To 2400 RVR*
RVR	ABCD	To ½ mile

*1800 RVR authorized with the use of FD or AP or HUD to DA.

(3) VOR, VOR/DME, TACAN, LOC, LOC/DME, LDA, LDA/DME, SDF, SDF/DME, GPS, ASR and RNAV (LNAV/VNAV and LNAV line of minima)

Inoperative Visual Aid	Approach Category	Increase Visibility
ALSF 1 & 2, MALSR, & SSALR	ABCD	½ mile
SSALS,MALS, & ODALS	ABC	¼ mile

(4) NDB

ALSF 1 & 2, MALSR, & SSALR	C	½ mile
	ABD	¼ mile
MALS, SSALS, ODALS	ABC	¼ mile

NOT FOR USE

3.3.2 e. (1) (b) Follow Step 2, except do not subtract the ALS length.

3.3.2 e. (2) Add the visibility increase from the INOP Components table to the SI visibility determined in Step 4. When the result is not equal to or greater than the visibility without approach lights [paragraph 3.3.2e (1)], annotate the chart in accordance with Order 8260.19, paragraph 8-54m.

3.3.3 Establishing Circling Visibility Minimums. Establish as a statute mile (SM) value. Meter (M) values are for locations outside the United States only.

3.3.3 a. Step 1. Determine the minimum HAA based on CAT from table 3-9, and then find the visibility appropriate to the HAA and CAT from table 3-10.

Table 3-9. Minimum Authorized HAA

CAT	A	B	C	D	E
HAA	350	450		550	

Table 3-10. Authorized Circling Visibility Minimums

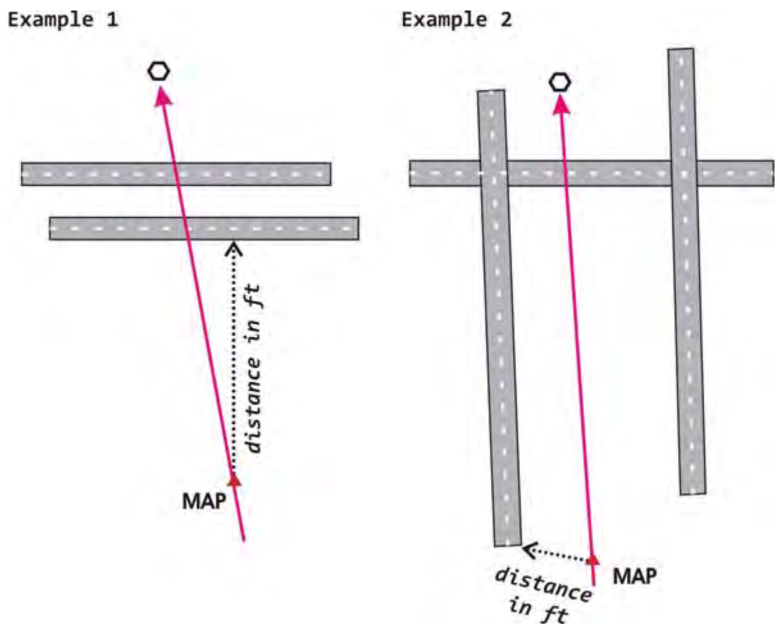
CAT →	A		B		C		D		E	
HAA ↓	SM	M	SM	M	SM	M	SM	M	SM	M
350 - 449	1	1600								
450 - 549	1	1600	1	1600	1 1/2	2400				
550 - 600	1	1600	1	1600	1 1/2	2400	2	3200	2	3200
601 - 670	1	1600	1	1600	1 3/4	2800	2	3200	2 1/4	3600
671 - 740	1	1600	1	1600	2	3200	2 1/4	3600	2 1/2	4000
741 - 810	1	1600	1	1600	2 1/4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

3.3.3 b. Step 2. Determine visibility based on MAP to nearest landing surface distance [see figure 3-5] (not applicable to circling minimums published in conjunction with SI procedure).

3.3.3 b. (1) For procedures meeting straight-in alignment requirements not authorized straight-in minimums, apply paragraph 3.3.2b.

3.3.3 b. (2) For "Circling-only" procedures not meeting straight-in alignment requirements, when the MAP is located at or after the nearest landing surface, proceed to Step 3. Otherwise, determine the distance from the MAP (plotted position) to the nearest landing surface. 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 table value (next higher whole SM when the distance exceeds 3 SM).

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



3.3.3 **c. Step 3.** Determine visibility based on evaluation of the visual portion of the final approach segment [see paragraph 3.3.2c].

3.3.3 **d. Step 4.** For circling minimums published in conjunction with SI procedure, compare circling visibility to the established SI visibility.

3.3.3 d. (1) The circling visibility may not be lower than the no-light visibility of the SI visibility of the highest NPA line.

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

3.3.3 **e. Step 5.** Establish circling visibility as the highest value determined from Steps 1-4 (as applicable)**.**

3.3.3 e. (1) Visibility greater than 3 SM. Where the HAA is 1000 ft or higher, 3 SM visibility may be established with Flight Standards approval when the procedure is annotated "Fly Visual to Airport."

Note 1: "Fly Visual to Airport" provides relief from visual reference requirements specified in Part 91.175, and related rules such as 121.651, 135.225, and 125.381. This option will only be approved where deemed safe and operationally beneficial.

Chapter 3. Takeoff and Landing Minimums
Section 4. Alternate Minimums

3.4. Civil Alternate Minimums [see 14 CFR Part 91.169] (Military – Refer to applicable Service Directives).

3.4.1 Authorization. To qualify the airport must have local weather disseminated via a "Service A" reporting network. Do not authorize alternate minimums when the facility providing final approach guidance is a CAT 3 monitored facility [see Order 8260.19, paragraph 2-13].

3.4.2 Establishing Alternate Minimums. If a procedure has a stepdown fix predicated on a CAT 3 monitored facility, base alternate minimums on the minimums without the fix.

3.4.2 a. Determine the need to establish alternate minimums by comparing the ceiling and/or visibility associated with the no-light minimums (local altimeter) for each approach category with the standard ceiling and visibility.

3.4.2 a. (1) When both the ceiling and visibility of the applicable no-light minimums are less than or equal to the standard specified in table 3-11, alternate minimums are not published.

3.4.2 a. (2) When either the ceiling or visibility from the applicable no-light minimums is greater than the standard, establish alternate minimums as the higher of the standard or the no-light value.

Note: Ceiling values are based on the DA/MDA minus airport elevation, rounded to the next higher 100-ft increment (e.g., 601 through 699 round to 700).

3.4.2 b. When required, alternate minimums are based on the NPA line with the highest ceiling or visibility on the same chart. For procedures without an NPA line, alternate minimums are based on the PA/APV line with the highest ceiling or visibility on the same chart.

3.4.2 c. Specify PA and NPA alternate minimums separately when both lines are published on the same chart.

Table 3-11. Standard Alternate Minimums

Approach Type	Ceiling	Visibility
NPA or APV	800	2
PA	600	2

Example (NPA or APV)	
Highest no-light Ceiling/Visibility	**Alternate Minimums**
CAT A/B = 700 – 1	Not Published (Both Ceiling/Vis ≤ Standard)
CAT C = 800 – 2 1/4	800 – 2 1/4
CAT D = 900 – 2 1/2	900 – 2 1/2

Chapter 3. Takeoff and Landing Minimums.
Section Five. Takeoff Minimums.

3.5 Civil Standard Takeoff Minimums.

Title 14 CFR Part 91.175 (f) defines civil takeoff minimums as shown in table 3-12. A ceiling value may also be required to see and avoid an obstacle. In this case, the published procedure must identify the location of the obstacle(s) that must be avoided. See Order 8260.46, Departure Procedure (DP) Program, or appropriate Military directives for guidance on how and when other than standard takeoff minimums and/or obstacles are defined.

Table 3-12. Standard Civil Takeoff Minimums

Aircraft type	Visibility (SM)
Fixed wing w/ ≤ 2 engines	1
Fixed wing w/ > 2 engines	1/2
Helicopters 1/2	

Chapter 3. Takeoff and Landing Minimums.
Section Four. Alternate Minimums.

3.4. Establishing Alternate Minimums (Other than Standard). Establish alternate minimums (other than standard) for **each** applicable aircraft category whenever the ceiling and/or visibility of the *highest no-light minimums (category specific) exceed the standard specified in *table 3-12*.

*Note: * Highest set when more than one set (e.g. dual minimums) published (remote altimeter not applicable).*

ILS and LOC alternate minimums are specified separately. Alternate minimums for RNAV procedures are based on the no-light minimums of the highest NPA line when published. Otherwise base RNAV alternate minimums on no-light minimums of the highest APV line.

Published alternate minimums may be no lower than the applicable circling ceiling and/or visibility. *See Order 8260.19 and appropriate DoD directives for additional guidance.*

When only the ceiling or visibility of the highest minimums exceeds the *table 3-12* standard, use the higher values. *See table 3-12 example*.

Table 3-12. *Standard Alternate Minimums.*		
Approach Type	**Ceiling**	**Visibility**
NPA or APV	**800**	**2**
PA 600		**2**
Example (PA)		
Highest Ceiling/Visibility	**Alternate Minimums**	
CAT A/B = 700 – 1 1/4	**Not Published (Ceiling/Vis < Standard)**	
CAT C = 700 – 2 1/4	**800 – 2 1/4**	
CAT D = 900 – 2 1/2	**900 – 2 1/2**	

Chapter 3. Takeoff and Landing Minimums.
Section Five. Takeoff Minimums.

3.5 Standard Takeoff Minimums.

Title 14 CFR Part 91.175 (f) civil takeoff minimums relate to the number of engines on the aircraft as shown in *table 3-13*. However, a ceiling value may also be required to see and avoid an obstacle. In this case, the published procedure must identify the location of the obstacle(s) that must be avoided. See Order 8260.46, *Departure Procedure (DP) Program*, or appropriate DoD directives for guidance on how and when other than standard takeoff minimums and/or obstacles are defined. Takeoff minimums for DoD operations must be as stated in the appropriate service directives.

Table 3-13. *Standard Civil Takeoff Minimums.*

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

CHAPTER 4. ON-AIRPORT VOR (NO FAF)

400 GENERAL. This chapter is divided into two sections; one for low altitude procedures and one for high altitude teardrop penetration procedures. These criteria apply to procedures based on a VOR facility located on an airport in which no final approach fix (FAF) is established. These procedures must incorporate a procedure or a penetration turn. An ON-AIRPORT facility is one which is located:

a. For Straight-In Approach. Within one mile of the nearest portion of the landing runway.

b. For Circling Approach. Within one mile of the nearest portion of the usable landing surface of the airport.

401.-409. RESERVED.

SECTION 1. LOW ALTITUDE PROCEDURES

410. FEEDER ROUTES. Criteria for feeder routes are contained in paragraph 220.

411. INITIAL APPROACH SEGMENT. The initial approach fix is received by overheading the navigation facility. The initial approach is a procedure turn (PT). The criteria for the PT areas are contained in paragraph 234.

412. INTERMEDIATE SEGMENT. This type of procedure has no intermediate segment. Upon completion of the PT, the aircraft is on final approach.

413. FINAL APPROACH SEGMENT. The final approach begins where the PT intersects the FAC.

a. Alignment. The alignment of the FAC with the runway centerline determines whether a straight-in or circling-only approach may be established.

(1) Straight-In. The angle of convergence of the FAC and the extended runway centerline shall not exceed 30°. The FAC should be aligned to intersect the extended runway centerline 3,000 feet outward from the runway threshold. When an operational advantage can be achieved, this point of intersection may be established at any point between the runway threshold and a point 5,200 feet outward from the runway threshold. Also, where an operational advantage can be achieved, a FAC which does not intersect the runway centerline or intersects it at a distance greater than 5,200 feet from the threshold may be established, provided that such course lies within 500 feet, laterally, of the extended runway centerline at a point 3,000 feet outward from the runway threshold. Straight-in category C, D, and E minimums are not authorized when the final approach course intersects the extended runway centerline at a an angle greater than 15° and a distance less than 3,000 feet (see figure 38).

(2) Circling Approach. When the final approach course alignment does not meet the criteria for straight-in landing, only a circling approach shall be authorized, and the course alignment should be made to the center of the landing area. When an operational advantage can be achieved, the final approach course may be aligned to pass through any portion of the usable landing surface (see figure 39).

b. Area. Figure 40 illustrates the final approach primary and secondary areas. The primary area is longitudinally centered on the final approach course, and is 10 miles long. The primary area is 2 miles wide at the facility and expands uniformly to 6 miles at 10 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 1.34 miles on each side of the primary area at 10 miles from the facility. When the 5-miles PT is used, only the inner 5 miles of the final approach area need be considered.

c. Obstacle Clearance.

(1) Straight-In. The minimum obstacle clearance in the primary area is 300 feet. In the secondary area, 300 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge. The minimum required obstacle clearance at any given point in the secondary area is found in paragraph 523b(3).

(2) Circling Approach. In addition to the minimum requirements specified in paragraph 413c(1), obstacle clearance in the circling area shall be as prescribed in chapter 2, section 6.

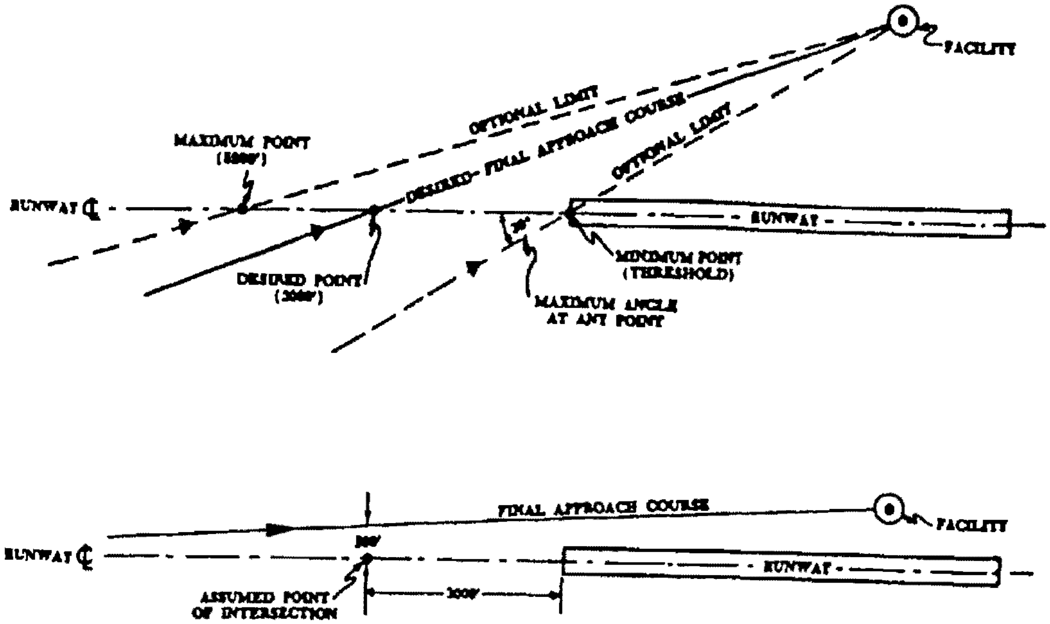


Figure 38. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. On-Airport VOR, No FAF. Straight-In Approach Procedure. Par. 413a(1).

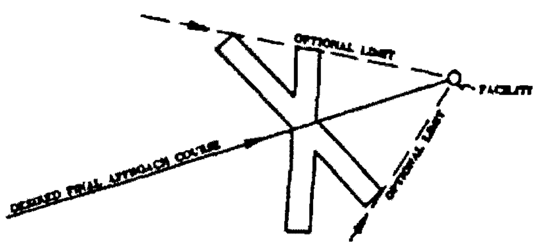


Figure 39. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. On-Airport VOR. No FAF. Circling Approach Procedure. Par 413a(2).

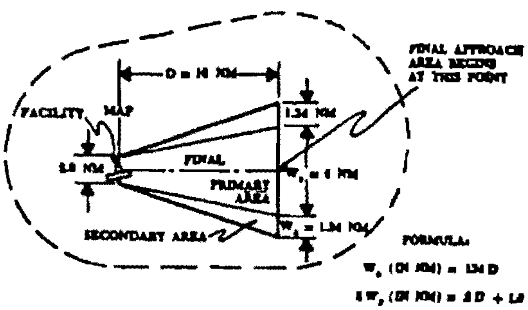


Figure 40. FINAL APPROACH PRIMARY AND SECONDARY AREAS. On-Airport VOR. No FAF. Par 413b.

d. PT Altitude (Descent Gradient). The PT completion altitude shall be within 1,500 feet of the MDA (1000 feet with a 5-mile PT), provided the distance from the facility to the point where the final approach course intersects the runway centerline (or the first usable portion of the landing area for "circling only" procedures) does not exceed 2 miles. When this distance exceeds 2 miles, the maximum difference between the PT completion altitude and the MDA shall be reduced at the rate of 25 feet for each one-tenth of a mile in excess of 2 miles (see figure 41).

NOTE: For those procedures in which the final approach does NOT intersect the extended runway centerline within 5200 feet of the runway threshold (see paragraph 413a(1)) the assumed point of intersection for computing the distance from the facility shall be 3000 feet from the runway threshold. See figure 38.

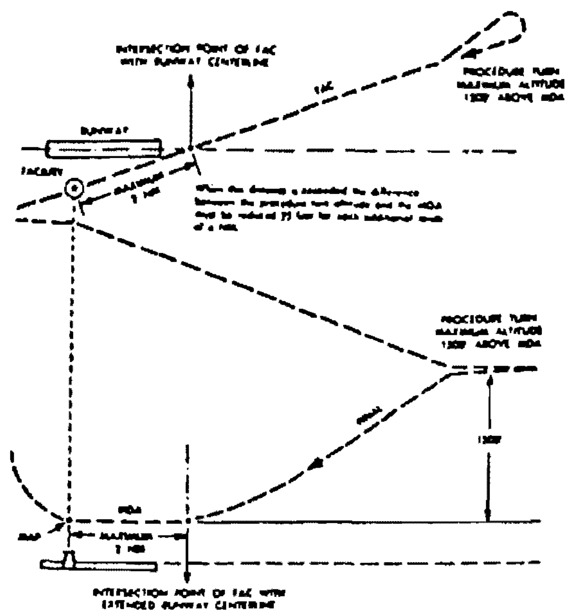


Figure 41. PT ALTITUDE.
On-Airport VOR, No FAF. Par 413d.

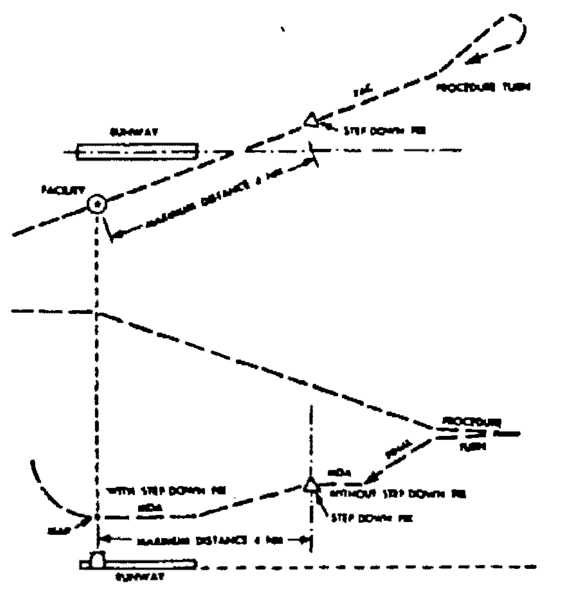


Figure 42. USE OF STEPDOWN FIX. On-Airport VOR. No FAF. Par 413e.

e. **Use of a Stepdown Fix.** Use of a stepdown fix (paragraph 288c) is permitted provided the distance from the facility to the stepdown fix does not exceed 4 miles. The descent gradient between PT completion altitude and stepdown fix altitude shall not exceed 150 ft/NM. The descent gradient will be computed based upon the difference in PT completion altitude minus stepdown fix altitude, divided by the specified PT distance, minus the facility to stepdown fix distance. Obstacle clearance may be reduced to 250 feet from the stepdown fix to the MAP/FEP. See figure 42, paragraphs 251, 252, and 253.

f. **MDA.** Criteria for determining the MDA are contained in chapter 3.

414. MISSED APPROACH SEGMENT. Criteria for the missed approach segment are contained in chapter 2, section 7. The MAP is the facility (see figure 42). The missed approach surface shall commence over the facility at the required height. (see paragraph 274).

415.-419. RESERVED.

SECTION 2. HIGH ALTITUDE TEARDROP PENETRATIONS

420. FEEDER ROUTES. Criteria for feeder routes are contained in paragraph 220.

421. INITIAL APPROACH SEGMENT (IAF). The IAF is received by overheading the navigation facility. The initial approach is a teardrop penetration turn. The criteria for the penetration turn are contained in paragraph 235.

422. INTERMEDIATE SEGMENT. This procedure has no intermediate segment. Upon completion of the penetration turn, the aircraft is on final approach.

423. FINAL APPROACH SEGMENT. An aircraft is considered to be on final approach upon completion of the penetration turn. However, the final approach segment begins on the FAC 10 miles from the facility. That portion of the penetration procedure prior to the 10-mile point is treated as the initial approach segment. See figure 43.

a. **Alignment.** Same as low altitude (paragraph 413a).

b. **Area.** Figure 43 illustrates the final approach primary and secondary areas. The primary area is longitudinally centered on the FAC and is 10 miles long. The primary area is 2 miles wide at the facility and expands uniformly to 8 miles at a point 10 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 2 miles each side of the primary area at a point 10 miles from the facility.

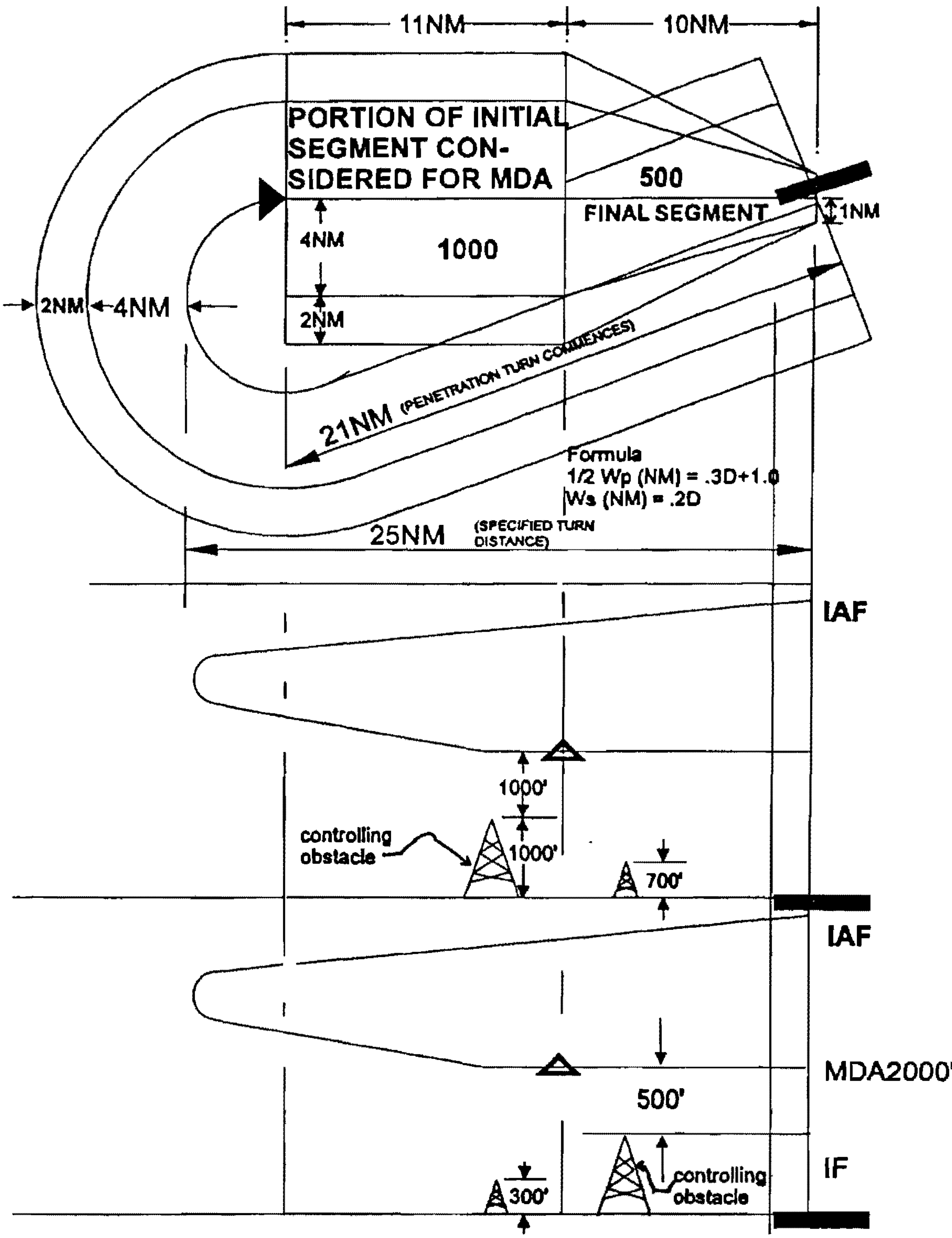


Figure 43. PENETRATION TURN. On-Airport VOR. No FAF. Par 423.

c. Obstacle Clearance.

(1) Straight-In. The minimum obstacle clearance in the primary area is 500 feet. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge. The minimum ROC at any given point in the secondary area is found in paragraph 232c.

(2) Circling Approach. In addition to the minimum requirements specified in paragraph 423c(1), obstacle clearance in the circling area shall be as prescribed in chapter 2, section 6.

d. Penetration Turn Altitude *(Descent Gradient)*. The penetration turn completion altitude shall be at least 1,000 feet, but not more than 4,000 feet above the MDA on final approach.

e. Use of Stepdown Fix. The use of the stepdown fix is permitted provided the distance from the facility to the stepdown fix does not exceed 10 miles (see paragraph 288c).

f. MDA. In addition to the normal obstacle clearance requirement of the final approach segment (see paragraph 423c), the MDA specified shall provide at least 1,000 feet of clearance over obstacles in the portion of the initial approach segment between the final approach segment and the point where the assumed penetration turn track intercepts the inbound course (see figure 43).

424. MISSED APPROACH SEGMENT. Criteria for the missed approach segment are contained in chapter 2, section 7. The MAP is the facility (see figure 43). The missed approach surface shall commence over the facility at the required height (see paragraph 274).

425.-499. RESERVED.

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CHAPTER 5. TACAN, VOR/DME, AND VOR WITH FAF

500. GENERAL. This chapter applies to approach procedures based on the elements of the VORTAC facility;i.e., VOR, VOR/DME, and TACAN, in which a final approach fix (FAF) is established. The chapter is divided into two sections; Section 1 for VOR procedures which do not use DME as the primary method for establishing fixes, and Section 2 for VOR/DME and TACAN procedures which use collocated, frequency paired DME as the sole method of establishing fixes. When both the VOR and TACAN azimuth elements of a VORTAC station will support it, a single procedure, identified as a VOR/DME or TACAN shall be published. Such a procedure may be flown using either a VOR/DME or TACAN airborne receiver and shall satisfy TACAN terminal area fix requirements. See Paragraph 286.d.

501.–509. RESERVED.

Section 1. VOR with FAF

510. FEEDER ROUTES. Criteria for feeder routes are contained in Paragraph 220.

511. INITIAL APPROACH SEGMENT. Criteria for the initial approach segment are contained in Chapter 2, Section 3. See Figures 44 and 45.

512. INTERMEDIATE APPROACH SEGMENT. Criteria for the Intermediate approach segment are contained in Chapter 2, Section 4. See Figures 44 and 45.

513. FINAL APPROACH SEGMENT. The final approach may be made either "FROM" or "TOWARD" the facility. The final approach segment begins at the final approach fix and ends at the runway or missed approach point, whichever is encountered last.

a. Alignment. The alignment of the final approach course with the runway centerline determines whether a straight-in or circling-only approach may be established. The alignment criteria differs depending on whether the facility is OFF or ON the airport. See definitions in Paragraph 400.

(1) Off-Airport Facility.

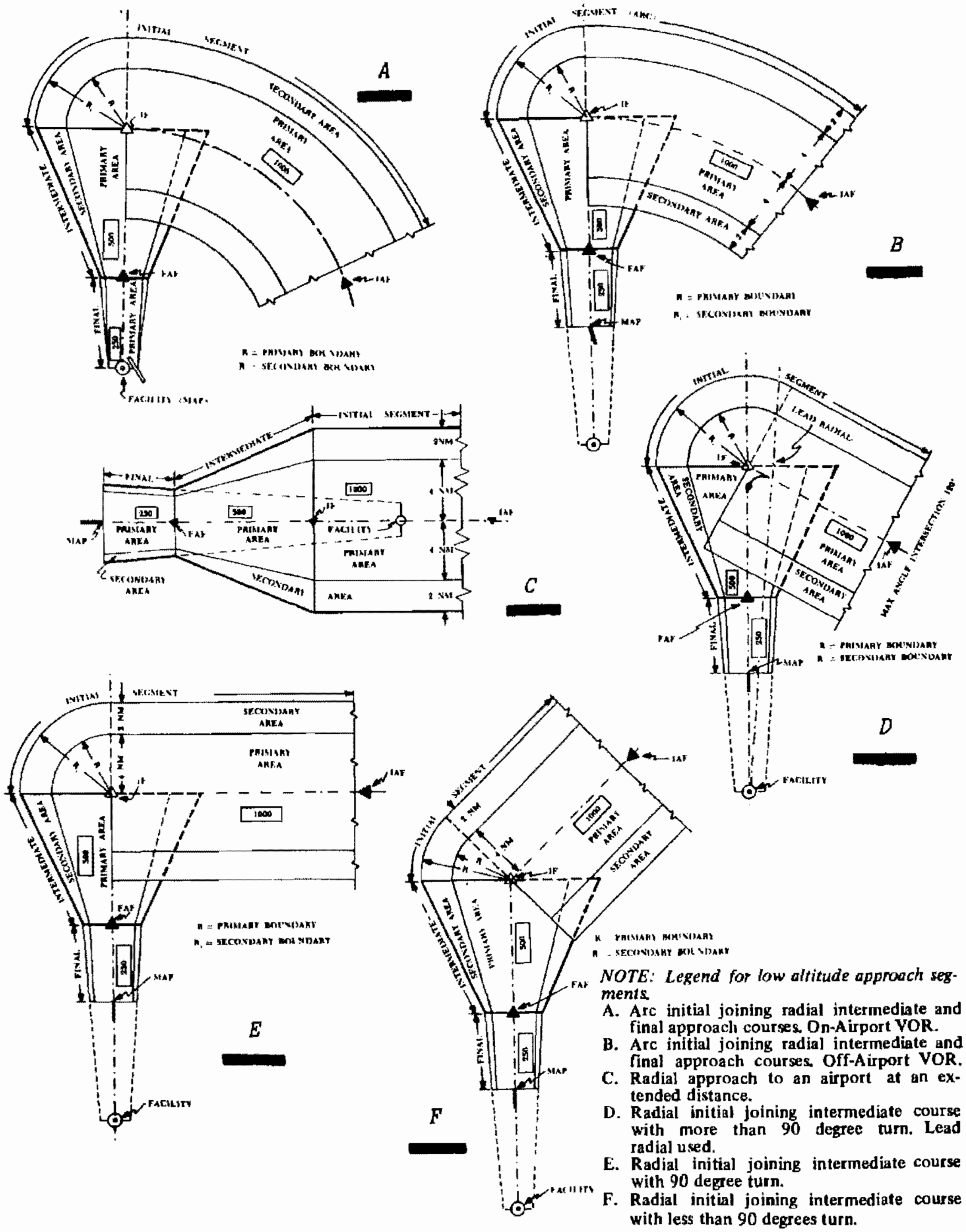
(a) Straight-In. The angle of convergence of the final approach course and the extended runway centerline shall not exceed 30 degrees. The final approach course should be aligned to intersect the runway centerline at the runway threshold. However, when an operational advantage can be achieved, the point of intersection may be established as much as 3000 feet outward from the runway threshold. See Figure 46.

(b) Circling Approach. When the final approach course alignment does not meet the criteria for a straight-in landing, only a circling approach shall be authorized, and the course alignment should be made to the center of the landing area. When an operational advantage can be achieved, the final approach course may be aligned to any portion of the usable landing surface. See Figure 47.

(2) On-Airport Facility.

(a) Straight-In. The angle of convergence of the final approach course and the extended runway centerline shall not exceed 30 degrees. The final approach course should be aligned to intersect the extended runway centerline 3000 feet outward from the runway threshold. When an operational advantage can be achieved, this point of intersection may be established at any point between the threshold and a point 5200 feet outward from the threshold. Also, where an operational advantage can be achieved a final approach course which does not intersect the runway centerline, or which intersects it at a distance greater than 5200 feet from the threshold, may be established, provided that such a course lies within 500 feet laterally of the extended runway centerline at a point 3000 feet outward from the runway threshold. See Figure 48.

(b) Circling Approach. When the final approach course alignment does not meet the crite-



NOTE: Legend for low altitude approach segments.

A. Arc initial joining radial intermediate and final approach courses. On-Airport VOR.
B. Arc initial joining radial intermediate and final approach courses. Off-Airport VOR.
C. Radial approach to an airport at an extended distance.
D. Radial initial joining intermediate course with more than 90 degree turn. Lead radial used.
E. Radial initial joining intermediate course with 90 degree turn.
F. Radial initial joining intermediate course with less than 90 degrees turn.

Figure 44. TYPICAL LOW ALTITUDE APPROACH SEGMENTS. VOR with FAF. Par 511 and 512.

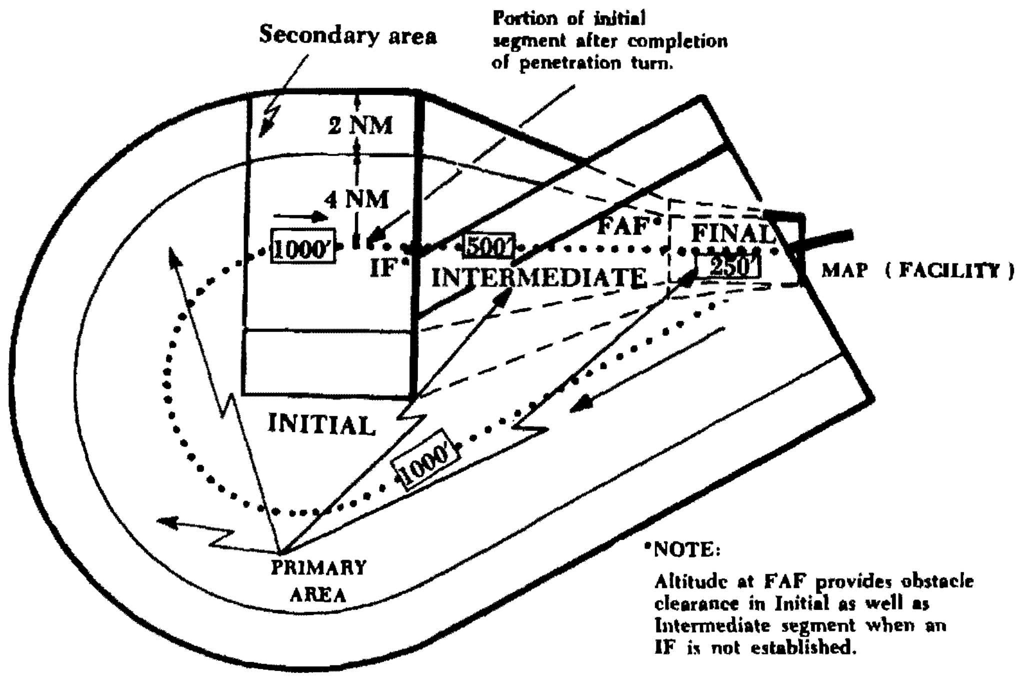


Figure 45. TYPICAL HIGH ALTITUDE SEGMENTS. VOR with FAF. Par 511 and 512.

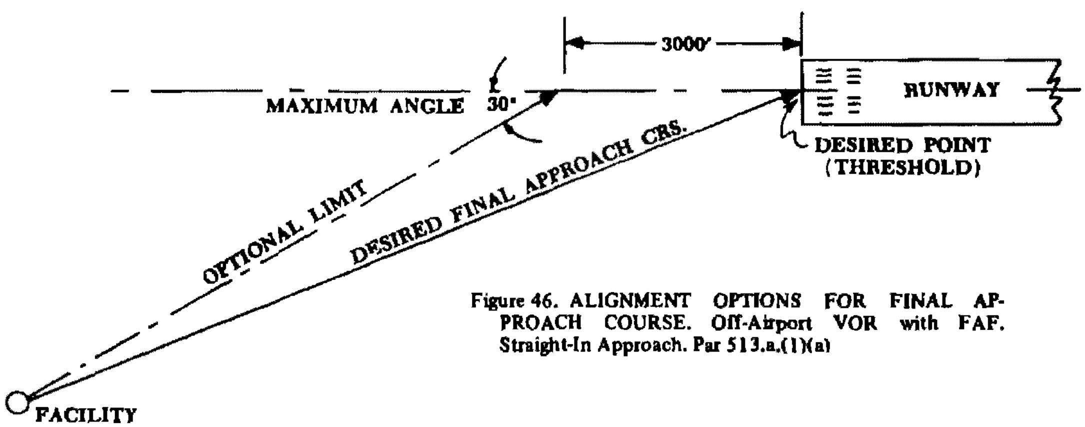
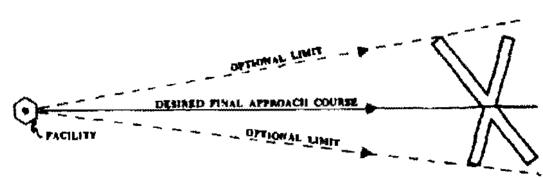


Figure 46. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. Off-Airport VOR with FAF. Straight-In Approach. Par 513.a.(1)(a)

Figure 47. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. Off-Airport VOR with FAF. Circling Approach. Par. 513.a.(1)(b).



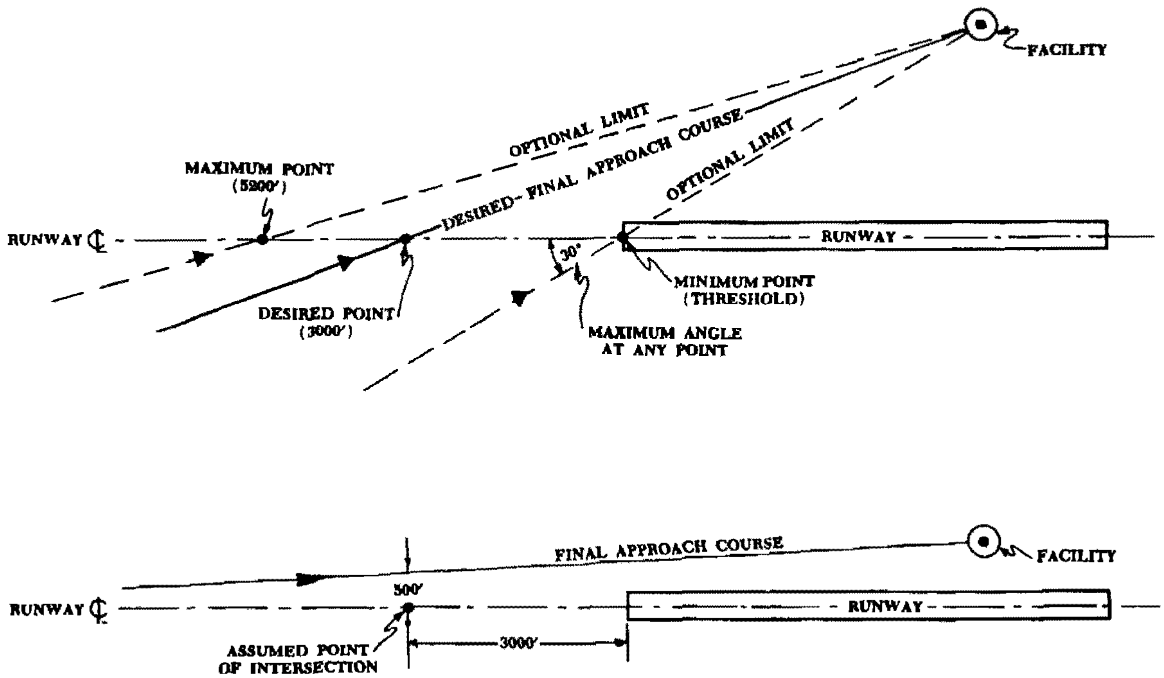


Figure 48. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. On-Airport VOR with FAF. Straight-In Approach. Par 513.a.(2)(a)

ria for a straight-in landing, only a circling approach shall be authorized, and the course alignment should be made to the center of the landing area. When an operational advantage can be achieved, the final approach course may be aligned to any portion of the usable landing surface. See Figure 49.

b. Area. The area considered for obstacle clearance in the final approach segment starts at the final approach fix and ends at the runway or missed approach point, whichever is encountered last. It is a portion of a 30-mile long trapezoid (see Figure 50) which is made up of primary and secondary areas. The primary area is centered longitudinally on the final approach course. It is 2 miles wide at the facility, and expands uniformly to 5 miles wide at 30 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 1 mile on each side of the primary area at 30 miles from the facility. Final approaches may be made to airports which are a maximum of 30 miles from the facility. See Figure 51. The OPTIMUM length of the final approach segment is 5 miles. The MAXIMUM length is 10 miles. The MINIMUM length of the final approach

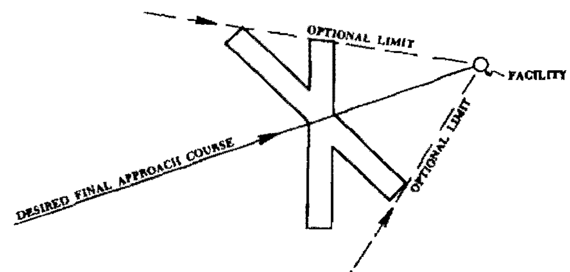


Figure 49. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. On-Airport VOR with FAF. Circling Approach. Par 513.a.(2)(b).

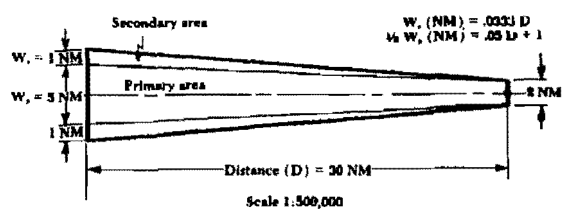


Figure 50. FINAL APPROACH TRAPEZOID. VOR with FAF. Par 513.b.

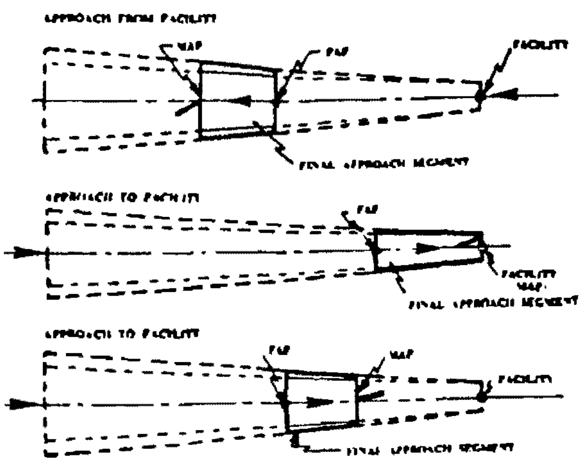


Figure 51. TYPICAL STRAIGHT-IN FINAL APPROACHES. VOR WITH FAF. Par 513b.

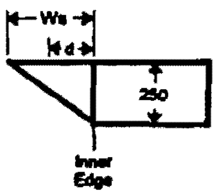
segment shall provide adequate distance for an aircraft to make the required descent, and to regain course alignment when a turn is required over the facility. Table 14 shall be used to determine the minimum length needed to regain the course.

c. **Obstacle Clearance.**

(1) **Straight-In Landing.** The minimum obstacle clearance in the primary area is 250 feet. In the secondary area, 250 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge. The minimum obstacle clearance at any given point in the secondary area is:

$$ROC = 250 \times \frac{Ws - d}{Ws}$$

Where Ws = Width of Secondary
d = distance from inner edge



(2) **Circling Approach.** In addition to the minimum requirements specified in paragraph 513c(1), obstacle clearance in the circling area shall be as prescribed in chapter 2, section 6.

d. **Descent Gradient. Paragraph 252 applies.**

Table 14. MINIMUM LENGTH OF FINAL APPROACH SEGMENT-VOR (MILES).

Approach Category	Magnitude of Turn over Facility (Degrees)		
	10	20	30
A	1.0	1.5	2.0
B	1.5	2.0	2.5
C	2.0	2.5	3.0
D	2.5	3.0	3.5
E	3.0	3.5	4.0

NOTE: This table may be interpolated. If the minimum lengths specified in the table are not available, straight-in minimums are not authorized. See figure 51 for typical final approach areas.

e. **Use of Fixes.** Criteria for the use of radio fixes are contained in chapter 2, section 8. Where a procedure is based on a PT and an on-airport facility is the PT fix, the distance from the facility to the FAF shall not exceed 4 miles.

f. **MDA.** Criteria for determining the MDA are contained in chapter 3, section 2.

514. MISSED APPROACH SEGMENT. Criteria for the missed approach segment are contained in chapter 2, section 7. For VOR procedures, the MAP and surface shall be established as follows:

a. **Off-Airport Facilities.**

(1) **Straight-In.** The MAP is a point on the FAC which is NOT farther from the FAF than the runway threshold (see figure 52). The missed approach surface shall commence over the MAP at the required height (see paragraph 274).

(2) **Circling Approach.** The MAP is a point on the FAC which is NOT farther from the FAF than the first usable portion of the landing area. The missed approach surface shall commence over the MAP at the required height (see paragraph 274).

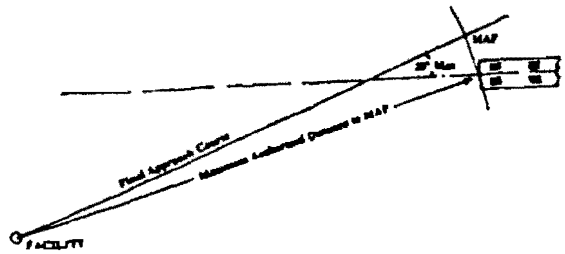


Figure 52. MAP.
Off-Airport VOR with FAF. Par 514a(1).

b. On-Airport Facilities. The MAP is a point on the FAC which is NOT farther from the FAF than the facility. The missed approach surface shall commence over the MAP at the required height (see paragraph 274).

515.-519. RESERVED.

SECTION 2. TACAN AND VOR/DME

520. FEEDER ROUTES. Criteria for feeder routes are contained in paragraph 220.

521. INITIAL SEGMENT. Due to the fixing capability of TACAN and VOR/DME a PT initial approach may not be required. Criteria for initial approach segments are contained in chapter 2, section 3.

522. INTERMEDIATE SEGMENT. Criteria for the intermediate segment are contained in chapter 2, section 4.

523. FINAL APPROACH SEGMENT. TACAN and VOR/DME final approaches may be based either on arcs or radials. The final approach begins at a FAF and ends at the MAP. The MAP is always marked with a fix.

a. Radial Final Approach. Criteria for the radial final approach are specified in paragraph 513.

b. Arc Final Approach. The final approach arc shall be a continuation of the intermediate arc. It shall be specified in NM and tenths thereof. Arcs closer than 7 miles (15 miles for high altitude procedures) and farther than 30 miles from the facility shall NOT be used for final approach. No turns are permitted over the FAF.

(1) **Alignment.** For straight-in approaches, the final approach arc shall pass through the runway threshold when the angle of convergence of the runway centerline and the tangent of the arc does not exceed 15°. When the angle exceeds 15°, the final approach arc shall be aligned to pass through the center of the airport and only circling minimums shall be authorized. See figure 53.

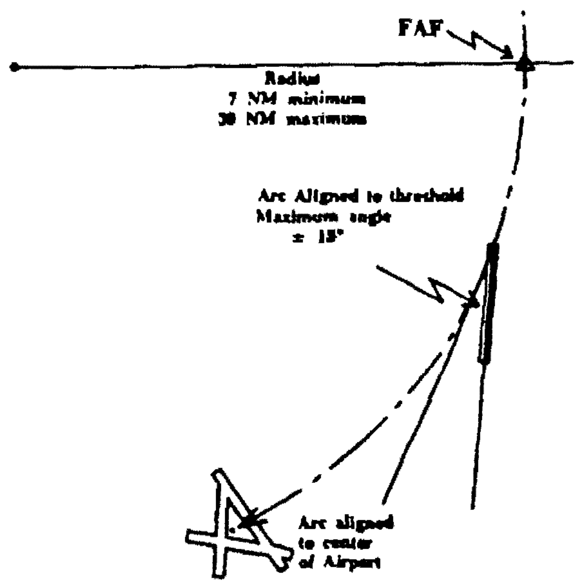


Figure 53. ARC FINAL APPROACH ALIGNMENT. Arc Aligned to Threshold. TACAN or VOR/DME. Par 523b(1).

(2) **Area.** The area considered for obstacle clearance in the arc final approach segment starts at the FAF and ends at the runway or MAP, whichever is encountered last. It should NOT be more than 5 miles long. It shall be divided into primary and secondary areas. The primary area is 8 miles wide, and extends 4 miles on either side of the arc. A secondary area is on each side of the primary area. The secondary areas are 2 miles wide on each side of the primary area (see figure 54).

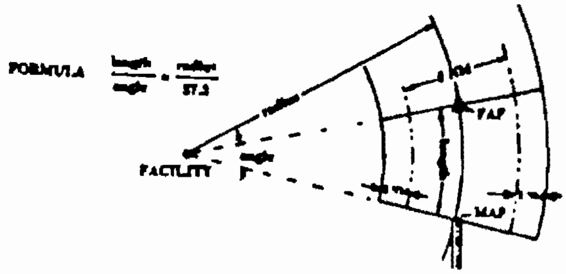


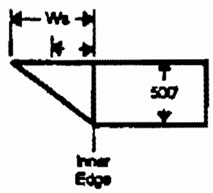
Figure 54. ARC FINAL APPROACH AREA. TACAN or VOR/DME. Par 523b(2)

(3) **Obstacle Clearance.** The minimum obstacle clearance in the primary area is 500 feet. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge.

$$Secondary\,ROC = 500 \times \frac{W_s - d}{W_s}$$

Where d = distance from inner edge

W_s = Width of secondary area



(4) **Descent Gradient.** Criteria for descent gradients are specified in paragraph 252.

(5) **Use of Fixes.** Fixes along an arc are restricted to those formed by radials from the VORTAC facility which provides the DME signal. Criteria for such fixes are contained in chapter 2, section 8.

(6) **MDA.** Straight-in MDA's shall not be specified lower than circling for arc procedures. Criteria for determining the circling MDA are contained in chapter 3, section 2.

524. MISSED APPROACH SEGMENT. Criteria for the missed approach segment are contained in chapter 2, section 7. The MAP shall be a radial/DME fix. The missed approach surface shall commence over the fix and at the required height. Also see paragraph 514.

NOTE: The arc missed approach course may be a continuation of the final approach arc.

525.-599. RESERVED.

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CHAPTER 6. NDB PROCEDURES ON-AIRPORT FACILITY, NO FAF

600. GENERAL. This chapter is divided into two sections: one for low altitude procedures and one for high altitude teardrop penetration procedures. These criteria apply to NDB procedures based on a facility located on the airport in which no FAF is established. These procedures must incorporate a PT or a penetration turn. An on-airport facility is one which is located:

a. For Straight-In Approach. Within 1 mile of any portion of the landing runway.

b. For Circling Approach. Within 1 mile of any portion of the usable landing surface on the airport.

601.-609. RESERVED.

SECTION 1. LOW ALTITUDE PROCEDURES

610. FEEDER ROUTES. Criteria for feeder routes are contained in paragraph 220.

611. INITIAL APPROACH SEGMENT. The IAF is received by overheading the navigation facility. The initial approach is a PT. Criteria for the PT areas are contained in paragraph 234.

612. INTERMEDIATE SEGMENT. This type of procedure has no intermediate segment. Upon completion of the PT, the aircraft is on final approach.

613. FINAL APPROACH SEGMENT. The final approach begins where the PT intersects the FAC.

a. Alignment. The alignment of the FAC with the runway centerline determines whether a straight-in or circling-only approach may be established.

(1) Straight-In. The angle of convergence of the FAC and the extended runway centerline shall not exceed 30°. The FAC should be aligned to intersect the extended runway centerline 3,000 feet outward from the runway threshold. When an operational advantage can be achieved, this point of intersection may be established at any point between the runway threshold and a point 5,200 feet outward from the runway threshold. Also, where an operational advantage can be achieved, a FAC which does not intersect the runway centerline or intersects it at a distance greater than 5,200 feet from the threshold may be established, provided that such course lies within 500 feet, laterally, of the extended runway centerline at a point 3,000 feet outward from the runway threshold. Straight-in category C, D, and E minimums are not authorized when the final approach course intersects the extended runway centerline at a an angle greater than 15° and a distance less than 3,000 feet (see figure 55).

(2) Circling Approach. When the FAC alignment does not meet the criteria for straight-in landing, only a circling approach shall be authorized, and the course alignment should be made to the center of the landing area. When an operational advantage can be achieved, the FAC may be aligned to pass through any portion of the usable landing surface (see figure 56).

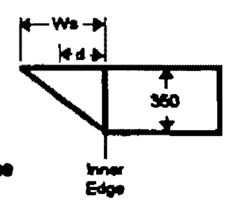
b. Area. Figure 57 illustrates the final approach primary and secondary areas. The primary area is longitudinally centered on the FAC and is 10 miles long. The primary area is 2.5 miles wide at the facility and expands uniformly to 6 miles wide at 10 miles from the facility. A secondary area is on each side of the primary area. It is zero miles wide at the facility, and expands uniformly to 1.34 miles on each side of the primary area at 10 miles from the facility. When the 5-mile PT is used, only the inner 5 miles of the final approach area need be considered.

c. Obstacle Clearance.

(1) Straight-In. The minimum obstacle clearance in the primary area is 350 feet. **Exception:** Military users may apply a minimum obstacle clearance in the primary area of 300 feet. In the secondary area, 350 feet (or 300 feet, as applicable) of clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge. To determine ROC in the secondary area, use the following formula:

$$ROC = 350 \times \frac{Ws - d}{Ws}$$

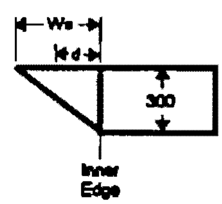
Where Ws = Width of Secondary
d = distance from inner edge



Exception: Military users utilize the following formula:

$$ROC = 300 \times \frac{Ws - d}{Ws}$$

Where Ws = Width of Secondary
d = distance from inner edge



(2) **Circling Approach.** In addition to the minimum requirements specified in paragraph 613c(1), obstacle clearance in the circling area shall be as prescribed in chapter 2, section 6.

d. PT Altitude (Descent Gradient). The PT completion altitude shall be within 1,500 feet of the MDA (1,000 feet with 5 mile PT), provided the distance from the facility to the point where the FAC intersects the runway centerline (or the first usable portion of the landing area for "circling only" procedures) does not exceed 2 miles. When this distance exceeds 2 miles, the maximum difference between the PT completion altitude and the MDA shall be reduced at the rate of 25 feet for each one-tenth of a mile in excess of 2 miles (see figure 58).

NOTE: For those procedures in which the FAC does not intersect the extended runway centerline within 5,200 feet of the runway threshold (paragraph 613a(1), the assumed point of intersection for computing distance from the facility shall be 3,000 feet from the runway threshold (see *figure 55).*

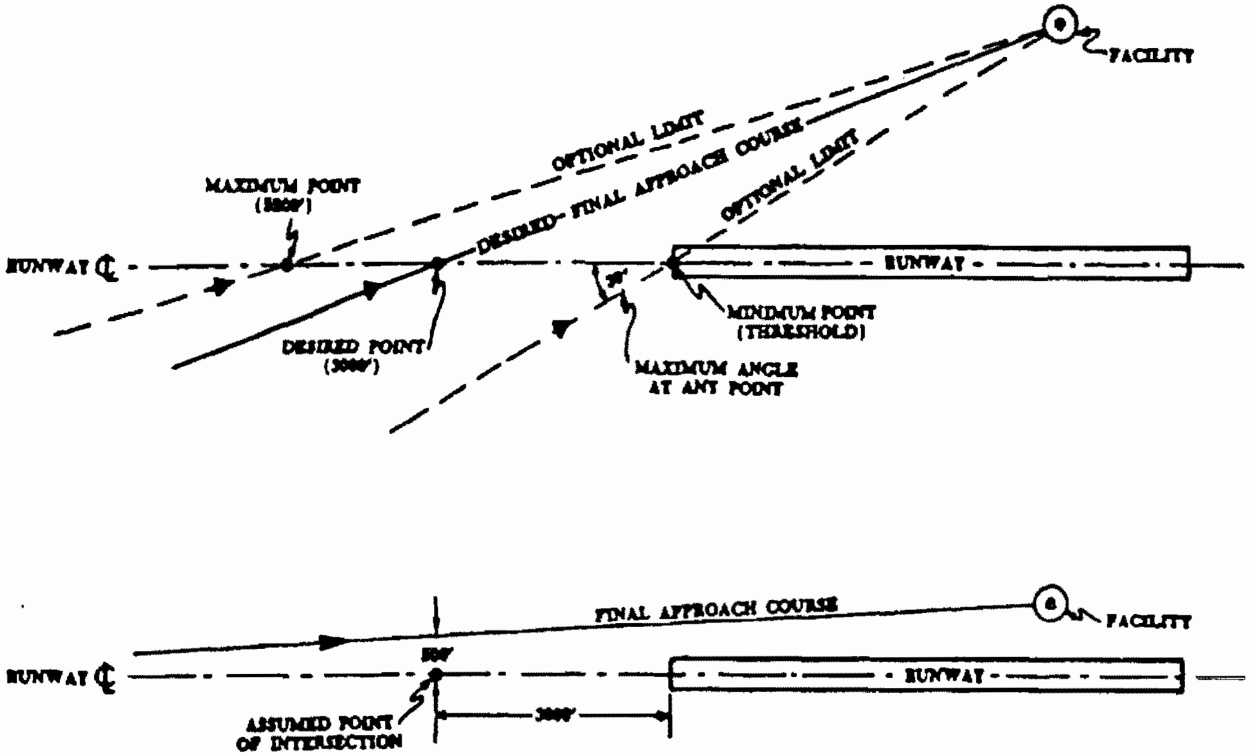


Figure 55. ALIGNMENT OPTIONS FOR FAC. On-Airport NDB. No FAF. Straight-In Procedure. Par 613a(1).

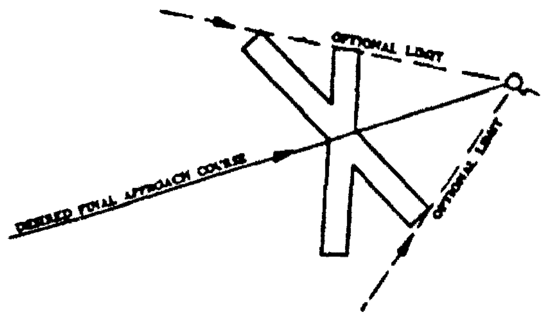


Figure 56. ALIGNMENT OPTIONS FAC. On-Airport NDB. No FAF. Circling Approach. Par 613a(2).

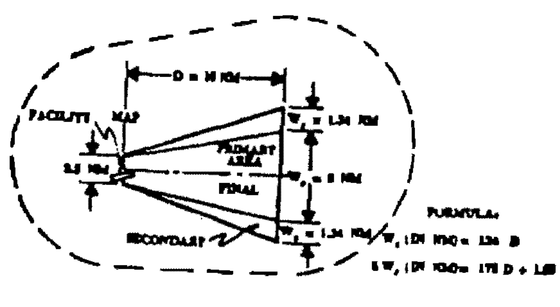


Figure 57. FINAL APPROACH PRIMARY AND SECONDARY AREAS. On-Airport NDB. No FAF. Par 613b.

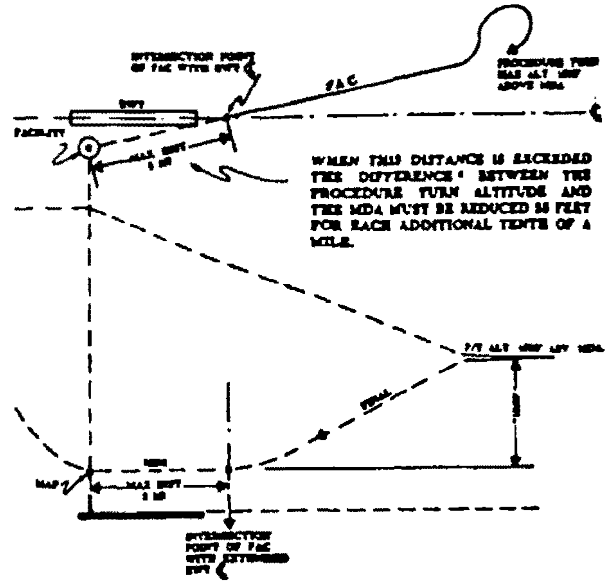


Figure 58. PT ALTITUDE. On-Airport NDB. No FAF. Par 613d.

e. Use of a Stepdown Fix. Use of a stepdown fix (paragraph 288c) is permitted provided the distance from the facility to the stepdown fix does not exceed 4 miles. The descent gradient between PT completion altitude and stepdown fix altitude shall not exceed 150 ft/NM. The descent gradient will be computed based upon the difference in PT completion altitude minus stepdown fix altitude, divided by the specified PT distance, minus the facility to stepdown fix distance. Obstacle clearance may be reduced to 300 feet (**Exception:** Military 250 feet) from the stepdown fix to the MAP/FEP. See figure 59, paragraphs 251, 252, and 253.

f. MDA. Criteria for determining the MDA are contained in chapter 3, section 2.

614. MISSED APPROACH SEGMENT. Criteria for the missed approach segment are contained in chapter 2, section 7. The MAP is the facility. See figure 59. The missed approach surface shall commence over the facility at the required height (see paragraph 274).

615.-619. RESERVED.

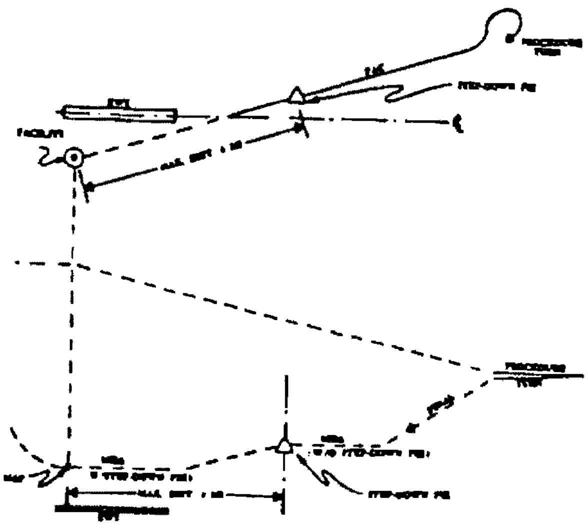


Figure 59. USE OF STEPDOWN FIX. On-Airport NDB. No FAF. Par 613e.

SECTION 2. HIGH ALTITUDE TEARDROP PENETRATIONS

620. FEEDER ROUTES. Criteria for feeder routes are contained in paragraph 220.

621. INITIAL APPROACH SEGMENT. The IAF is received by overheading the navigation facility. The initial approach is a teardrop penetration turn. The criteria for the penetration turn are contained in paragraph 235.

622. INTERMEDIATE SEGMENT. The procedure has no intermediate segment. Upon completion of the penetration turn, the aircraft is on final approach.

623. FINAL APPROACH SEGMENT. An aircraft is considered to be on final approach upon completion of the penetration turn. However, the final approach segment begins on the FAC 10 miles from the facility. That portion of the penetration procedure prior to the 10-mile point is treated as the initial approach segment (see figure 60).

a. Alignment. Same as low altitude criteria (see paragraph 613a).

b. Area. Figure 60 illustrates the final approach primary and secondary areas. The primary area is longitudinally centered on the FAC, and is 10 miles long. The primary area is 2.5 miles wide at the facility, and expands uniformly to 8 miles at 10 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 2 miles each side of the primary area at 10 miles from the facility.

c. Obstacle Clearance.

(1) Straight-In. The minimum obstacle clearance in the primary area is 500 feet. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge. The minimum ROC at any given point in the secondary area is found in paragraph 232c.

(2) Circling Approach. In addition to the minimum requirements specified in paragraph 623c(1), obstacle clearance in the circling area shall be as prescribed in chapter 2, section 6.

d. Penetration Turn Altitude (Descent Gradient). The penetration turn completion altitude shall be at least 1,000 feet, but not more than 4,000 feet above the MDA on final approach.

e. Use of a Stepdown Fix. Use of a stepdown fix (paragraph 288c) is permitted, provided the distance from the facility to the stepdown fix does not exceed 10 miles (see paragraph 251).

f. MDA. In addition to the normal obstacle clearance requirements of the final approach segment (see paragraph 623c), the MDA specified shall provide at least 1,000 feet of clearance over obstacles in that portion of the initial approach segment between the final approach segment and the point where the assumed penetration turn track intercepts the inbound course (see figure 60).

624. MISSED APPROACH SEGMENT. Criteria for the missed approach segment are contained in chapter 2, section 7. The MAP is the facility (see figure 60). The missed approach surface shall commence over the facility at the required height (see paragraph 274).

625.-699. RESERVED.

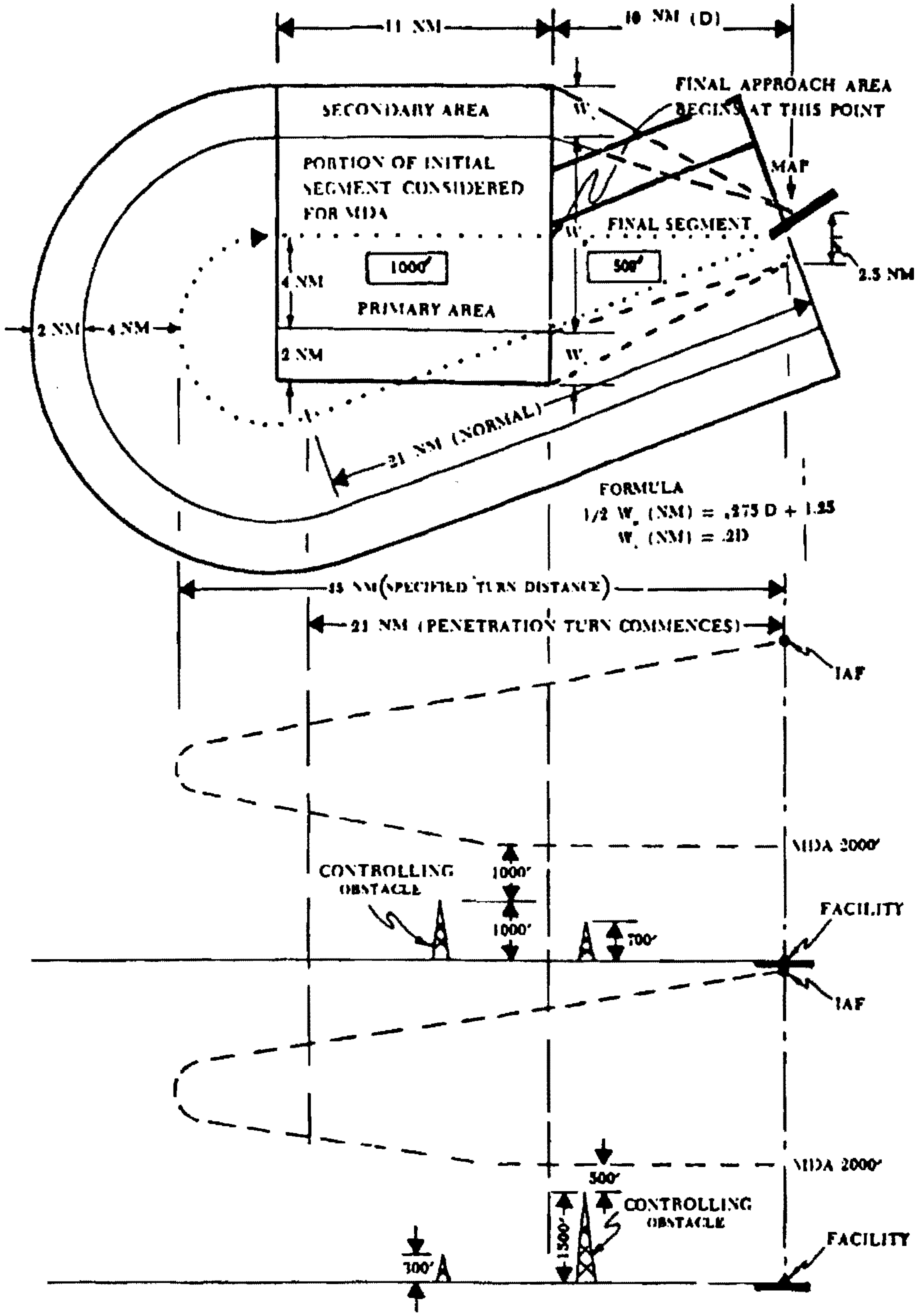


Figure 60. PENETRATION TURN. On-Airport NDB. No FAF. Par 623.

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* CHAPTER 7. NDB WITH FAF *

* **700. GENERAL.** This chapter prescribes criteria for NDB procedures which incorporate a final approach fix. NDB procedures shall be based only on facilities which transmit a continuous carrier. *

701.–709. RESERVED.

Section 1. NDB With FAF

710. FEEDER ROUTES. Criteria for feeder routes are contained in paragraph 220

711. INITIAL APPROACH SEGMENT. Criteria for the initial approach are contained in Chapter 2, Section 3.

712. INTERMEDIATE APPROACH SEGMENT. Criteria for the intermediate approach segment are contained in Chapter 2, Section 4.

713. FINAL APPROACH SEGMENT. The final approach may be made either FROM or TOWARD the facility. The final approach segment begins at the final approach fix and ends at the runway or missed approach point, whichever is encountered last.

* **NOTE:** *Criteria for the establishment of arc final approaches are specified in paragraph 523b.* *

a. Alignment. The alignment of the final approach course with the runway centerline determines whether a straight-in or circling-only approach may be established. The alignment criteria differs depending on whether the facility is OFF or ON the airport. See definition in paragraph 400.

(1) Off-Airport Facility.

(a) Straight-in. The angle of convergence of the final approach course and the extended runway centerline shall not exceed 30°. The final approach course should be aligned to intersect the runway centerline at the runway threshold. However, when an operational advantage can be achieved, the point of intersection may be established as much as 3,000 feet outward from the runway threshold. See Figure 61.

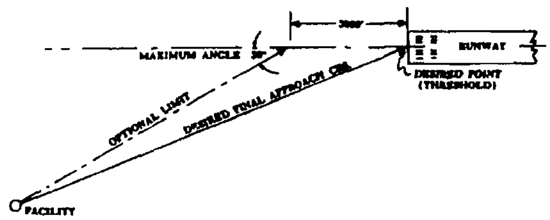


Figure 61. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. Off-Airport NDB with FAF. Straight-in Approach. Par 713.a.(1)(a).

(b) Circling Approach When the final approach course alignment does not meet the criteria for straight-in landing, only a circling approach shall be authorized, and the alignment should be made to the center of the landing area. When an operational advantage can be achieved, the final approach course may be aligned to any portion of the usable landing surface. See Figure 62.

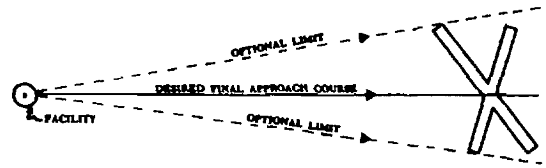


Figure 62. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. Off-Airport NDB with FAF. Circling Approach. Par 713.a.(1)(b).

(2) On-Airport Facility.

(a) Straight-in. The angle of convergence between the final approach course and the extended runway centerline shall not exceed 30 degrees. The final approach course should be aligned to intersect the extended runway centerline 3,000 feet outward from the runway threshold. When an operational advantage can be achieved, this point of intersection may be established at any point between the runway threshold and a point 5,200 feet outward from the runway threshold. Also, where an operational advantage can be achieved, a final approach course which does not intersect

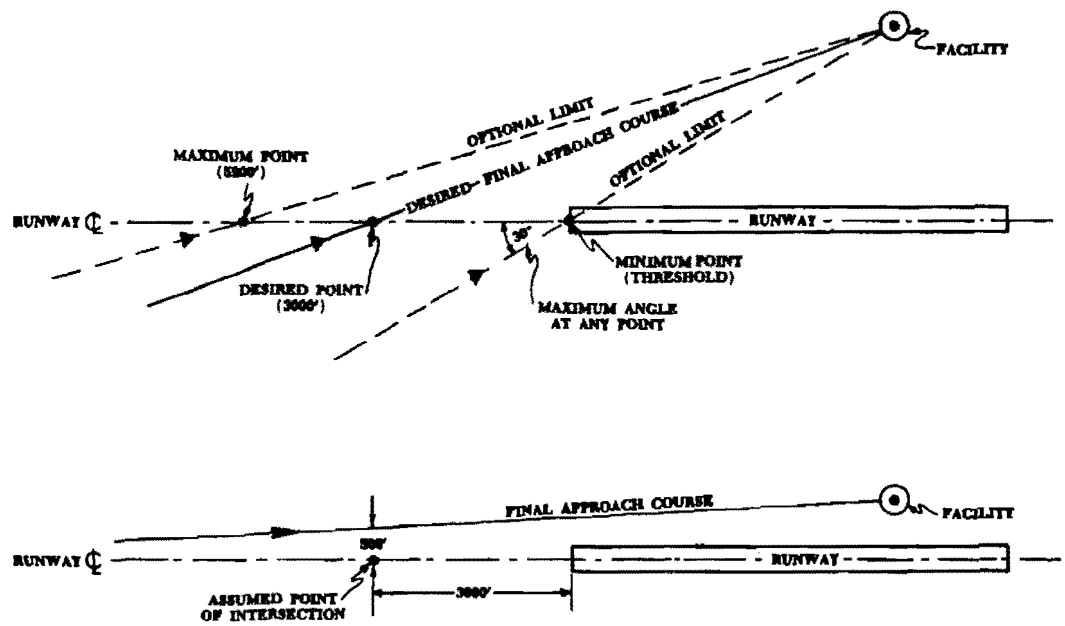


Figure 63. ALIGNMENT OPTIONS FOR FINAL APPROACH. On-airport NDB. Par 713.a.(2)(a).

the runway centerline, or which intersects it at a distance greater than 5,200 feet from the threshold, may be established provided such a course lies within 500 feet laterally of the extended runway centerline at a point 3,000 feet outward from the runway threshold. See Figure 63.

(b) *Circling Approach.* When the final approach course alignment does not meet the criteria for a straight-in landing, only a circling approach shall be authorized, and the course alignment should be made to the center of the landing area. When an operational advantage can be achieved, the final approach course may be aligned to any portion of the usable landing surface. See Figure 64.

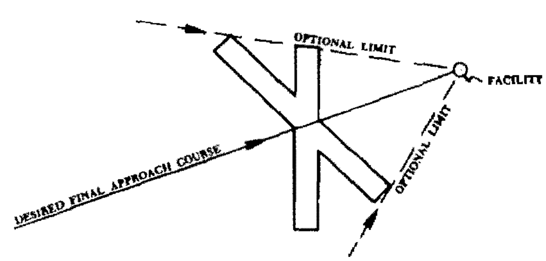


Figure 64. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. On-Airport NDB with FAF. Circling Approach. Par 713.a.(2)(b).

* b. *Area.* The area considered for obstacle clearance in the final approach segment starts at the final approach fix and ends at the runway or missed approach point, whichever is encountered last. It is a portion of a 15-mile long trapezoid (see Figure 65) which is made up of primary and secondary areas. The primary area is centered longitudinally on the final approach course. It is 2.5 miles wide at the facility and expands uniformly to 5 miles at 15 miles from the facility. A secondary area is on each side of the primary area. It is zero miles wide at the facility, and

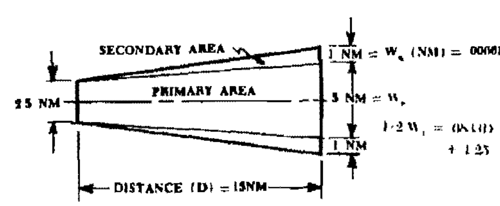


Figure 65. FINAL APPROACH TRAPEZOID. NDB with FAF. Par 713.b. *

expands uniformly to 1 mile each side of the primary area at 15 miles from the facility. Final approaches may be made to airports which are a maximum of 15 miles from the facility. The OPTIMUM length of the final approach segment is 5 miles. The MAXIMUM length is 10 miles. The MINIMUM length of the final approach segment shall provide adequate distance for an aircraft to make the required descent, and to regain course alignment when a turn is required over the facility. The following table shall be used to determine the minimum length needed to regain the course.

Table 15. MINIMUM LENGTH OF FINAL APPROACH SEGMENT - NDB (Miles)

Approach Category	Magnitude of Turn over Facility (Degrees)		
	10	20	30
A	1.0	1.5	2.0
B	1.5	2.0	2.5
C	2.0	2.5	3.0
D	2.5	3.0	3.5
E	3.0	3.5	4.0

NOTE: This table may be interpolated. If turns of more than 30° are required, or if the minimum lengths specified in the table are not available for the procedure, straight-in minimums are NOT authorized. See figure 66 for typical final approach areas.

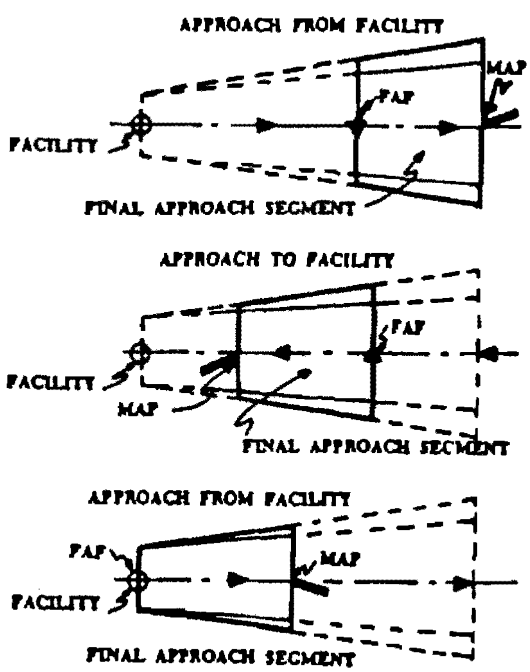


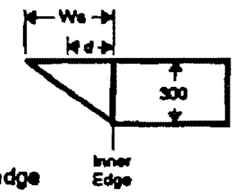
Figure 66. TYPICAL FINAL APPROACH AREAS. NDB with FAF. Par 713b.

c. Obstacle Clearance.

(1) Straight-In. The minimum obstacle clearance in the primary area is 300 feet. **Exception:** Military users may apply a minimum obstacle clearance in the primary area of 250 feet. In the secondary area, 300 feet (or 250 feet, as applicable) of obstacle clearance shall be provided at the inner edge, tapering uniformly to zero feet at the outer edge. The minimum ROC at any given point in the secondary area is:

$$ROC = 300 \times \frac{Ws - d}{Ws}$$

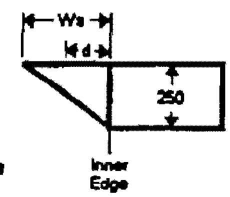
Where Ws = Width of Secondary
d = distance from inner edge



Exception: Military users utilize the formula to determine ROC in the secondary area. Annotate joint civilian/military SIAP's that civilian users add 50 feet to all minimums if 250 ROC is used.

$$ROC = 250 \times \frac{Ws - d}{Ws}$$

Where Ws = Width of Secondary
d = distance from inner edge



(2) Circling Approach. In addition to the minimum requirements specified in paragraph 713c(1), obstacle clearance in the circling area shall be as prescribed in chapter 2, section 6.

d. Descent Gradient. Paragraph 252 applies.

e. Use of Fixes: Criteria for the use of radio fixes are contained in chapter 2, section 8. Where a procedure is based on a PT and an on-airport facility is the PT fix, the distance from the facility to the FAF shall not exceed 4 miles.

f. MDA. Criteria for determining the MDA are contained in chapter 3, section 2.

714. MISSED APPROACH SEGMENT. Criteria for the missed approach segment are contained in chapter 2, section 7. The MAP and surface shall be established as follows:

a. Off-Airport Facilities.

(1) **Straight-In.** The MAP is a point on the FAC which is NOT FARTHER from the FAF than the runway threshold. The missed approach surface shall commence over the MAP at the required height (see paragraph 274 and figure 67).

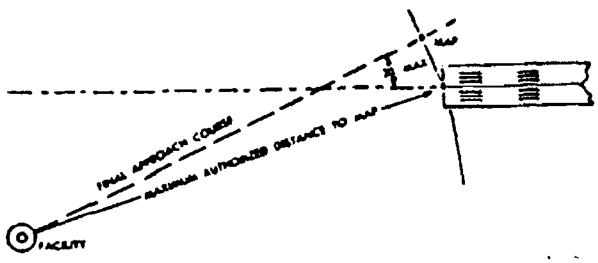


Figure 67. MAP.
Off-Airport NDB with FAF. Par 714a(1).

(2) **Circling Approach.** The MAP is a point on the FAC which is NOT FARTHER from the FAF than the first usable portion of the landing area. The missed approach surface shall commence over the MAP at the required height (see paragraph 274).

b. On-Airport Facilities. The MAP is a point on the FAC which is NOT FARTHER from the FAF than the facility. The missed approach surface shall commence over the MAP at the required height (see paragraph 274).

715.-799. RESERVED.

CHAPTER 8. VHF/UHF DF PROCEDURES

800. GENERAL. These criteria apply to direction finder (DF) procedures for both high and low altitude aircraft. DF criteria shall be the same as criteria provided for automatic direction finder (ADF) procedures, except as specified herein. As used in this chapter, the word "facility" means the DF antenna site. DF approach procedures are established for use in emergency situations. However, where required by a using agency, DF may be used for normal instrument approach procedures.

801.-809. RESERVED.

Section 1. VHF/UHF DF Criteria

810. EN ROUTE OPERATIONS. En route aircraft under DF control follow a course to the DF station as determined by the DF controller. A minimum safe altitude shall be established which provides at least 1,000 feet (2,000 feet in mountainous areas) of clearance over all obstacles within the operational radius of the DF facility. When this altitude proves unduly restrictive, sector altitudes may be established to provide relief from obstacles, which are clear of the area where flight is conducted. Where sector altitudes are established, they shall be limited to sectors of not less than 45 degrees in areas BEYOND a 10-mile radius around the facility. For areas WITHIN 10 miles of the facility, sectors of NOT LESS THAN 90 degrees shall be used. Because the flight course may coincide with the sector division line, the sector altitude shall provide at least 1,000 feet (2,000 feet in mountainous terrain) of clearance over obstacles in the adjacent sectors within 6 miles or 20 degrees of the sector division line, whichever is the greater. No sector altitude shall be specified which is lower than the procedure or penetration turn altitude or lower than the altitude for area sectors, which are closer to the navigation facility.

811. INITIAL APPROACH SEGMENT. The initial approach fix is overhead the facility.

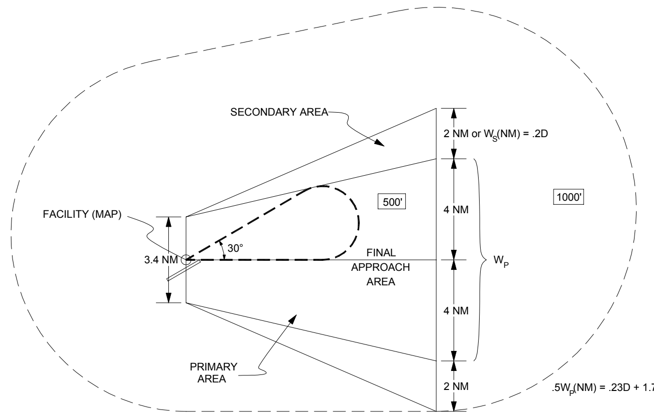


Figure 72. LOW ALTITUDE DF APPROACH AREA, Par 8ll.

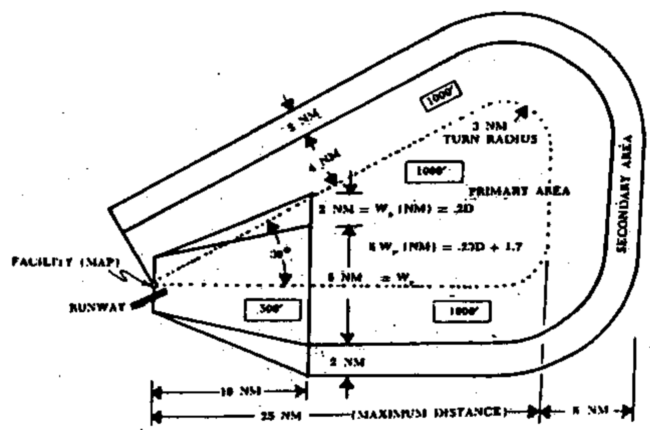


Figure 73, HIGH ALTITUDE DF APPROACH AREA, Par 811.

a. Low Altitude Procedures. The initial approach may be either a 10-mile teardrop procedure turn or the triangular procedure illustrated in figure 72. In either case, the 10-mile procedure turn criteria contained in paragraphs 234a, b, c, and d apply.

b. High Altitude Procedures. The initial approach may be either the standard teardrop penetration turn or the triangular procedure illustrated in figure 73. When the teardrop penetration turn is used, the criteria contained in paragraphs 235a, b, c, and d apply. When the triangular procedure is used, the same criteria apply except that the limiting angular divergence between the outbound course and the reciprocal of the inbound course may be as much as 45 degrees.

812. INTERMEDIATE APPROACH SEGMENT. Except as outlined in this paragraph, criteria for the intermediate segment are contained in chapter 2, section 4. An intermediate segment is used only when the DF facility is located off the airport and the final approach is made from overhead the facility to the airport. The width of the primary intermediate area is 3.4 miles at the facility, expanding uniformly on each side of the course to 8 miles wide 10 miles from the facility. A secondary area is on each side of the primary area. It is zero miles wide at the facility, expanding along the primary area to 2 miles each side at 10 miles from the facility. See figure 74.

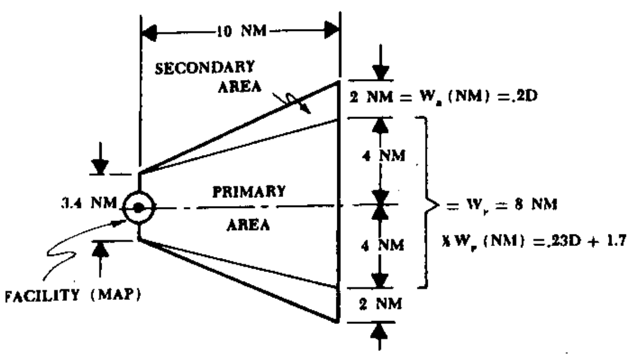


Figure 74. DF INTERMEDIATE APPROACH AREA. Par 812.

813. FINAL APPROACH SEGMENT. The final approach begins at the facility for off-airport facilities or where the procedure turn intersects the final approach course for on-airport facilities (see paragraph 400 for the definition of on-airport facilities). DF procedures shall not be developed for airports that are more than 10 miles from the DF facility. When a facility is located in excess of 6 miles from an airport, the instrument approach shall end at the facility and flight to the airport shall be conducted in accordance with visual flight rules (VFR).

a. Alignment.

(1) On - Airport Facilities. Paragraphs 613a(1) and (2) apply.

(1) Off - Airport Facilities. Paragraphs 713a(1)(a) and (b) apply.

b. Area.

(1) Low Altitude Procedures. Figure 74 illustrates the final approach primary and secondary areas. The primary area is longitudinally centered on the final approach course and is 10 miles long. The primary area is 3.4 miles wide at the facility and expands uniformly to 8 miles wide at 10 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 2 miles on each side of the primary area at 10 miles from the facility.

(2) High Altitude Procedures. The area considered is identical to that described in paragraph 623b and figure 60 except that the primary area is 3.4 miles wide at the facility.

c. Obstacle Clearance.

(1) Straight-In. The minimum obstacle clearance in the primary area is 500 feet. In the secondary areas, 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge. The minimum required obstacle clearance at any given point in the secondary area can be computed by using the formula specified in paragraph 523b.

(2) Circling Approach. In addition to the minimum requirements specified in paragraph 813c(1), obstacle clearance in the circling area shall be as prescribed in chapter 2, section 6.

d. Procedure Turn Altitude. The procedure turn completion altitude (minimum base leg altitude in triangular procedures) shall be within 1,500 feet of the MDA on final approach.

e. Penetration Turn Altitude (Descent Gradient). The penetration turn altitude (minimum base leg altitude in triangular procedures) shall be at least 1,000 feet but not more than 4,000 feet above the MDA on final approach.

f. Minimum Descent Altitude (MDA). The criteria for determining MDA are contained in chapter 3, section 2, except that in high altitude procedures, the MDA specified shall provide at least 1,000 feet of clearance over obstacles in that portion of the initial approach segment between the final approach segment and the point where the assumed penetration course intercepts the inbound course (see figure 60).

814. MISSED APPROACH SEGMENT. Criteria for the missed approach segment are contained in chapter 2, section 7. For on-airport facility locations, the missed approach point is the facility. For off-airport facility locations, the missed approach point is a point on the final approach course which is NOT farther from the facility than the first usable landing surface. The missed approach surface shall commence over the missed approach point at the required height (see paragraph 274).

815.-819. RESERVED.

Section 2. Communications.

820. TRANSMISSION INTERVAL. DF navigation is based on voice transmission of heading and altitude instructions by a ground station to the aircraft. The MAXIMUM interval between transmissions is:

a. En route Operations. 60 seconds.

b. From the Initial Approach Fix to Within an Estimated 30 Seconds of the Final Station Passage or Missed Approach Point. 15 seconds

c. **Within 30 Seconds of the Final Station Passage or Missed Approach Point.** 5 seconds. (15 seconds for doppler DF equipment).

821.-829. RESERVED.

Section 3. Minimums.

830. APPROACH MINIMUMS. The minimums established for a particular airport shall be as prescribed by the appropriate approving agency, but the MDA shall NOT be lower than that required for obstacle clearance on final approach and in the circling area specified in chapter 2, section 6.

831.-899. RESERVED.

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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:

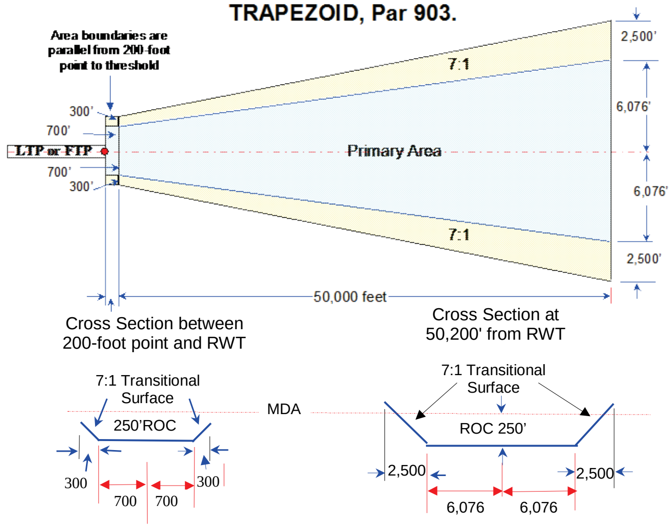
Perpendicular Width from RCL to the Edge of the Primary = $0.10752(D-200)+700$

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 segment termination fix. Primary area half-width is equal to the minimum lateral clearance applicable to the radar adaptation (***TERPS***, Vol.1, chapter 10, paragraph 10.0.2) from course centerline. There is no secondary area. The area has no specified maximum or minimum length; however, the segment must be long enough to permit the required altitude loss without exceeding the maximum authorized descent gradient.

Note: When the minimum lateral clearance changes within a segment (e.g. when transitioning from a multi- to single-sensor adaptation, or at the applicable distance for a single-sensor adaptation), the OEA half-width also changes without the need to "splay" or "taper".

10.1.1 a. (2) (c) Obstacle Clearance. Apply the ***TERPS*** Volume 1, chapter 2 standard applicable to the segment. ***TERPS*** Volume 1, chapter 3 precipitous terrain adjustments apply

10.1.1 a. (2) (d) Descent Angle. Apply ***TERPS*** Volume 1, chapter 2 standard applicable to the segment.

10.1.1 a. (2) (e) Altitude Selection. Apply ***TERPS*** Volume 1, chapter 2 standard applicable to the segment. Do not publish fix altitudes higher than the minimum required for obstacle clearance or airspace to achieve an "*optimum*" descent gradient.

10.1.2 **Intermediate Approach Segment.** Establish an intermediate segment when necessary (e.g., ATC radar vectors not available or MVA too high to support desired FAF/PFAF altitude). The intermediate segment begins at the intermediate fix and extends to the PFAF. When there is a preceding conventional /RNAV route segment, the applicable conventional/RNAV intermediate segment standards apply, except as specified in ***TERPS***, Vol 1, chapter 10, paragraph 10.1.2b(2).

10.1.2 **a. Alignment.** The intermediate course is an extension of the final approach course (no course change permitted at the PFAF).

10.1.2 **b. Area.**

10.1.2 b. (1) Radar Intermediate. When radar is used for course guidance (route or vector), the OEA begins at the applicable radar fix displacement prior to the Intermediate Fix (IF) and extends to the PFAF. Primary area half-width is equal to the minimum lateral clearance applicable to the radar adaptation (***TERPS***, Volume1, chapter 10, paragraph 10.0.2) until reaching a point 2 NM prior to the PFAF, then tapers to the width of the ASR/PAR/PAR without glideslope Final Approach Segment (FAS) primary OEA width abeam the PFAF (***TERPS,*** Volume 1, chapter 10, paragraph 10.1.4 and ***TERPS***, Volume 3, chapter 3, paragraph 3.0) (USN NA). There are no intermediate secondary areas. *See figure 10-1.*

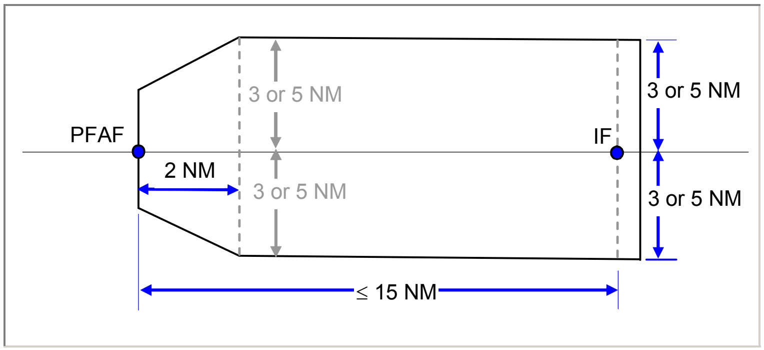
Note: When the minimum lateral clearance changes within a segment (e.g. when transitioning from a multi- to single-sensor adaptation, or at the applicable distance for a single-sensor adaptation), the OEA half-width also changes without the need to "splay" or "taper".

10.1.2 b. (2) Non-Radar Intermediate. When conventional/RNAV navigation is used for course guidance, apply the intermediate OEA criteria from the applicable 8260-series order with the following exceptions:

10.1.2 b. (2) a. Connection to PAR Final. Connect the outer edges of the intermediate primary area abeam the IF to the outer edges precision "X" Obstacle Clearance Surface (OCS) and the intermediate secondary area to the precision "Y" OCS abeam the PFAF.

10.1.2 b. (2) b. Connection to ASR Final. Connect the outer edges of the intermediate primary and secondary areas abeam the IF to the outer edge of the ASR area abeam the PFAF.

Figure 10-1. *Intermediate Segment Area.*



10.1.2 b. (3) Length. The intermediate segment length is normally 6 NM. The MINIMUM length varies based on course guidance but must always accommodate the required altitude loss. The *maximum* length is 15 NM.

10.1.2 b. (3) a. For conventional/RNAV and radar route course guidance, apply ***TERPS***, Volume 1, chapter 2 for ASR approaches and ***TERPS***, Volume 3, chapter 2 for PAR approaches. Radar intermediate segments may not be less than 2 NM.

10.1.2 **c. Obstacle Clearance.** Apply 500 ft ROC over the highest obstacle in the area. ***TERPS***, Volume 1 chapter 3 precipitous terrain and RASS adjustments apply. For conventional/RNAV course guidance, apply secondary area ROC criteria from the applicable 8260-series directive.

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).*

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

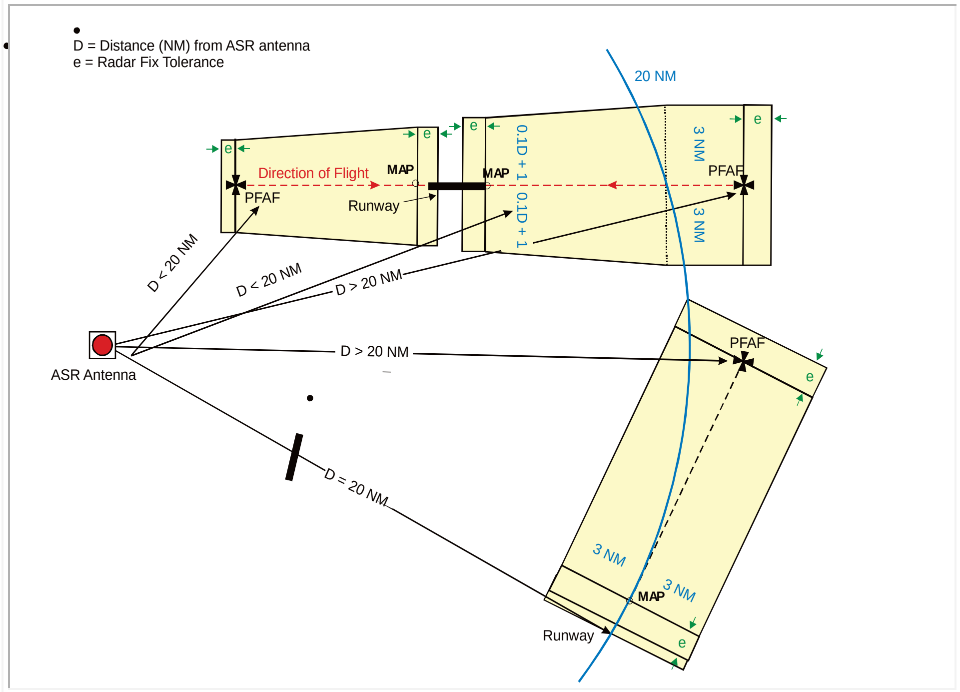
where

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.

Chapter 10. Radar Approach Procedures and Vectoring Charts (MVAC)

Section 3. Minimum Vectoring Altitude Charts.

10.2 Minimum Vectoring Altitude Chart (MVAC). An MVAC is used by air traffic facilities when providing terminal service. An MVAC may be developed by En Route facilities in selected areas where the MIA chart does not meet operational needs. An MVAC specifies the lowest MSL altitude at or above the floor of controlled airspace that provides at least the minimum ROC over obstacles. The MVAC may be used in lieu of feeder, initial, and intermediate approach segment(s) for radar approaches.

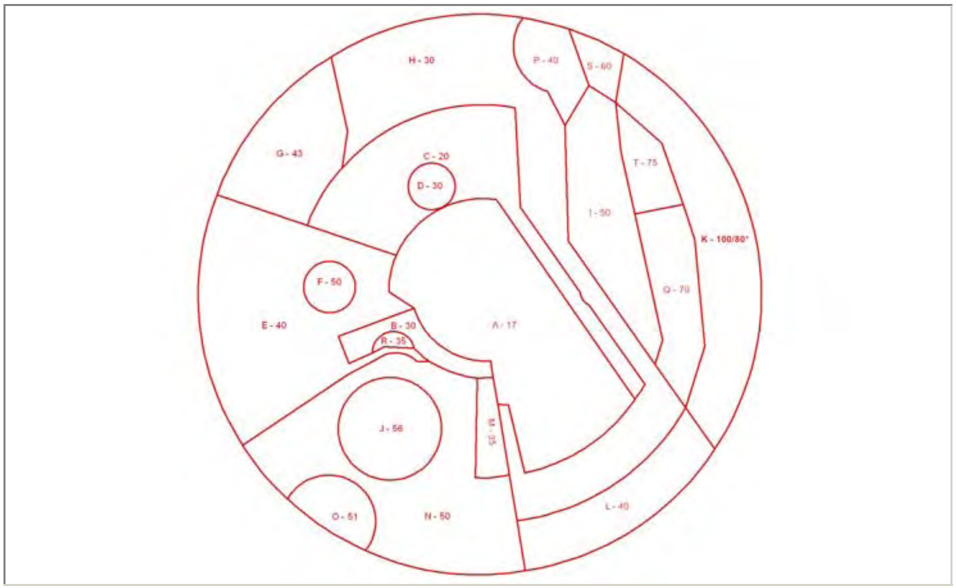
Note: See Orders 7210.3, Facility Operations and Administration, 7210.37, En Route Minimum IFR Altitude (MIA) Sector Charts, or DoD directive.

10.2.1 General. Apply current Order 7210.3 criteria (or applicable DoD directive) to determine when an MVAC is required, the range/coverage of the chart(s) and the lateral obstacle clearance applicable to the chart and/or specific sectors. When the area of responsibility is beyond the radar system limits but a vectoring chart is still operationally necessary, apply Order 7210.37 for the non-radar area.

Note: The current vertical and horizontal obstacle accuracy standards in Order 8260.19 apply.

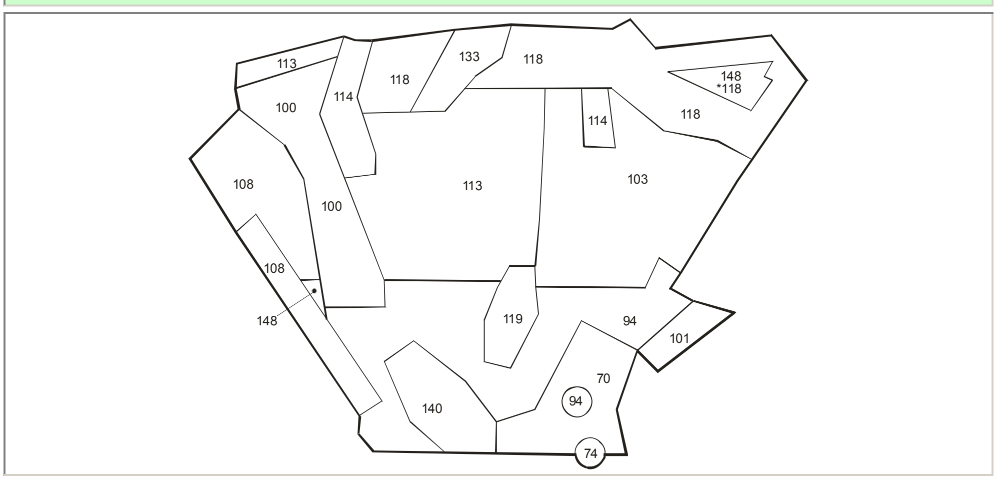
10.2.2 Single Sensor Adaptation. Center the MVAC on the radar sensor to facilitate distance measurements (e.g., to determine the minimum lateral clearance). Define sector boundaries by bearings, point-to-point lines, arcs, and/or circles relative to a specified point or points (e.g., radar antenna, NAVAID, fix, latitude/longitude coordinate, etc.). *See figure 10-3*.

Figure 10-3. *MVAC for Single-Sensor Adaptation.*



10.2.3 **Multi-sensor Adaptation.** Sector boundaries may be defined by any combination of bearings, point-to-point lines, arcs, and/or circles relative to a specified point or points (e.g., radar antenna, NAVAID, fix, latitude/longitude coordinate, etc.). *See figure 10-4.*

Figure 10-4. *MVAC for Multi Sensor Adaptation.*



10.2.4 **Sectors.** The MVAC may be subdivided into sectors to gain relief from obstacles. There is no prescribed limit on the size, shape, or orientation of MVAC sectors. **Where small contiguous sectors with different altitudes do not serve an operational need, consider combining them.**

10.2.4 a. **Obstacle Evaluation Area.** Adjacent sectors share common boundaries; however, each sector OEA is stand-alone and evaluated separately. The sector

OEA includes the volume of airspace contained within it's defined boundaries. Except for isolation areas (see ***TERPS***, Volume1, chapter 10, paragraph 10.2.4b), each sector includes a buffer equal to the minimum required lateral clearance for the applicable radar adaptation.

10.2.4 a. (1) Single Sensor. An OEA buffer expands outward at least 3 NM from those portions of the boundary within *40 NM of the radar antenna and at least 5 NM outward from those portions of the boundary equal to or greater than *40 NM from the radar antenna. When a contiguous sector **crosses** *40 NM from the radar antenna, the sector is effectively divided into sub-sectors at the *40 NM arc and normal OEA/buffers applied to each, except buffers expanding INTO the sector may be truncated at the boundary. The highest altitude from each sub-sector applies. See figures 10-5/5a.

**60 NM for approved full time reinforced MSSR systems.*

Figure 10-5. *Sector Buffer Areas* ***(Single sensor,w/out reinforced MSSR)***

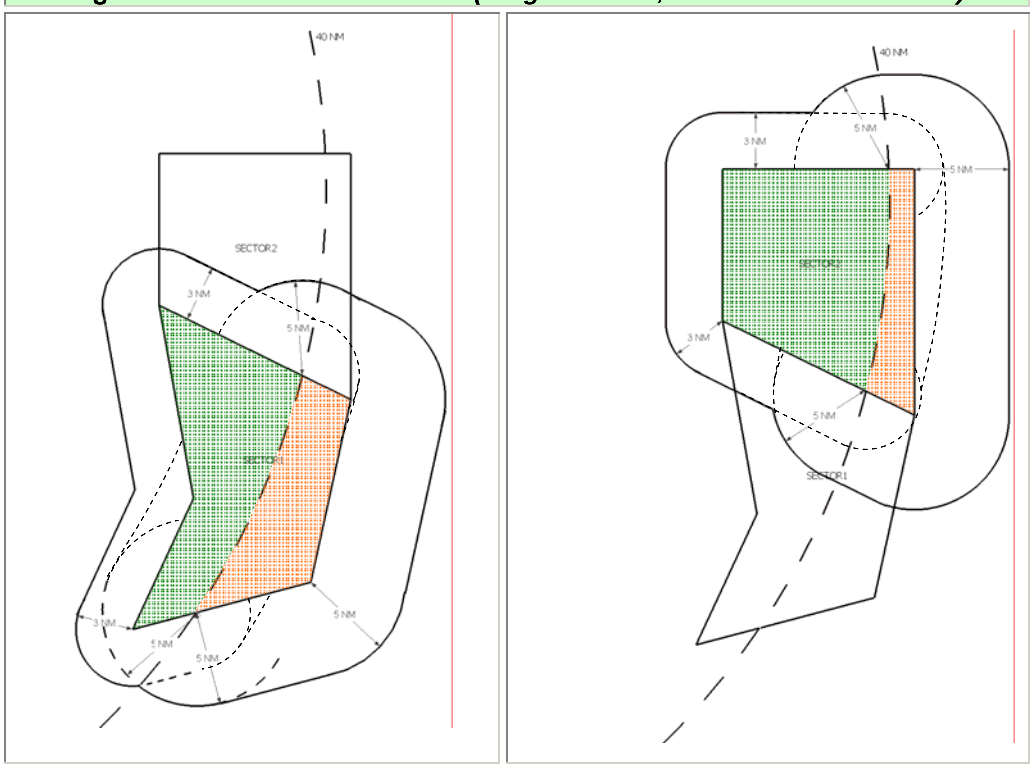
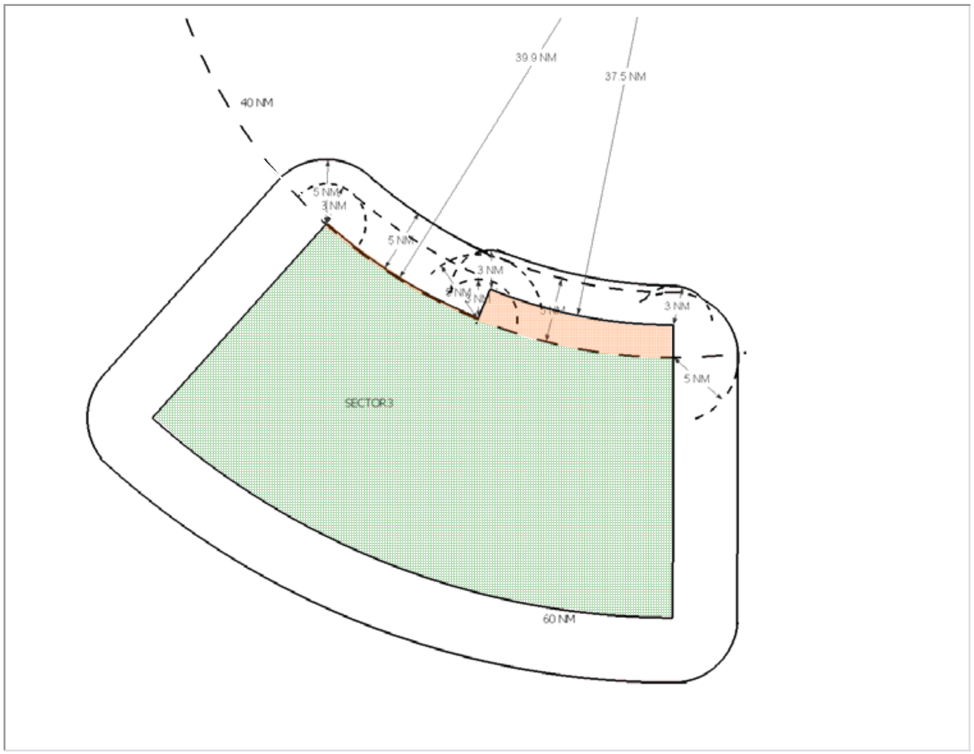
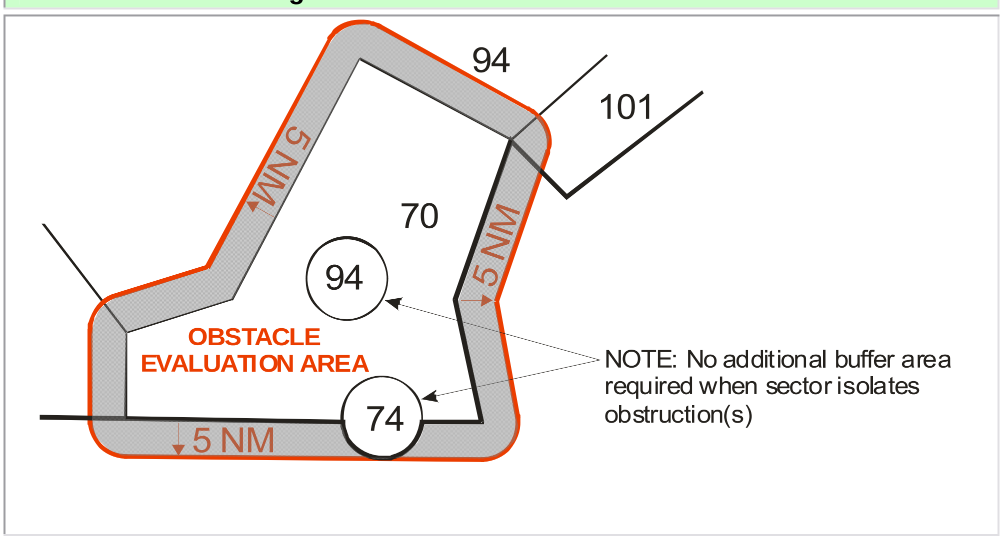


Figure 10-5a. *Buffer Area, Contiguous Sector crossing 40 NM.*
(Single sensor,w/out reinforced MSSR)



10.2.4 a. (2) Multi-sensor adaptation. The OEA includes a buffer extending at least 5 NM outward from the boundary, regardless of distance to radar antenna or MVAC center. *See figure 10-6.*

Figure 10-6. *Multi-sensor Buffer Areas.*



10.2.4 **b. Isolating Obstacles.** Any obstacle may be isolated to ***lower*** the MVA in one or more standard sectors. The OEA buffers of neighboring sectors still apply in the isolation area, but *exclude* the specific feature being isolated (i.e., all other obstacles must be considered). Truncate an isolation area at the sector boundary when it expands into a sector requiring a higher MVA. The dimensions of the isolation area otherwise depends on the feature type and whether single or multi-sensor adaptation applies.

10.2.4 b. (1) Point Feature (antennas, towers, high-rise buildings, etc). The isolation area is based on a radius centered on the feature that provides at least the minimum lateral clearance applicable to the radar adaptation (***TERPS***, Volume1, chapter 10, paragraph 10.0.2). Order 8260.19 chapter 2, Section 11 applies. Isolation areas for multiple point features (i.e., antenna or wind farms) may be combined, however the minimum required lateral clearance must be provided from each feature and the MVA must equal the highest required for any individual feature.

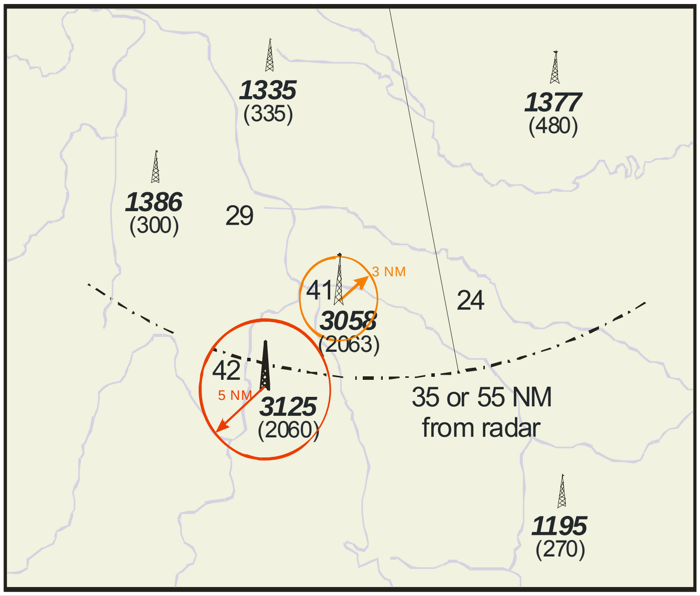
10.2.4 b. (1) (a) Single-sensor adaptations. The isolation area boundary is a 3 NM radius when the feature is #35 NM or less from the radar antenna, and a 5 NM radius when the feature is more than #35 NM from the radar antenna. *See figure 10-7.* When operationally advantageous, the boundary may be reduced to less than 5 NM for those portions of the isolation area within *40 NM from the antenna, but not less than the minimum required lateral clearance. *See Figure 10-7a.*

#55 NM for approved full time reinforced MSSR systems.

**60 NM for approved full time reinforced MSSR systems.*

10.2.4 b. (1) (b) Multi-sensor adaptations. Isolation area boundary is a 5 NM radius, regardless of distance from radar antenna.

Figure 10-7. *Isolation Area , Point Feature*



10.2.4 b. (2) Zone Feature (e.g., distinct terrain, topographical contours, etc.). When determining the sector boundary first define the dimensions of the feature to be isolated (e.g., mountain from 4,700 ft contour and above).

10.2.4 b. (2) (a) Single-sensor adaptations. Establish the isolation area boundary 3 NM from the feature for points 35 NM or less from the radar antenna, and 5 NM from the feature for points more than 35 NM from the radar antenna. When operationally advantageous, the boundary may be reduced to less than 5 NM for those portions of the isolation area within 40 NM from the antenna, but not less than the minimum required lateral clearance. *See Figures 10-8 and 10-8a.*

10.2.4 b. (2) (b) Multi-sensor adaptations. Isolation area boundary is a 5 NM from the feature, regardless of distance from radar antenna.

Figure 10-7a. *Isolation Area, Point Feature, Example construction > 35 NM from Radar (Single sensor,w/out reinforced MSSR)*

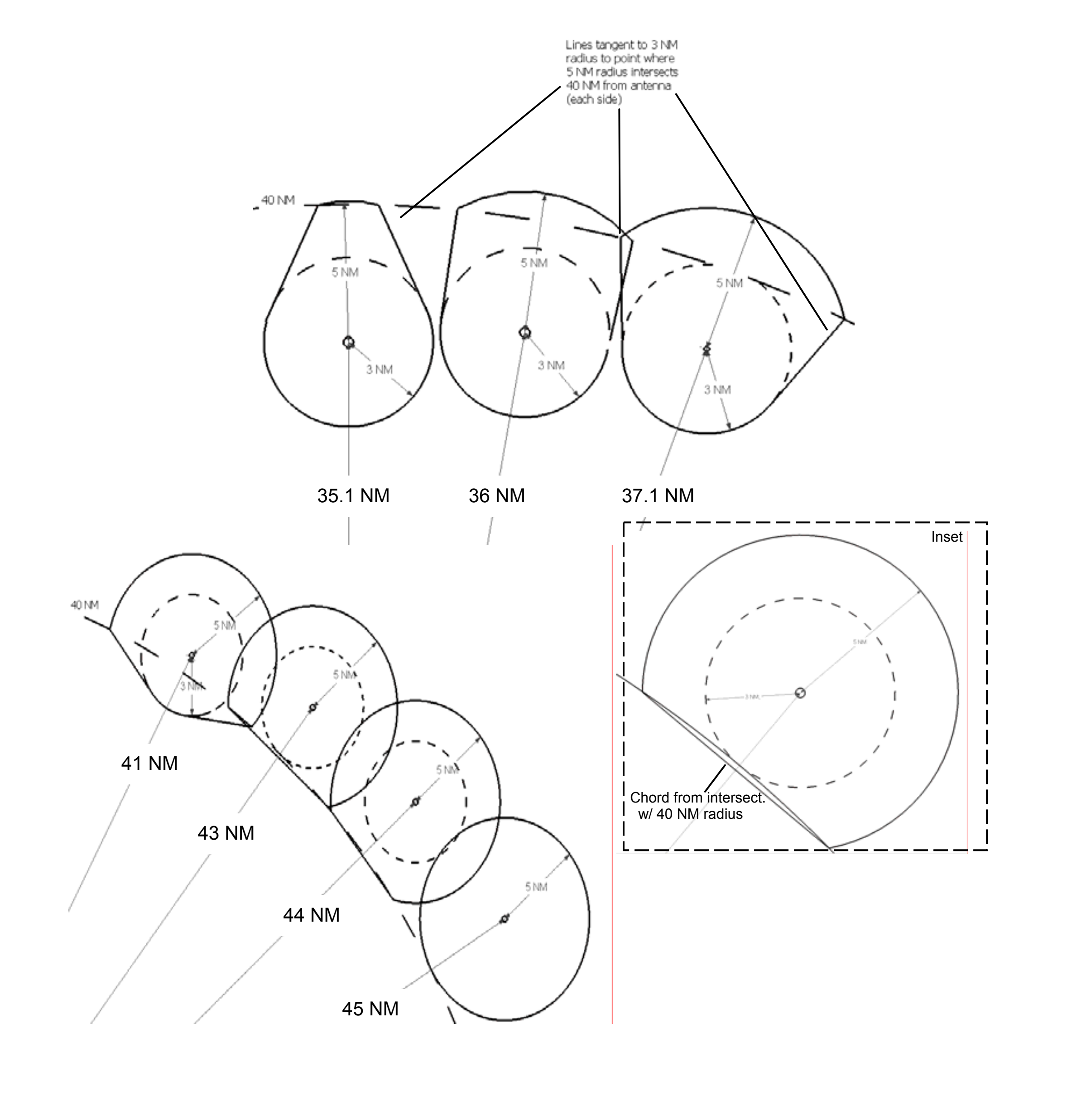


Figure 10-8. *Isolation Area, Zone Feature > 35 NM from Radar* ***(Single sensor,w/out reinforced MSSR)***

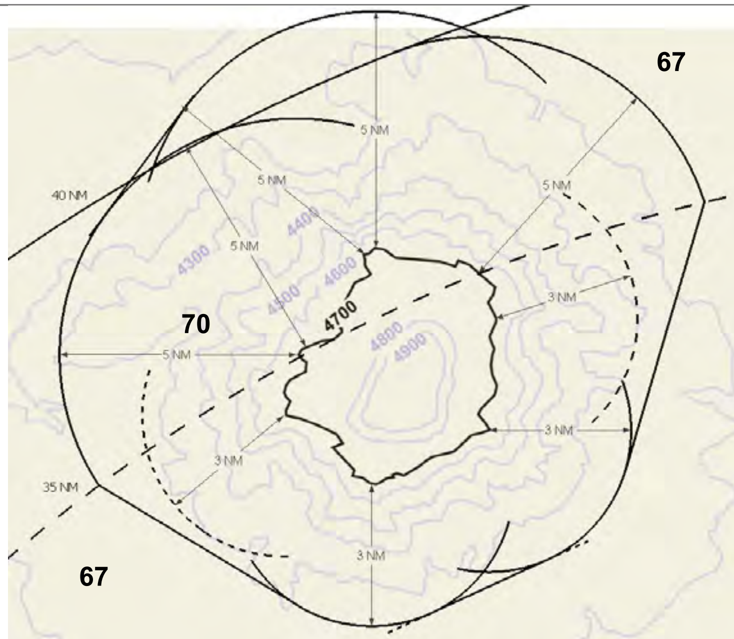
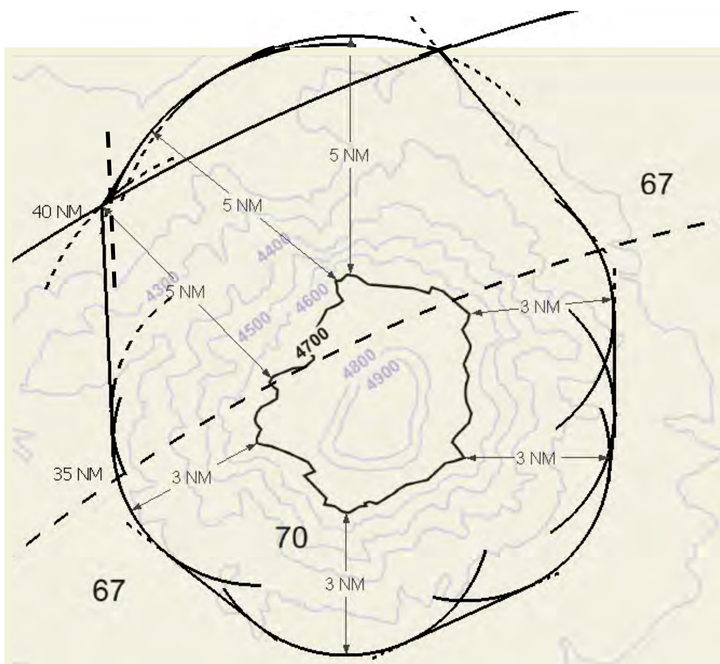


Figure 10-8a. *Isolation Area, Zone Feature, Example construction > 35 NM* ***(Single sensor,w/out reinforced MSSR)***



10.2.5 **Obstacle Clearance.** Required obstacle clearance depends on the radar adaptation and the relationship of the obstacle to those areas designated mountainous per 14 CFR Part 95 Subpart B.

10.2.5 **a. Non-mountainous terrain.** Apply 1,000 ft ROC over obstacles in non-mountainous areas.

10.2.5 **b. Mountainous terrain.** Apply 2,000 ft ROC over obstacles in designated mountainous areas. ROC may only be reduced when a reduction has been requested, approved, and documented in accordance with current Order 7210.3, *ATC Facility Operation and Administration* standards (to include associated Notices). Standard reduced ROC values are:

10.2.5 b. (1) Single sensor adaptation: Not less than 1,000 ft.

10.2.5 b. (2) Multi-sensor adaptation:

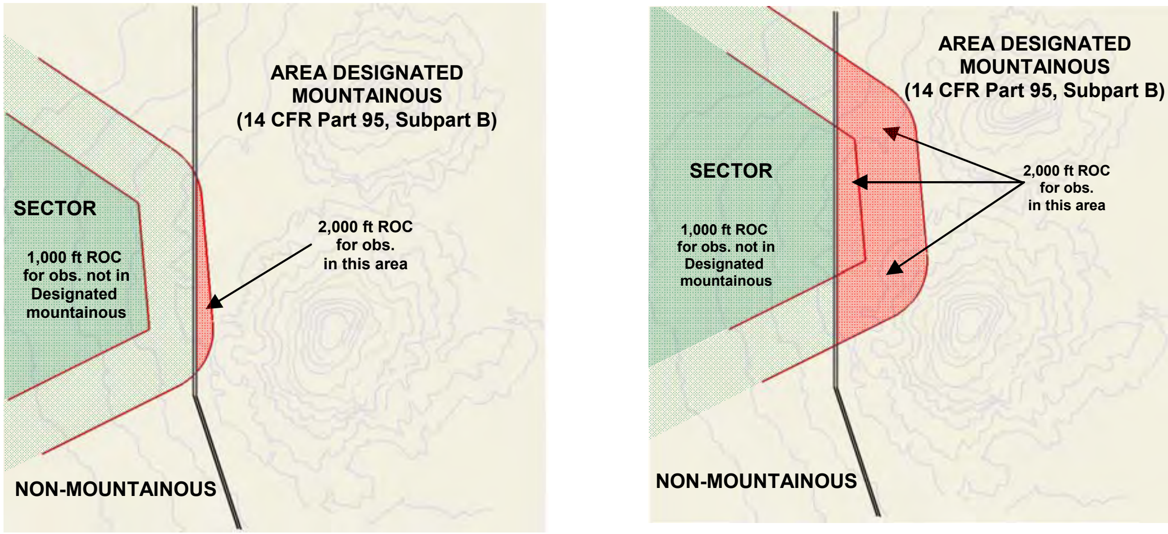
10.2.5 b. (2) a. Terrain. Not less than 1,500 ft (designated mountainous areas of the Eastern United States, Commonwealth of Puerto Rico, and Hawaii) or 1,700 ft (designated mountainous areas of the Western United States and Alaska).

10.2.5 b. (2) b. Man-made obstacles. Not less than 1,000 ft over the obstacle, but the MVA must also provide the minimum required 1,500/1,700 ROC over the terrain underlying the man-made structure.

10.2.5 **c. When a sector/buffer/isolation area overlies** both non-mountainous and mountainous terrain, consider revising sector boundaries. Otherwise, apply the appropriate ROC based on the location of the obstacle. See figure 10-9.

10.2.6 **Adverse Assumption Obstacle (AAO) considerations.** (USAF N/A). Apply AAO to terrain except those areas around primary/satellite airports exempted by Order 8260.19 and/or when applying 2,000 unreduced ROC.

Figure 10-9. Sector/Buffer Overlying Both Mountainous and Non-Mountainous Areas



10.2.7 **Airspace.** Establish sector altitudes (to include isolation areas) to provide at least a 300-ft buffer above the floor of controlled airspace. When operationally required, altitudes may be reduced not lower than the floor of controlled airspace.

When consideration of floor of controlled airspace results in an exceptionally high altitude; e.g., in areas where the floor of controlled airspace is 14,500 MSL and operationally required to vector aircraft in underlying Class G (uncontrolled) airspace, two sector altitudes may be established. The first must be based on obstacle clearance and the floor of controlled airspace. A second lower altitude that provides obstacle clearance only may be established. The obstacle clearance only altitude must be uniquely identified; e.g., by an asterisk (*). Do not consider sector buffer areas for controlled airspace evaluations.

10.2.8 **Altitude Selection.** Specify sector altitudes (to include isolation areas) in the 100-ft increment that provides ROC over all obstacle(s) in the OEA.

10.2.8 **a. (USAF N/A).** Sector altitudes may be rounded to the nearest 100-ft increment over AAO obstacles when operationally required.

10.2.8 **b. (USAF and USN N/A).** For non-AAO obstacles, sector altitudes may be rounded to the nearest 100-ft where the entire sector (excluding buffer) or isolation area is;

10.2.8 b. (1) In the contiguous United States (not authorized in Alaska, Hawaii, or any other territory or possession) and documented to be within 65 nautical miles (NM) of an altimeter setting source which is issued by Air Traffic Control in accordance with Order JO 7110.65 chapter 2, section 7 and either;

10.2.8 b. (1) a. Outside of any area designated mountainous by 14 CFR Part 95, or;

10.2.8 b. (1) b. In an area designated mountainous where required obstacle clearance (ROC) is not reduced, or;

10.2.8 b. (1) c. In an area designated mountainous where for this purpose the terrain is considered not to be precipitous (i.e. no significant elevation changes greater than 1,500 feet) and at least 951 ft ROC is provided or;

10.2.8 b. (1) d. In an area designated mountainous where rounding provides ROC in accordance with table 10-1. Interpolation of this table permitted.

Table 10-1. Minimum Obstacle Clearance (ft)
Based on ACT/distance from Altimeter Source.

ACT (°C/°F)	Distance ≤ 65 NM
-40/-40	1851
-30/-22	1651
-20/-4	1451
-10/14	1251
0/32	1051
2/36	1051*
7/45	951

* 951 within 35 NM

Example: The ACT is determined to be -30°C. The controlling obstacle is a 2,549 MSL tower, and ROC is reduced to 1,800 ft. The minimum sector altitude may be rounded to 4,300 since it provides at least 1,651 ft clearance.

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

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

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

*0.1*D+1*

Calculator

D	15.000	Click here to calculate
Hw	2.500	

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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

Calculator

A	3,000.000	Click here to Calculate
DG	286.000	
RecAlt	2,714.000	

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CHAPTER 11. HELICOPTER PROCEDURES

Section 1. Administrative

1100. GENERAL. This chapter contains criteria for application to "helicopter only" procedures. These criteria are based on the premise that helicopters are classified in approach Category A and are capable of special maneuvering characteristics. The intent, therefore, is to provide relief from those portions of other TERPS chapters that are more restrictive than the criteria specified herein. However, any criteria contained elsewhere in other chapters of this document may be applied to helicopter only procedures when an operational advantage may be gained.

a. Identification of Inapplicable Criteria. Criteria contained elsewhere in this document normally apply to helicopter procedures. Where this chapter changes such criteria, the changed material is identified. Circling approach and high altitude penetration criteria do not apply to helicopter procedures.

b. Use of Existing Facilities. Helicopter only procedures based on existing facilities may be developed using criteria contained in this chapter.

1101. TERMINOLOGY. The following terms are peculiar to helicopter procedures and are defined as follows:

a. Height Above Landing (HAL) is the height above landing area elevation.

b. Height Above the Surface (HAS) is the height of the MDA above the highest terrain/surface within a 5,200-foot radius of the MAP in point in space procedures.

c. Landing Area as used in helicopter operations refers to the portion of the heliport or airport runway used, or intended to be used for the landing and takeoff of helicopters.

d. Landing Area Boundary (LAB) is the beginning of the landing area of the heliport or runway.

e. Point in Space Approach is an instrument approach procedure to a point in space, identified as a missed approach point, which is not associated with a specific landing area within 2,600 feet of the MAP.

f. Touchdown zone, as used in helicopter procedures, is identical to the landing area.

1102. DELETED.

1103. TYPE OF PROCEDURE. HELICOPTER ONLY PROCEDURES are designed to meet low altitude straight-in requirements ONLY.

1104. FACILITIES FOR WHICH CRITERIA ARE NOT PROVIDED. This chapter does not include criteria for procedures predicated on VHF/UHF DF, area navigation (RNAV), airborne radar approach (ARA), or microwave landing system (MLS). Procedures using VHF/UHF DF may be developed in accordance with the appropriate chapters of this document.

1105. PROCEDURE IDENTIFICATION. Identify helicopter-only procedures using the term "COPTER," the type of facility or system providing final approach course guidance, and:

a. For Approaches to Runways. The abbreviation RWY, and the runway number; e.g., COPTER ILS or LOC RWY 17; COPTER RNAV (GPS) RWY 31.

b. For Approaches to Heliports and a Point-in-Space. The magnetic final approach course value and degree symbol; e.g., COPTER ILS or LOC 014°; COPTER TACAN O97°, COPTER RNAV (GPS) 010°.

c. For Approaches Based on an ARC Final. The word ARC will be used, and will be followed by a sequential number; e.g., COPTER VOR/DME ARC 1.

d. For separate procedures at the same location. Use the same type of facility and same final approach course, add an alpha suffix starting in reverse alphabetical order; COPTER ILS or LOC Z RWY 28L (first procedure), COPTER ILS or LOC Y RWY 28L (second procedure), COPTER ILS or LOC X RWY 28L (third procedure), etc.

Section 2. General Criteria

1106. APPLICATION. These criteria are based on the unique maneuvering capability of the helicopter at airspeeds not exceeding 90 knots.

1107. POINT IN SPACE APPROACH. Where the center of the landing area is not within 2,600 feet of the MAP, an approach procedure to a point in space may be developed using any of the facilities for which criteria are provided in this chapter. In such procedures the point in space and the missed approach point are identical and upon arrival at this point, helicopters must proceed under visual flight rules (or special VFR in control zone as applicable) to a landing area or conduct the specified missed approach procedure. The published procedure shall be noted to this effect and also should identify available landing areas in the vicinity by noting the course and distance from the MAP to each selected landing area. Point in space approach procedures will not contain alternate minima.

1108. APPROACH CATEGORIES. When helicopters use instrument flight procedures designed for fixed wing aircraft, approach Category "A" approach minima shall apply regardless of helicopter weight.

1109. PROCEDURE CONSTRUCTION. Paragraph 214 applies except for the reference to circling approach.

1110. DESCENT GRADIENT. The descent gradient criteria specified in other chapters of this document do not apply. The optimum descent gradient in *all* segments of helicopter approach procedures is 400 feet per mile. Where a higher descent gradient is necessary, the recommended maximum is 600 feet per mile. However, where an operational requirement exists, a gradient of as much as 800 feet per mile may be authorized, provided the gradient used is depicted on approach charts. See special procedure turn criteria in paragraph 1112.

1111. INITIAL APPROACH SEGMENTS BASED ON STRAIGHT COURSES AND ARCS WITH POSITIVE COURSE GUIDANCE. Paragraph 232 is changed as follows:

a. Alignment.

(1) Courses. The 2-mile lead radial specified in paragraph 232a(1) is reduced to 1 mile. See Figure 3.

(2) Arcs. The minimum arc radius specified in paragraph 232a(2) is reduced to 4 miles. The 2-mile lead radial may be reduced to 1 mile. See Figure 10.

1112. INITIAL APPROACH BASED ON PROCEDURE TURN. Paragraph 234 applies except for all of subparagraph d and the number 300 in subparagraph e(1) which is changed to 600. Since helicopters operate at approach Category A speeds the 5-mile procedure turn will normally be used. However, the larger 10-and 15-mile areas may be used if considered necessary.

a. Descent Gradient. Because the actual length of the track will vary with environmental conditions and pilot technique, it is not practical to specify a descent gradient solely in feet per mile for the procedure turn. Instead, the descent gradient is controlled by requiring the procedure turn completion altitude to be as close as possible to the final approach fix altitude. The difference between the procedure turn completion altitude and the altitude over the final approach fix shall not be greater than those shown in Table 23.

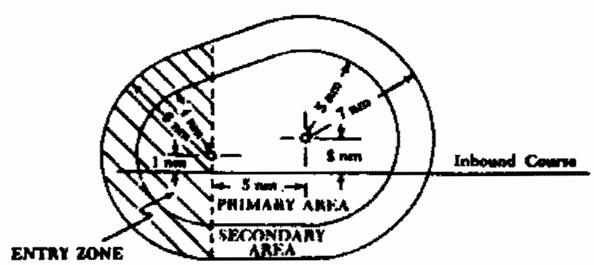


Figure 105. HELICOPTER PROCEDURE TURN AREA. Par 1112.

Table 23. PROCEDURE TURN COMPLETION ALTITUDE DIFFERENCE. Par 1112.

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

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:

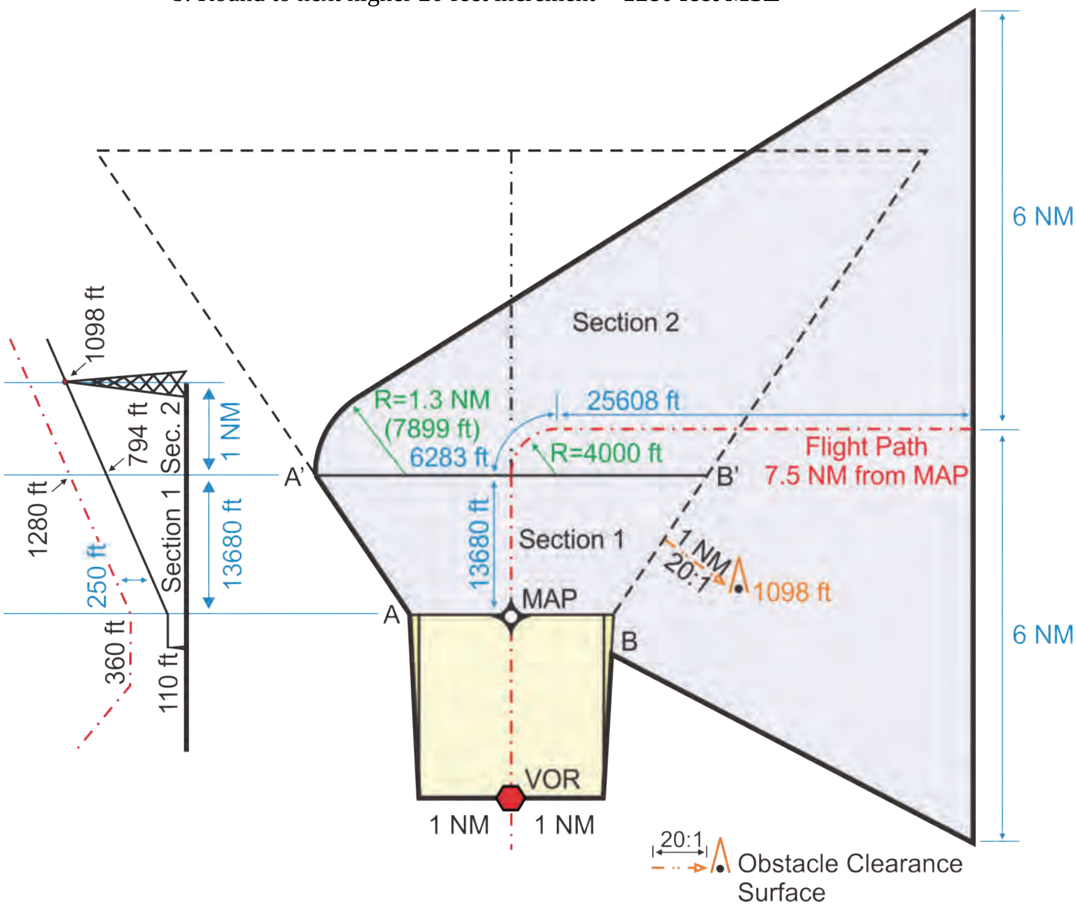
1. MDA is 360 feet MSL based on obstacles in the approach area
2. 1098 feet MSL obstacle is 1 NM (6076 feet) from the near edge of section 1

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.

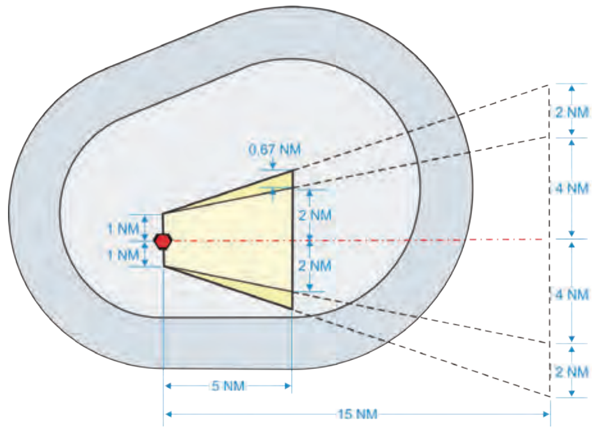


Figure 107. Final Approach Primary and Secondary Area. On-Heliport VOR, No PFAF, Par 1132b. See also Figure 105.

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.

c. Obstacle Clearance. Paragraph 513.c.(1) applies.

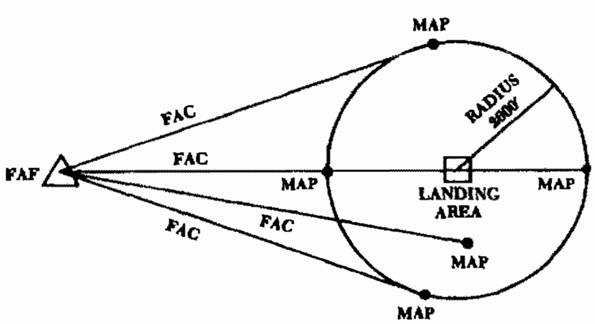
1134. RESERVED

1135. MISSED APPROACH POINT. The identification of the MAP in Paragraph 514 is changed as follows: The missed approach point is a point on the final approach course which is not farther than 2600 feet from the center of the landing area. See Figure 108. For point in space approaches the MAP is on the final approach course at the end of the final approach area.

1136. ARC FINAL APPROACH SEGMENT RADIUS. Paragraph 523.b. does not apply. The final approach arc shall be a continuation of the intermediate arc. It shall be specified in nautical miles and tenths thereof. The minimum arc radius on final approach is 4 miles.

1137. ARC FINAL APPROACH SEGMENT ALIGNMENT. Paragraph 523.b.(1) does not apply. The final approach arc should be aligned so as to pass through the landing area. Where an operational advantage can be achieved, a final approach course which does not pass through the landing area may be established provided the arc lies within 2600 ft. of the landing area at the MAP.

1138. RESERVED.



MISSED APPROACH POINT OPTIONS

Figure 108. MISSED APPROACH POINTS. Off-Heliport VOR with FAF. Par. 1135.

Section 6. ON-HELIPORT NDB, No FAF

1139. GENERAL. Paragraph 600 does not apply. These criteria apply to procedures based on an NDB facility located within 2600 feet of the center of the landing area in which no final approach fix is established. These procedures must incorporate a procedure turn.

1140. FINAL APPROACH SEGMENT. Paragraph 613 does not apply except as noted below. The final approach begins where the procedure turn intersects the final approach course, inbound.

a. Alignment. Paragraph 1116.a. applies.

b. Area. The primary area is longitudinally centered on the final approach course. The MINIMUM length is 5 miles. This may be extended if an operational requirement exists. The primary area is 2.5 miles wide at the facility, and expands uniformly to 4.25 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 miles wide on each side of the primary area at 5 miles from the facility. Figure 109 illustrates the primary and secondary areas.

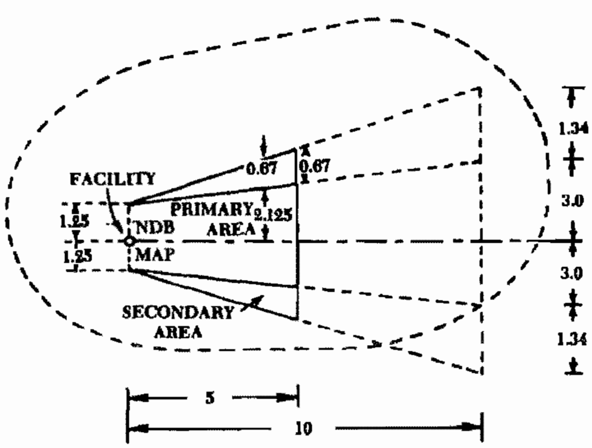


Figure 109. FINAL APPROACH PRIMARY AND SECONDARY AREAS. On-Heliport NDB. No FAF. Paragraph 1140.

c. Obstacle Clearance. Paragraph 613.c.(1) applies.

d. Procedure Turn Altitude (Descent Gradient). The procedure turn completion altitude shall be in accordance with Table 23.

e. Use of Stepdown Fix. Paragraph 613.e. applies except that 4 miles is changed to 2.5 miles.

f. Minimum Descent Altitude. Criteria for determining the MDA are contained in Section 3 of this chapter and Chapter 3.

Section 7. NDB Procedures with FAF

1141. GENERAL. These criteria apply to procedures based on an NDB facility which incorporates a final approach fix.

1142. FINAL APPROACH SEGMENT. Paragraph 713 does not apply except as noted below:

a. Alignment. Paragraphs 1116.a. and b. apply.

b. Area. Paragraph 713.b. applies except that portion which refers to the minimum length of the final approach segment. The minimum length is specified in Table 26.

c. Obstacle Clearance. Paragraph 713.c.(1) applies.

1143. MISSED APPROACH POINT. The identification of the MAP in Paragraph 714 is changed as follows: The missed approach point is a point on the final approach course which is not farther than 2600 feet from the center of the landing area. See Figure 108. For point in space approaches, the MAP is on the final approach course at the end of the final approach area.

Section 8. RESERVED.

1144.–1149. RESERVED.

Section 9. ILS Procedures

1150. GENERAL. Chapter 9 is changed as noted in this section. These criteria apply to the present design of instrument landing systems (on airport) only.

1151. INTERMEDIATE APPROACH SEGMENT. Paragraph 922 applies with the exception that Table 27 specifies the minimum length of the intermediate segment based on the angle of intersection of the initial approach course with the localizer course.

1152. FINAL APPROACH SEGMENT. Paragraph 930 applies except that glide slope interception need not occur prior to the FAF normally used for fixed wing operations.

a. The optimum length of the final approach course is 3.0 miles. The minimum length is 2.0 miles. A distance in excess of 4.0 miles should not be used unless a special operational requirement exists.

b. Final Approach Termination. The final approach shall terminate at a landing point (runway) or at a hover point between the Decision Height and the GPI. Where required, visual hover/taxi routes will be provided to the terminal area.

1153. MISSED APPROACH AREA. Normally existing missed approach criteria will be utilized for helicopter operations. However, if an operational advantage can be gained, the areas described in Paragraphs 1168 through 1171 may be substituted.

1154. MICROWAVE ILS. Additional criteria will be developed to exploit the capabilities of the microwave ILS which is now under development. It is expected that this new equipment will provide glide slope angles in the range from 3 to 12 degrees and the flexibility to satisfy special aircraft and ground siting requirements.

1155. LOCALIZER AND LDA. Section 5 of Chapter 9 is changed as noted in this paragraph.

a. Alignment. Paragraph 952 applies except that LDA alignment shall be as specified in paragraphs 1116.a. and b.

b. Area. Paragraph 953 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.

c. Missed Approach Point. The identification of the MAP in Paragraph 957 is changed as follows: The missed approach point is a point on the final approach course which is not farther than 2600 feet from the landing area. See Figure 108. For point-in-space approaches, the MAP is on the final approach course at the end of the final approach area.

Section 10. Precision Approach Radar (PAR)

1156. INTERMEDIATE APPROACH SEGMENT. Paragraph 1014 applies with the exception that Table 27 specifies the minimum length of the intermediate segment based on the angle of intersection of the initial approach course with the intermediate course.

Table 27. INTERMEDIATE SEGMENT ANGLE OF INTERCEPT VS. SEGMENT LENGTH. Paragraph 1156.

Angle (Degrees)	Minimum Length (Miles)
30	1
60	2
90	3

NOTE: This table may be interpolated.

1157. RESERVED.

1158. FINAL APPROACH SEGMENT. The provisions of Paragraph 1020.b.(1) and (2) do not apply. The minimum distance from the glide slope intercept point to the GPI is 2 miles.

1159. FINAL APPROACH ALIGNMENT. Paragraph 1020.a. applies with the exception that a final approach course shall be aligned to a landing area. Where required, visual hover/taxi routes shall be established leading to terminal areas.

1160. FINAL APPROACH AREA.

a. *Length.* The final approach area is 25,000 feet long, measured outward along the final approach course from the GPI. Where operationally required for other procedural considerations or for existing obstacles, the length may be increased or decreased symmetrically, except when glide slope usability would be impaired or restricted. See Figure 110.

b. *Width.* The final approach area is centered on the final approach course. The area has a total width of 500 feet at the GPI and expands uniformly to a total width of 8000 ft. at a point 25,000 ft. outward from the GPI. The widths are further uniformly expanded or reduced where a different length is required as in Paragraph 1160.a. above. See Figure 110. The width either side of the centerline at a given distance "D" from the point of beginning can be found by using the formula 250 + .15D = 1/2 width.

1161. RESERVED.

1162. FINAL APPROACH OBSTACLE CLEARANCE SURFACE. Paragraph 1021 does not apply. The final approach obstacle clearance surface is divided into two sections.

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

b. *Section 2.* This section originates 775 feet outward from the GPI. It connects with Section 1 at the elevation of the GPI. The gradient of this section varies with the glide path angle used.

(1) To identify the glide slope angle and associated final approach surface gradient to clear obstacles in Section 2:

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

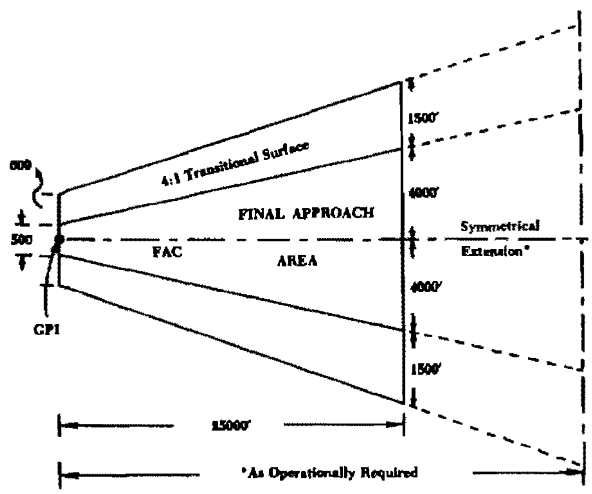


Figure 110. PAR FINAL APPROACH AREA.
Par 1159 and 1160

Table 28. FINAL APPROACH GLIDE SLOPE – SURFACE SLOPE ANGLES.
Par. 1162.b.

Glide Slope Angle (Degrees)	Less Than 3	3	4	5	6	7	8	12
Section 2 obstacle clearance surface gradient (degrees)	*	1.65	2.51	3.37	4.23	5.09	5.95	9.39

NOTE: This table may be interpolated.
** See Par 1165.a.*

(b) Enter these values in the formula:

$$\text{TAN. ANGLE} = \frac{\text{Obstacle height}}{\text{D-775}}$$

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

(d) The minimum glide slope angle required is found in Table 28.

1163. TRANSITIONAL SURFACES. Paragraph 1022 does not apply. Transitional surfaces for PAR are inclined planes with a slope of 4:1 which extend outward and upward from the edges of the final approach surfaces. They start at the height of the applicable final approach surface, and are perpendicular to the final approach course. They extend laterally 600 feet at the GPI and expand uniformly to a width of 1500 feet at 25,000 feet from the GPI.

1164. OBSTACLE CLEARANCE. Paragraph 1024 does not apply. No obstacle should penetrate the applicable final approach surfaces specified in Paragraph 1162 or the transitional surfaces specified in Paragraph 1163. Obstacle clearance requirements greater than 500 feet need not be applied unless required in the interest of safety due to precipitous terrain or radar system peculiarities.

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

1165. GLIDE SLOPE. Required obstacle clearance is specified in Paragraph 1164. In addition, consideration shall be given to the following in the selection of the glide slope angle:

a. If angles less than 3 degrees are established, the obstacle clearance requirements shall be arrived at in accordance with Paragraphs 1024 and 1025.

b. Angles greater than 6 degrees shall not be established without authorization of the approving authority. The angle selected should be no greater than that required to provide obstacle clearance.

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

1166. RELOCATION OF THE GLIDE SLOPE. Paragraph 1027 does not apply. The GPI shall normally be located at the arrival edge of the landing area. If obstacle clearance requirements cannot be satisfied, or if other operational advantages will result, the GPI may be moved into the landing area provided sufficient landing area is available forward of the displaced or relocated GPI.

1167. ADJUSTMENT OF DH. An adjustment is required whenever the angle to be used exceeds 3.8 degrees. See Table 29. This adjustment is necessary to provide ample deceleration distance between the DH point and the landing area.

1168. MISSED APPROACH OBSTACLE CLEARANCE. No obstacle may penetrate a 20:1 missed approach surface which overlies the missed

Table 29. MINIMUM DH – GS ANGLE RELATIONSHIP.
Par. 1167.

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

approach areas illustrated in Figures 113, 114 and 115. The missed approach surface originates at the GPI. However, to gain relief from *existing* obstacles in the missed approach area the point at which the surface originates may be relocated as far backward from the GPI as a point on the final approach course which is directly below the MAP. In such cases the surface originates at a height below the DH as specified in Table 30. See Figure 112.

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

1169. STRAIGHT MISSED APPROACH AREA. The straight missed approach (maximum of 15 degree turn from final approach course) area starts at the MAP and extends to 7.5 miles.

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

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

(2) Section 1B is centered on the missed approach course. It begins at the GPI and extends to a point 1 mile from the MAP outward along the missed

Table 30. BEGINNING POINT OF MISSED APPROACH SURFACE. Par. 1168.

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

NOTE: This table may be interpolated.

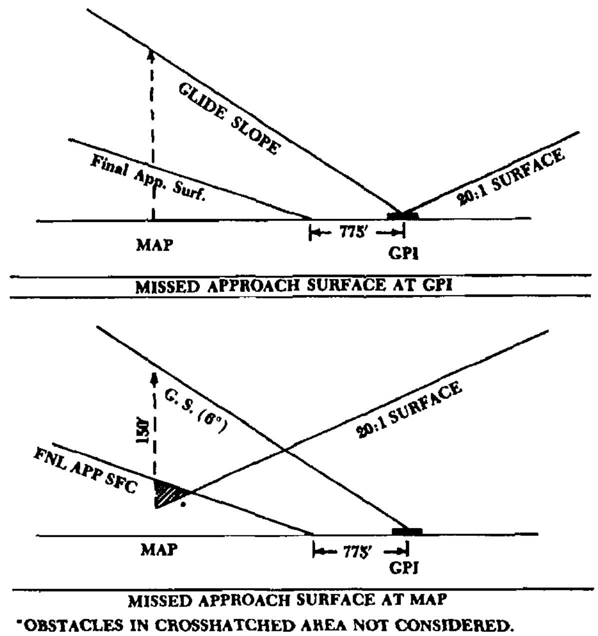


Figure 112. MISSED APPROACH SURFAC? OPTIONS (Par 1168)

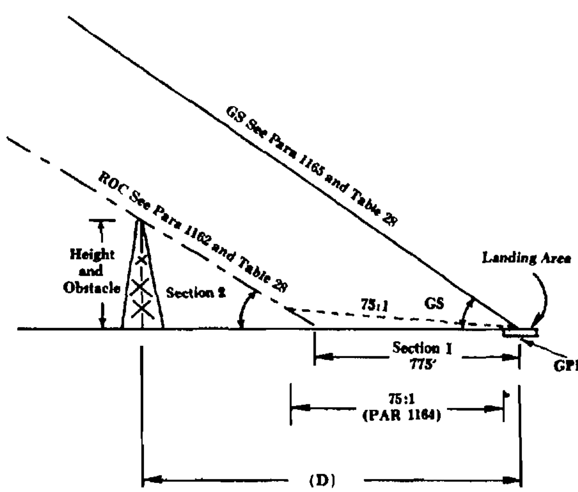


Figure 111. FINAL APPROACH AREA SURFACE AND OBSTACLE CLEARANCE. Paragraphs 1162 and 1164.

approach course. It has a beginning width the same as the final approach area at the MAP and expands uniformly to 4000 feet at 1 mile from the MAP.

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

b. Secondary Area. The secondary area begins at the MAP, where it has the same width as the final approach secondary area. In Section 1A the width remains constant from the MAP to the GPI, after which it increases uniformly to the appropriate airway width at 7.5 miles from the MAP. See Figure 113.

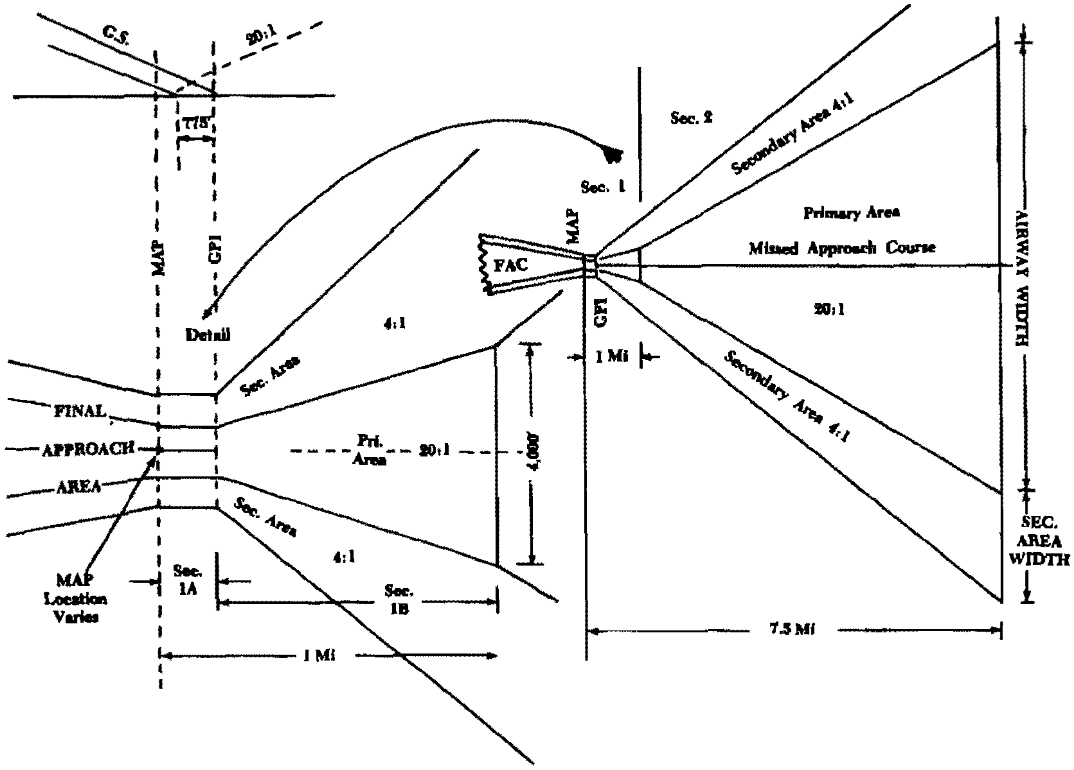


Figure 113. STRAIGHT MISSED APPROACH.

1170. TURNING MISSED APPROACH AREA. Where turns of more than 15 degrees are required in a missed approach procedure, they shall commence at an altitude which is at least 400 feet above the elevation of the landing area. Such turns are assumed to commence at the point where Section 2 begins. The turning flight track radius shall be 4000 feet (.66 miles).

a. *Primary Area.* The outer boundary of the Section 2 primary area shall be drawn with a 1.3 mile radius. The inner boundary shall commence at the beginning of Section 1B. The outer and inner boundary shall flare to the width of an initial approach area 7.5 miles from the MAP.

b. *Secondary Area.* Secondary areas for reduction of obstacle clearance are identified with Section 2. The secondary areas begin after completion of the turn. They are zero miles wide at the point of beginning and increase uniformly to the appropriate airway width at the end of Section 2. Positive course guidance is required to reduce obstacle clearance in the secondary area. See Figure 114.

1171. COMBINATION STRAIGHT AND TURNING MISSED APPROACH AREA. If a straight climb to an altitude greater than 400 feet is necessary prior to commencing a missed approach turn, a combination straight and turning missed approach area must be constructed. The straight portion of this missed approach area is divided into Sections 1 and 2A. The portion in which the turn is made is Section 2B.

a. *Straight Portion.* Sections 1 and 2A correspond respectively to Sections 1 and 2 of the normal straight missed approach area and are constructed

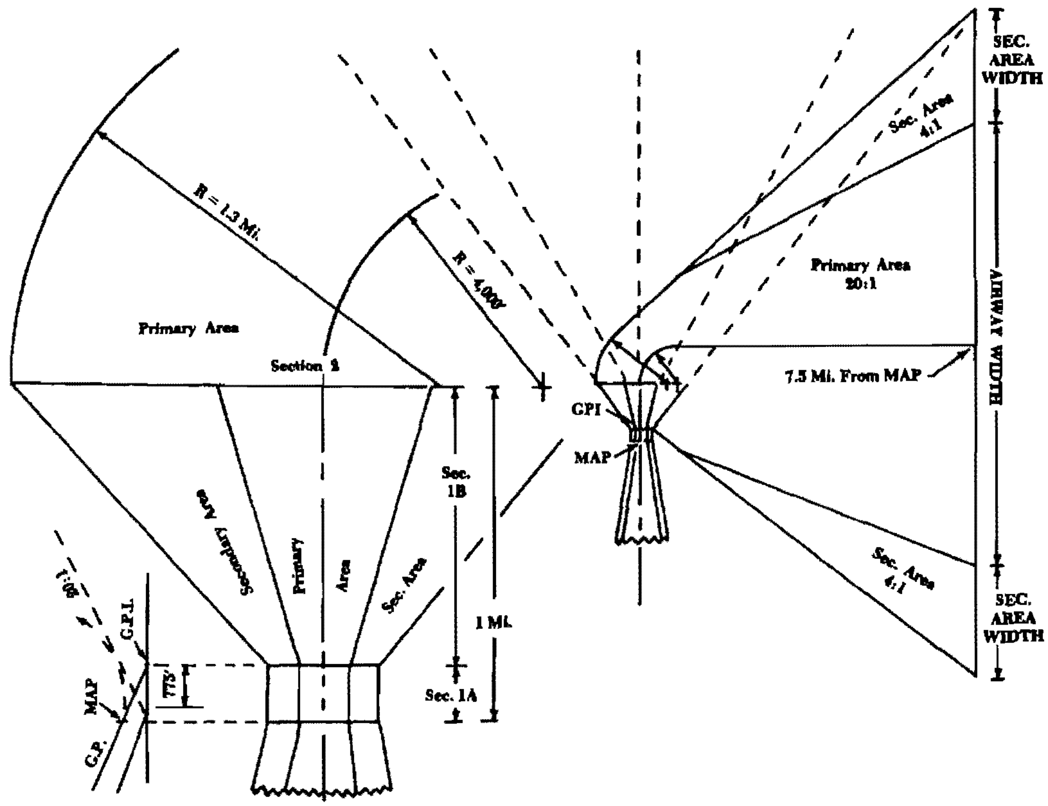


Figure 114. TURNING MISSED APPROACH AREA.
Par 1170.

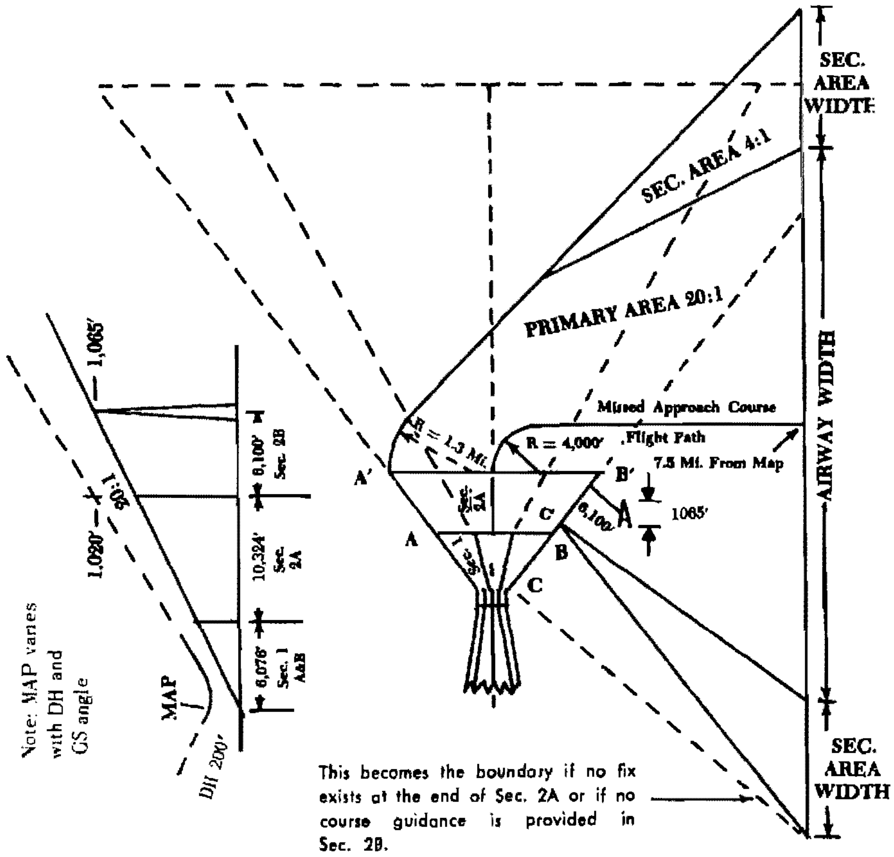
as specified in Paragraph 1169 except that Section 2A has no secondary areas. Obstacle clearance is provided as specified in Paragraph 1119. The length of Section 2A is determined as shown in Figure 115, and relates to the need to climb to a specified altitude prior to commencing the turn. The line A'-B' marks the end of Section 2A. Point C' is 5300 feet from the end of Section 2A.

b. Turning Portion. Section 2B is constructed as specified in Paragraph 1169 except that it begins at the end of Section 2A instead of the end of Section 1. To determine the height which must be attained before commencing the missed approach turn, first identify the controlling obstacle on the side of Section 2A to which the turn is to be made. Then measure the distance from this obstacle to the nearest edge of the Section 2A area. Using this distance as illustrated in Figure 115, determine the height of the 20:1 slope at the edge of Section 2A. This height plus 250 feet (rounded off to the next higher 20 foot increment) is the height at which the turn should be started. Obstacle clearance requirements in Section 2B are the same as those specified in Paragraph 1121 except that Section 2B is expanded to start at Point C if no fix exists at the end of Section 2A or if no course guidance is provided in Section 2 (see Figure 115).

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

Section 11. Airport Surveillance Radar (ASR)

1172. INITIAL APPROACH SEGMENT. Paragraph 1041.a.(1) applies except that 90 degrees is changed to 120 degrees.



EXAMPLE:

DH is 200' MSL.

A 1065' controlling obstacle is 6100' from the near edge of Sec. 2A.

A 20:1 surface which clears the obstacle has a height of 760' MSL at the near edge of Section 2A.

6100' ÷ 20' = 305'

1065 − 305 = 760'

To determine minimum altitude at which the missed approach aircraft may start the turn add 250' obstacle clearance and round up the sum to the next higher 20' increment.

760' + 250' = 1010'

Rounded up = 1020'

To climb 820' from DH 200' to the turning altitude (1020' MSL) at the 20:1 climb gradient requires 16,400'. Sec. 1 is 6076' long; therefore Section 2A is required to be 10,324' long.

Figure 115. COMBINATION STRAIGHT AND TURNING MISSED APPROACH. Paragraph 1171.

1173. INTERMEDIATE APPROACH SEGMENT. Paragraph 1042.b. applies with the exception that the maximum angle of intercept is changed to 120 degrees and Table 24 is used to determine the required minimum length of the intermediate segment.

1174. FINAL APPROACH SEGMENT. Paragraph 1044 applies except for subparagraphs a., c.(2) and d.

a. Alignment. Paragraphs 1116.a. and b. apply.

1175. MISSED APPROACH POINT. The identification of the MAP in Paragraph 1048 is changed as follows. The missed approach point is a point on the final approach course which is not farther than 2600 feet from the center of the landing area. See Figure 108. For point in space approaches the MAP is on the final approach course at the end of the final approach area.

1176.–1199. RESERVED.

CHAPTER 14. SIMPLIFIED DIRECTIONAL FACILITIES (SDF) PROCEDURES

1400. GENERAL. This chapter applies to approach procedures based on Simplified Directional Facilities (SDF). "SDF" is a directional aid facility providing only lateral guidance (front or back course) for approach from a final approach fix.

1401.-1409. RESERVED.

1410. FEEDER ROUTES. Criteria for feeder routes are contained in paragraph 220.

1411. INITIAL APPROACH SEGMENT. Criteria for the initial approach segment are contained in chapter 2, section 3

1412. INTERMEDIATE APPROACH SEGMENT. Criteria for the intermediate approach segment are contained in chapter 2, section 4.

1413. FINAL APPROACH SEGMENT. The final approach shall be made only "TOWARD" the facility because of system characteristics. The final approach segment begins at the final approach fix and ends at the missed approach point.

a. Alignment. The alignment of the final approach course with the runway centerline determines whether a straight-in or circling-only approach may be established.

(1) Straight-in. The angle of convergence of the final approach course and the extended runway centerline shall not exceed 30°. The final approach course should be aligned to intersect the extended runway centerline 3,000 feet outward from the runway threshold. When an operational advantage can be achieved, this point of intersection may be established at any point between the threshold and a point 5,200 feet outward from the threshold. Also, where an operational advantage can be achieved, a final approach course which does not intersect the runway center, or which intersects it at a distance greater than 5,200 feet from the threshold may be established, provided that such a course lies within 500 feet laterally of the extended runway centerline at a point 3,000 feet outward from the runway threshold (see figure 48).

(2) Circling Approach. When the final approach course alignment does not meet the criteria for a straight-in landing, only a circling approach shall be authorized, and the course alignment should be made to the center of the landing area. When an operational advantage can be achieved, the final approach course may be aligned to any portion of the usable landing surface (see figure 49).

b. Area. The area considered for obstacle clearance in the final approach segment starts at the final approach fix (FAF) and ends at, or abeam, the runway threshold. It is a portion of a 10-mile long trapezoid that is centered longitudinally on the final approach course (see figure 14-1). For 6° course width facilities, it is 1,000 feet wide at, or abeam, the runway threshold and expands uniformly to 19,228 feet at 10 miles from the threshold. For 12° course width facilities, it is 2,800 feet wide at, or abeam, the runway threshold and expands uniformly to a width of 21,028 feet at 10 miles from the threshold. For course widths between 6° and 12°, the area considered for obstacle clearance may be extrapolated from the 6° and 12° figures to the next intermediate whole degree. For example, the width of the obstacle clearance area for a 9° course width would start at 1,900 feet and expand to 20,148 feet. The OPTIMUM length of the final approach segment is 5 miles. The MAXIMUM length is 10 miles. The MINIMUM length of the final approach segment shall provide adequate distance for an aircraft to make the required descent, and to regain course alignment when a turn is required over the facility. Table 14 shall be used to determine the minimum length needed to regain the course.

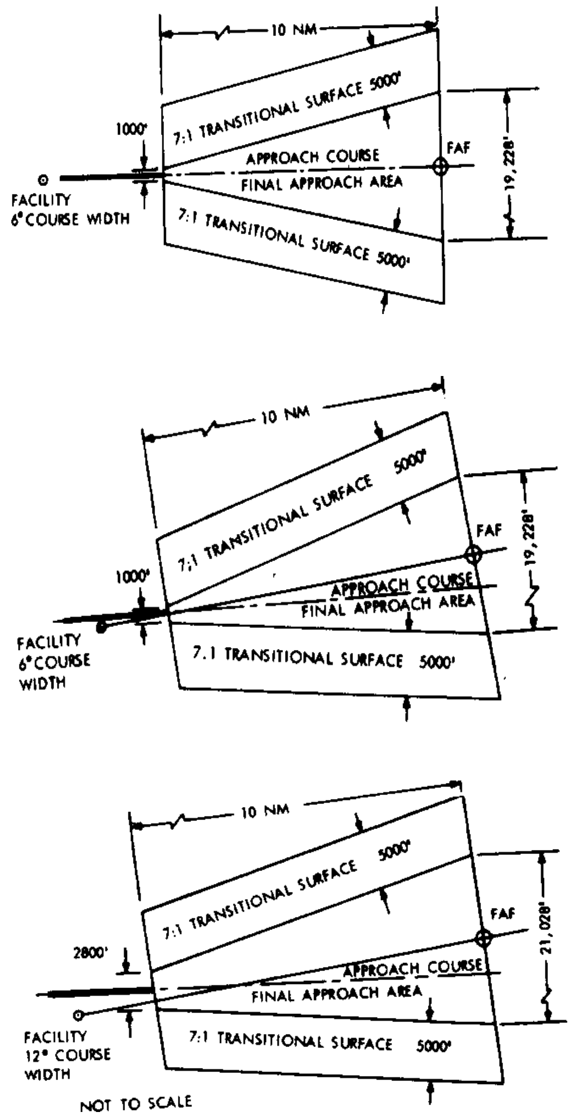


Figure 14-1. FINAL APPROACH AREAS WITH FAF.

c. Transitional Surfaces. Transitional surfaces are inclined planes with a slope of 7:1 that extend upward and outward 5,000 feet from the edge of the final approach area. The transitional surfaces begin at a height no less than 250 feet below the MDA .

d. Obstacle Clearance.

(1) Straight-in Landing. The minimum obstacle clearance in the final approach area shall be 250 feet. In addition, the MDA established for the final approach area shall assure that no obstacles penetrate the transitional surfaces.

(2) Circling Approach. In addition to the minimum requirements specified in paragraph 1413d(1), obstacle clearance in the circling area shall be as prescribed in chapter 2, section 6.

e. Descent Gradient. Criteria for descent gradient are specified in paragraph 252.

f. Use of Fixes. Criteria for the use of radio fixes are contained in chapter 2, section 8.

g. Minimum Descent Altitudes. Criteria for determining the MDA are contained in chapter 3, section 2.

1414. MISSED APPROACH SEGMENT. Criteria for the missed approach segment are contained in chapter 2, section 7. For SDF procedures the missed approach point is a point on the final approach course that is NOT farther from the final approach fix than the runway threshold (first usable portion of the landing area for circling). The missed approach surface shall commence over the missed approach point at the required height. See paragraph 274, missed approach obstacle clearance.

1415. BACK COURSE PROCEDURES. Back course SDF procedures may be developed using these criteria except that the beginning point of the final approach obstacle clearance trapezoid is at the facility.

1416.-1499. RESERVED.

CHAPTER 15. AREA NAVIGATION (RNAV)

1500. GENERAL. This chapter applies to instrument procedures based on area navigation systems. Separate criteria are presented for VOR/DME and non-VOR/DME RNAV systems.

a. VOR/DME Systems. This includes systems using signals based solely upon VOR/DME, VORTAC, and TACAN facilities. VOR/DME is synonymous with the terms VORTAC or TACAN.

b. Non-VOR/DME Systems.

(1) **Self-contained systems**, including inertial navigation system (INS) and Doppler.

(2) **Loran-C, Omega** and Rho-Rho ground-based systems.

(3) **Multi-sensor systems.** Those which use a combination of input information.

1501. TERMINOLOGY. The following terms, peculiar to RNAV procedures, are defined as follows:

a. APT WP. A WP located on the FAC at or abeam the first usable landing surface, which is used for construction of the final approach area for a circling-only approach. (LORAN circling approaches only).

b. Alongtrack Distance (ATD). The ATD fix is an alongtrack (ATRK) position defined as a distance in NM, with reference to the next WP.

c. ATRK Fix Displacement Tolerance. Fix displacement tolerance along the flight track.

d. Crosstrack (XTRK) Fix Displacement Tolerance. Fix displacement tolerance to the left or right of the flight track.

e. Instrument Approach Waypoint. Fixes used in defining RNAV IAP's, including the feeder waypoint (FWP), the initial approach waypoint (IAWP), the intermediate waypoint (IWP), the final approach waypoint (FAWP), the RWY WP, and the APT WP, when required.

f. Non-VOR/DME RNAV is not dependent upon a reference facility and will hereinafter be referred to as non-VOR/DME, which includes the following:

(1) **Long-Range Navigation (Loran-C).** Loran-C is a long-range radio navigation system. A Loran-C "chain" consists of four transmitting facilities, a master and three secondaries, each transmitting in the same group repetition interval (GRI).

(2) **Omega.** A low frequency navigation system using precise timed pulsed signals from eight ground transmitting stations spaced long distances apart. Limited to en route only.

(3) **Inertial Navigation System (INS).** A self-contained system which utilizes gyros to determine angular motion and accelerometers to determine linear motion. They are integrated with computers to provide several conditions which include true heading, true air speed, wind, a glidepath, velocity, and position.

(4) **Doppler.** A self-contained system which determines velocity and position by the frequency shift of a signal transmitted from the aircraft and reflected from the surface back to the aircraft.

(5) **Global Positioning System (GPS).** A system of satellites providing three-dimensional position and velocity information. Position and velocity information is based on the measurement of the transit time of radio frequency (RF) signals from satellites.

(6) **Rho-Rho.** A system based on two or more DME ground facilities.

(7) **Multi-Sensor System.** Based on any VOR/DME or non-VOR/DME certified approved system or a combination of certified approved systems. The non-VOR/DME criteria apply.

g. Reference Facility. A VOR/DME, VORTAC or TACAN facility used for the identification and establishment of an RNAV route, WP, or SIAP.

h. RNAV Descent Angle. A vertical angle defining a descending flightpath from the FAF to the RWY WP.

i. Routes. Two subsequently related WP's or ATD fixes define a route segment.

(1) **Jet/Victor Routes.**

(2) **Random Routes.** Any airway not established under the jet/victor designation. This is normally used to refer to a route that is not based on VOR radials and requires an RNAV system.

j. RWY WP. A WP located at the runway threshold and used for construction of the final approach area when the FAC meets straight-in alignment criteria.

k. Tangent Point (TP). The point on the VOR/DME RNAV route centerline from which a line perpendicular to the route centerline would pass through the reference facility.

l. Tangent Point Distance (TPD). Distance from the reference facility to the TP.

m. Time Difference (TD) Corrections. Loran-C systems use the time of signal travel from ground facilities to the aircraft to compute distance and position. The time of signal travel varies seasonally within certain geographical areas. The TD correction factor is used to correct these seasonal variations for each geographical area. RNAV criteria assume local TD corrections will be applied.

n. Turn Anticipation. The capability of RNAV systems to determine the point along a course, prior to a turn WP, where a turn should be initiated to provide a smooth path to intercept the succeeding course, and to enunciate the information to the pilot.

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

p. VOR/DME RNAV is dependent on VOR/DME, VORTAC, or TACAN. It is a system using radials and distances to compute position and flight track and will hereinafter be referred to as VOR/DME.

q. WP. A predetermined geographical position used for route definition and progress reporting purposes that is defined by latitude/longitude. For VOR/DME systems, it is defined by the radial/distance of the position from the reference facility.

r. WP Displacement Area. The rectangular area formed around and centered on the plotted position of a WP. Its dimensions are plus-and-minus the appropriate ATRK and XTRK fix displacement tolerance values which are found in tables 15-1, 15-2, and 15-3.

1502. PROCEDURE CONSTRUCTION. RNAV procedural construction requirements are as follows:

a. Reference Facility. An RNAV approach procedure shall be supported by a single reference facility.

b. WP. A WP shall be used to identify the point at which RNAV begins and the point at which RNAV ends, except when the RNAV portion of the procedure terminates at the MAP, and the MAP is an ATD fix.

c. Segment. Approach segments begin and end at the WP or ATD fix.

(1) **The segment area** considered for obstacle clearance begins at the earliest point the WP or ATD fix can be received and, except for the final approach segment, ends at the plotted position of the fix.

(2) **Segment length** is based on the distance between the plotted positions of the WP or ATD fix defining the segment ends.

(3) **Segment widths** are specified in appropriate paragraphs of this chapter, but in no case will they be narrower than XTRK fix displacement tolerances for that segment.

(4) **Minimum segment widths** are also determined/limited in part according to WP location relative to the reference facility. This limiting relationship is depicted in figure 15-2 and explained in the note following figure 15-2.

d. Fix Displacement. Except in the case of the MAP overlapping the RWY WP or APT WP (see paragraph 1532), the ATRK fix displacement tolerance shall not overlap the plotted position of the adjacent fix. Additionally, except for a turn at a MAP designated by a WP, WP displacement tolerances shall be oriented along the courses leading to and from the respective WP (see figure 15-17).

e. Turning Areas. Turning area expansion criteria shall be applied to all turns, en route and terminal, where a change of direction of more than 15° is involved. See paragraphs 1510c and 1520.

f. Cone of Ambiguity. The primary obstacle clearance area at the minimum segment altitude shall not be within the cone of ambiguity of the reference facility. If the primary area for the desired course lies within the cone of ambiguity, the course should be relocated or the facility flight inspected to verify that the signal is adequate within the area. FAA Order 9840.1, U.S. National Aviation Handbook for the VOR/DME/TACAN Systems, defines the vertical angle coverage. Azimuth signal information permitting satisfactory performance of airborne components is not provided beyond the following ranges:

(1) **VOR** - beyond 60° above the radio horizon.

(2) TACAN - beyond 40° above the radio horizon (see figure 15-1).

g. **Use of ATD Fixes.** ATD fixes are normally used in lieu of approach WP's when no course change is required at that point. An ATD fix shall not be used in lieu of a RWY WP. The FAF, MAP, and any stepdown fixes may be defined by ATD fixes.

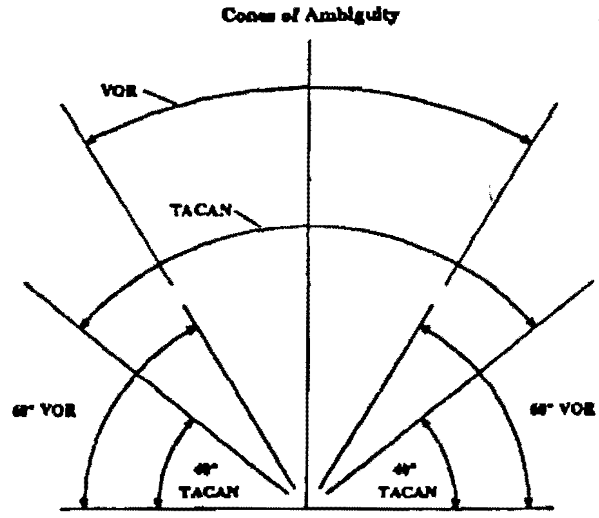


Figure 15-1. CONES OF AMBIGUITY. Par 1502.

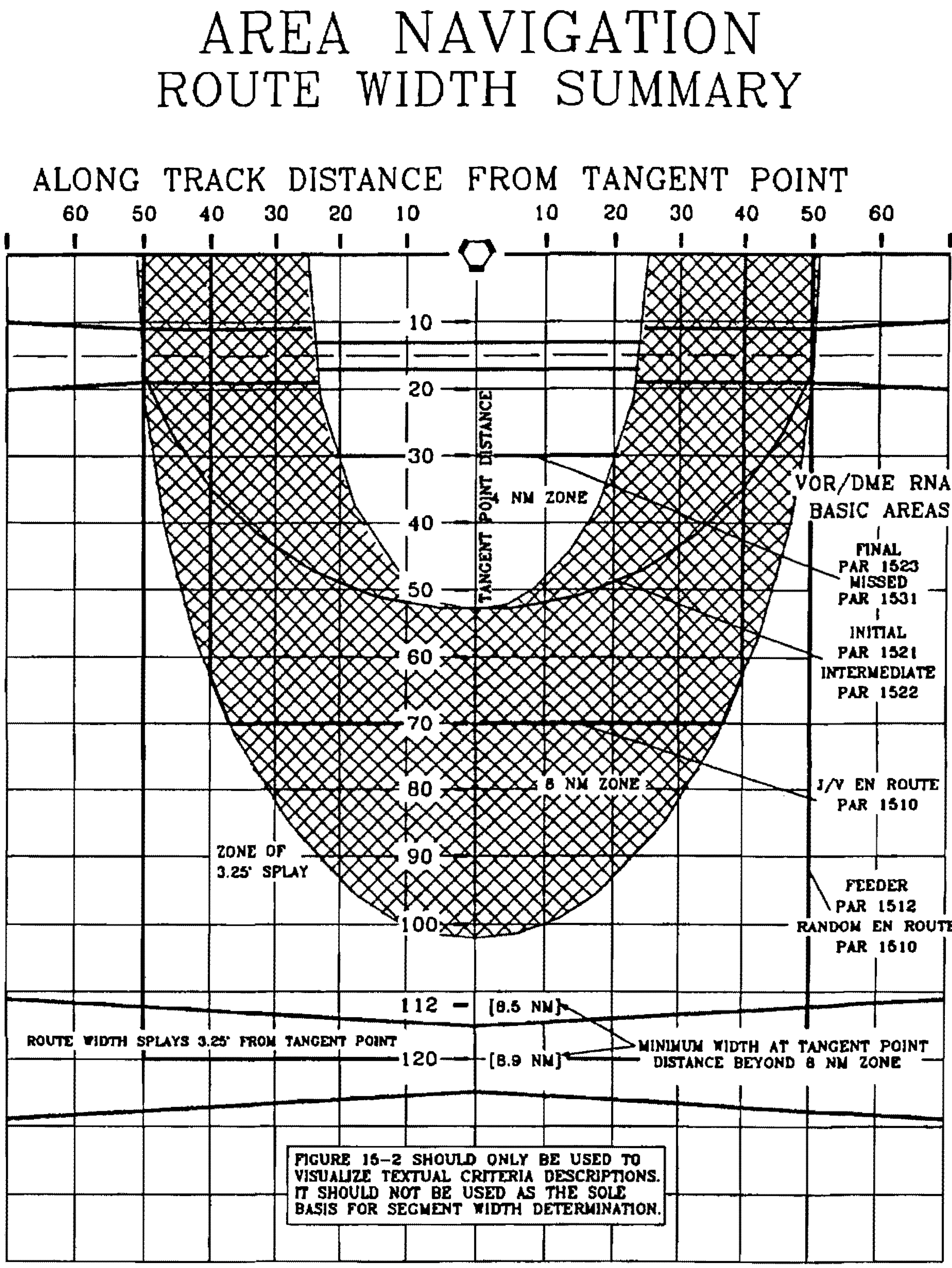


Figure 15-2. Par 1502.

NOTE: Segment width (for instance at a specific WP) is based upon a mathematical relationship between TPD, and the ATD from the TP, at that point. This relationship is represented by the two elliptical curves shown on figure 15-2. One curve encloses the "4 NM ZONE" wherein the segment primary area width is ± 2 miles from route centerline. The other curve encloses the "8 NM ZONE" wherein the segment primary area width is ± 4 miles from route centerline.

The formula for the 4 NM ZONE curve is: $\frac{X^2}{(25.5)^2}+\frac{Y^2}{(53)^2}=1$

The formula for the 8 NM ZONE curve is: $\frac{X^2}{(51)^2}+\frac{Y^2}{(102)^2}=1$

where X = ATD from the TP
and, Y = TPD

APPLICATION:

4 NM ZONE: To determine the maximum acceptable ATD value associated with a given TPD value and still allow segment primary width at ± 2 miles.

Given: TPD = 40 miles (this is the Y-term)
Find: ATD value (this is the X-term)

$$X=25.5\sqrt{1-\frac{Y^2}{(53)^2}}$$

$$X=25.5\sqrt{1-\frac{(40)^2}{(53)^2}}=16.73 \text{ miles}$$

i.e., for TPD at 40 miles, if the ATD exceeds 16.73 miles, the primary area width must be expanded to ± 4 miles.

8 NM ZONE: Given: ATD = 30 miles
Find: TPD Maximum for ± 4 miles width

$$Y=102\sqrt{1-\frac{X^2}{(51)^2}}$$

$$Y=102\sqrt{1-\frac{(30)^2}{(51)^2}}=82.49 \text{ miles}$$

i.e., for ATD at 30 miles, the TPD must not exceed 82.49 miles and still allow ± 4 miles width.

APPLICATION: The formulas can tell you whether the specific point is inside or outside either zone area. For instance:

Given: ATD = 40 miles, and TPD = 65 miles. Determine if the location is within the 8 NM ZONE.

The basic formula for the 8 NM ZONE is an equation made equal to 1. By substituting the specific values (ATD = 40, and TPD = 65), the point will be determined to be OUTSIDE the zone if the resultant is > 1, and INSIDE the zone if the resultant is < or = to 1.

$$\frac{x^2}{(51)^2}+\frac{y^2}{(102)^2}=1$$

by substitution:

$$\frac{(40)^2}{(51)^2}+\frac{(65)^2}{(102)^2}=0.615+0.406=1.021$$

Since this is >1, the point lies OUTSIDE the 8 NM ZONE.

For distances beyond 102 miles of the TPD, the route width expands an additional 0.25 miles each side of the route centerline for each 10 miles the TPD is beyond 102 miles.

Example: 112 NM-102 NM = 10 NM beyond 102 TPD.

a. (10 NM/10 NM) X .25 NM (rate per 10 NM) = 0.25 increase.

b. 0.25 NM + 4 NM = 4.25 NM each side centerline.

c. 4.25 X 2 = 8.5 NM (total width) at the 112 TPD.

h. PCG. All RNAV segments shall be based on PCG, except that a missed approach segment without PCG may be developed when considered to provide operational advantages and can be allowed within the obstacle environment.

1503. RESERVED.

1504. REFERENCE FACILITIES. Reference facilities shall have collocated VOR and DME components. For terminal procedures, components within 100 feet of each other are defined as collocated. For en route procedures, components within 2,000 feet of each other are defined as collocated.

1505. WP's. RNAV WP's are used for navigation reference and for ATC operational fixes, similar to VOR/DME ground stations, and intersections used in the conventional VOR structures.

a. Establishment. WP's shall be established along RNAV routes at the following points:

(1) At end points.

(2) At points where the route changes course.

(3) At holding fixes.

(4) At other points of operational benefit, such as route junction points which require clarity.

(5) For VOR/DME WP's, one WP must be associated with each reference facility used for en route navigation requirements. If a segment length exceeds 80 miles and no turning requirement exists along the route, establish a WP at the TP.

b. WP. WP placement is limited by the type of RNAV system as follows:

(1) VOR/DME WP's or route segments shall not be established outside of the service volume of the reference facility and shall be limited to the values contained in tables 15-1 and 15-2.

(2) Non-VOR/DME WP's or route segments shall not be established outside of the area in which the particular system signal has been approved for IFR operation.

(3) **Self-contained systems** such as INS and Doppler do not have limitations on WP placement.

(4) **Fix Displacement Tolerances.** Tables 15-1 and 15-2 show fix displacement tolerances for VOR/DME systems. Table 15-3 shows fix displacement tolerances for non-VOR/DME systems. When the fix is an ATD fix, the ATRK fix and XTRK displacement tolerances are considered to be the same as a WP located at that fix.

c. Defined WP Requirements.

(1) **VOR/DME WP's.** Each WP shall be defined by:

(a) **A VOR radial** - developed to the nearest hundredth of a degree.

(b) **DME distance** - developed to the nearest hundredth of a mile; and

(c) **Latitude/longitude** - in degrees, minutes, and seconds to the nearest hundredth.

(2) **Non-VOR/DME WP's.** Each WP shall be defined by latitude and longitude in degrees, minutes, and seconds developed to the nearest hundredth. Rho-Rho WP's shall also be developed to the nearest hundredth of a mile.

(3) **Station elevation** of the reference facility shall be defined and rounded to the nearest 20-foot increment.

1506. RWY WP AND APT WP. Straight-in procedures shall incorporate a WP at the runway threshold. Circling procedures shall incorporate an APT WP at or abeam the first usable landing surface. See figure 15-3. These WP's are used to establish the length and width of the final approach area.

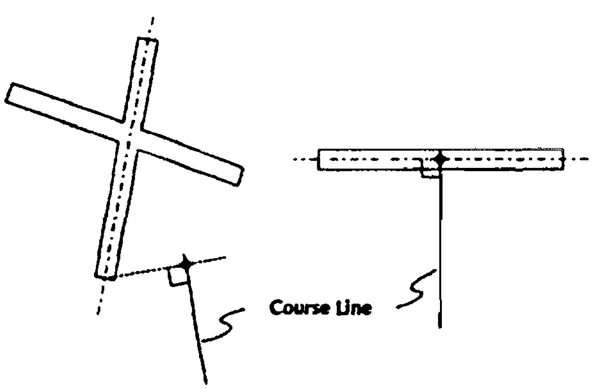


Figure 15-3. LOCATION OF APT WP.
Par 1506.

1507. HOLDING. Chapter 2, section 9, applies, except for paragraph 292d. When holding is at an RNAV fix, the selected pattern shall be large enough to contain the entire area of the fix displacement tolerance within the primary area of the holding pattern.

a. VOR/DME Pattern Size Selection. For VOR/DME, the distance from the WP to the reference facility shall be applied as the "fix-to-NAVAID distance" in FAA Order 7130.3, Holding Pattern Criteria, figure 3, pattern-template selection.

b. Non-VOR/DME Pattern Size Selection. For non-VOR/DME, use the 15-29.9 NM distance column for terminal holding procedure, and 30 NM or over column for en route holding, FAA Order 7130.3.

1508.-1509. RESERVED.

SECTION 1. EN ROUTE CRITERIA.

1510. EN ROUTE OBSTACLE CLEARANCE AREAS. En route obstacle clearance areas are identified as primary and secondary. These designations apply to straight and turning segment obstacle clearance areas. The required angle of turn connecting en route segments to other en route, feeder, or initial approach segments shall not exceed 120°. Where the turn exceeds 15°, expanded turning area construction methods in paragraph 1510c apply.

a. Primary Area. The primary obstacle clearance area is described as follows:

(1) **VOR/DME Basic Area.** The area is 4 miles each side of the route centerline, when the TPD is 102 miles or less and the TPD/ATD values do not exceed the limits of the 8 NM zone. The width increases at an angle of 3.25° as the ATD increases for that portion of the area where the route centerline lies outside the 8 NM zone. See figure 15-4. When the TPD exceeds the 102-mile limit, the minimum width at the TPD expands greater than $\pm$ 4 miles at a rate of 0.25 miles on each side of the route for each 10 miles the TPD is beyond 102 miles. See figures 15-2, 15-5, and table 15-1. When the widths of adjoining route segments are unequal for reasons other than transition of zone boundaries, the following apply:

(a) If the TP of the narrower segment is on the route centerline, the width of the narrower segment includes that additional airspace within the lateral extremity of the wider segment, where the route segments join, thence toward the TP of the narrower route segment until intersecting the boundary of the narrower segment (see figure 15-6).

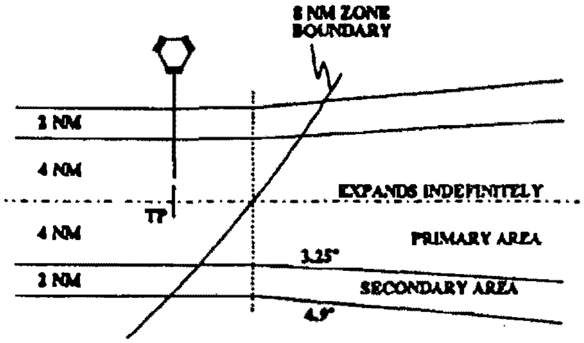


Figure 15-4. VOR/DME BASIC AREA. Par 1510a(1)

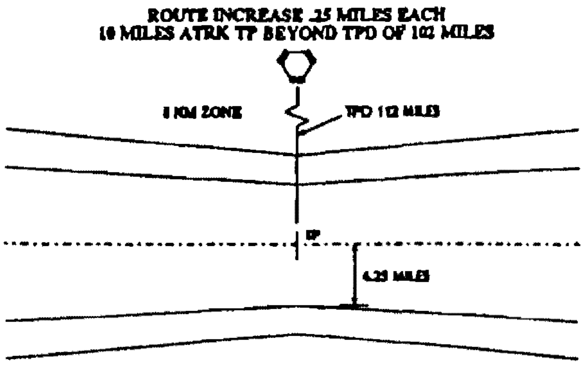


Figure 15-5. VOR/DME BASIC AREA. Par 1510a(1) and b(1).

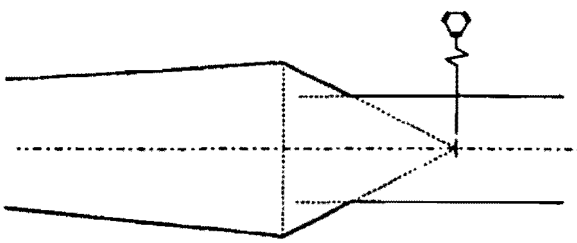


Figure 15-6. UNEQUAL JOINING ROUTE SEGMENTS. Par 1510a(1)(a).

(b) If the TP of the narrower segment is on the route centerline extended, the width of the narrower segment includes that additional airspace within lines from the lateral extremity of the wider segment where the route segments join, thence toward the TP until reaching the point where the narrower segment terminates, changes direction, or until intersecting the boundary of the narrower segment (see figure 15-7).

(2) Non-VOR/DME Basic Area. The area is 4 miles each side of the route centerline at all points. Non-VOR/DME primary boundary lines do not splay.

(3) Termination Point. An RNAV route termination point shall be at a WP. The primary area extends beyond the route termination point. The boundary of the area is defined by an arc which connects the two primary boundary lines. The center of the arc is located at the most distant point on the edge of the WP displacement area on the route centerline (see figure 15-8).

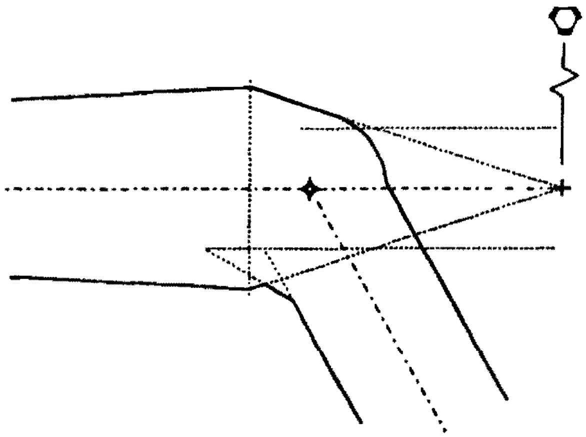


Figure 15-7. UNEQUAL JOINING ROUTE SEGMENTS WITH A TURN. Par 1510a(1)(b).

b. Secondary Areas.

(1) VOR/DME Basic Area. The VOR/DME secondary obstacle clearance area extends 2 miles on each side of the primary area and splays 4.9° where the primary splays at 3.25°. See figure 15-4. The secondary area beginning width does not increase beyond the 102-mile TPD.

(2) Non-VOR/DME Basic Area. The non-VOR/DME secondary obstacle clearance areas are a constant 2-mile lateral extension on each side of the primary area.

(3) Termination Point. The secondary obstacle clearance area extends beyond the arc which defines the termination point primary area by an amount equal to the width of the secondary area at the latest point the WP can be received (see figure 15-8).

c. Construction of Expanded Turning Areas. Obstacle clearance areas shall be expanded to accommodate turns of more than 15°. The primary and secondary obstacle clearance turning areas are expanded by outside and inside areas (see figure 15-9). The inside expansion area is constructed to accommodate a turn anticipation area. Outside expansion area is provided to accommodate overshoot at high speeds and excessive wind conditions. No portion of the primary area at the minimum segment altitude may be in the cone of ambiguity for VOR/DME RNAV routes.

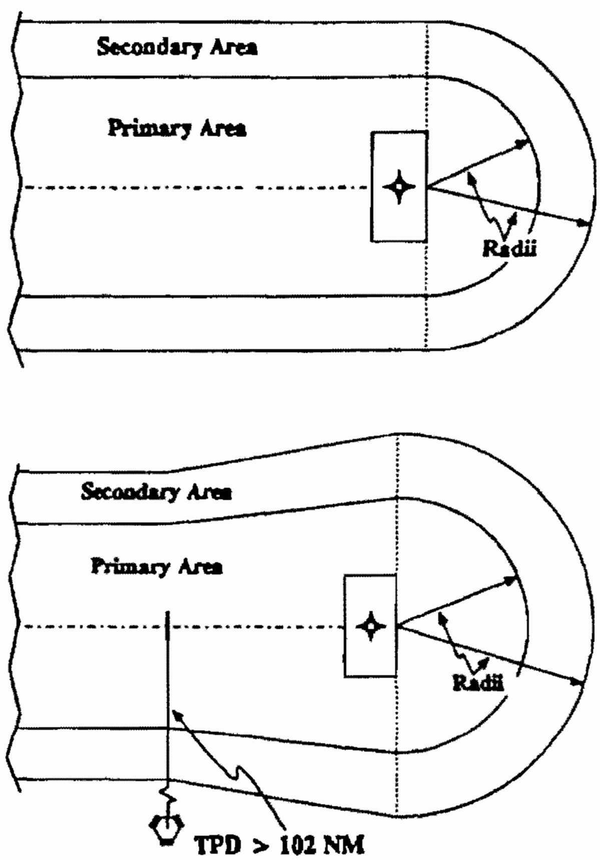


Figure 15-8. TERMINATION POINTS. Par 1510a(3) and 1510b(3).

(1) Outside Expansion Area. Determine the expanded area at the outside of the turn as follows:

(a) Construct a line perpendicular to the route centerline 3 miles prior to the latest point the fix can be received or to a line perpendicular to the route centerline at the plotted position of the fix, whichever occurs last. For altitudes 10,000 feet or greater, construct a line perpendicular to the plotted position of the fix. This perpendicular line is a base line for constructing arc boundaries.

(b) From a point on the base line, strike an 8-mile arc from the outer line of the fix displacement area on the outside of the turn to a tangent line to a second 8-mile arc. The second arc is struck from a point on the base line inside the inner line of the fix displacement area to a 30° tangent line to the primary boundary line. From a point where an extension of the base line intersects the primary area outer boundary line, connect the 8-mile arc with a line tangent to the arc.

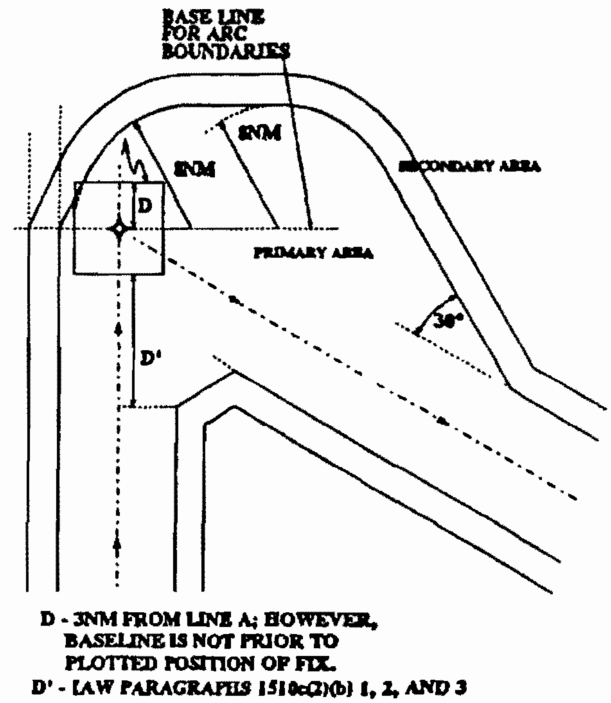


Figure 15-9. EXPANDED TURNING AREAS. Par 1510c.

(c) Strike arcs from the center points used for the primary area expansion and provide a parallel expansion of 2 miles of the secondary area at the turn.

(d) Connect the extremities with a straight-line tangent to the two associated arcs.

(e) Draw the remaining secondary area boundary 2 miles outside the boundary of the primary area.

(f) If the width of the primary area at the turn point is greater than 8 miles, the expanded area is constructed in the same manner, as outlined in paragraph 1510c(1), using the primary area width at the point where the route changes course as the radius of the arc in place of 8 NM and constructing the secondary area of constant width equal to the width of the secondary area at the turn point.

(2) Inside Expansion Area. Determine the expanded area at the inside of the turn as follows:

(a) Determine the fix area by application of the ATRK and XTRK fix displacement tolerances.

(b) Prior to the earliest point the WP (oriented along the course leading to the fix) can be received, locate a point on the primary area boundary at one of the following distances:

1 Three miles below 10,000 feet MSL; three and one-half miles when the turn exceeds 112°.

2 Seven miles for 10,000 feet MSL up to but not including FL 180.

3 Twelve miles for FL 180 and above.

(c) From this point, splay the primary area by an angle equal to one-half of the course change.

(d) Draw the secondary area boundary 2 miles outside the boundary of the primary area.

d. TPD/WP Limitation. WP's for the Jet/Victor Airway structure shall be limited to the 8 NM zone, a TPD of 70 miles or less, and an ATD fix from the TP of 40 miles or less. WP's for random airway structure shall be limited to a TPD of 120 miles or less and an ATD fix from the TP of 50 miles.

e. Joining RNAV with non-RNAV Route Segments.

(1) If the RNAV and non-RNAV segments have the same width at the point of transition, the segments are joined at that location and RNAV criteria are continued in the direction of the RNAV segment.

(2) If the RNAV segment is narrower at the location of the transition, the segments shall be joined according to paragraph 1512b(1)(b).

(3) If the RNAV segment is wider at the location of the transition, the boundaries shall taper from the transition location toward the non-RNAV segment at an angle of 30° until joining the boundaries at the RNAV segments. If the location of transition includes a turn, the width of the RNAV segment is maintained and the turn area constructed according to this chapter. After the completion of the turn area, the boundaries shall taper at an angle of 30° until passing the non-RNAV boundaries.

1511. OBSTACLE CLEARANCE. Paragraphs 1720 and 1721 apply, except that the width of the VOR/DME secondary area is 2 miles at the point of splay initiation and the value 236 feet for each additional mile in paragraph 1721 is changed to 176 feet/NM. Non-VOR/DME systems do not splay. Obstacles in the secondary area are measured perpendicular to the course centerline, except for the expanded turn areas. Obstacles in these areas are measured perpendicular to the primary area boundary, or its tangent, to the obstacle.

1512. FEEDER ROUTES. When the IAWP is not part of the en route structure, it may be necessary to designate feeder routes from the en route structure to another FWP or the IAWP.

a. The required angle of turn for the feeder-to-feeder and feeder-to-initial segment connections shall not exceed 120°. Where the angle exceeds 15°, turning area criteria in section 2 apply. En route vertical and lateral airway obstacle clearance criteria shall apply to feeder routes. The minimum altitudes established for feeder routes shall not be less than the altitude established at the IAWP. WP's for feeder routes shall be limited to a TPD of 120 miles or less and an ATD fix from the TP of 50 miles or less.

b. Obstacle Clearance Areas. Obstacle clearance areas are identified as primary and secondary. These designations apply to straight segment and turning segment obstacle clearance areas.

(1) Primary Area. The primary obstacle clearance area is derived from figure 15-2 and the associated formulas. It is described as follows:

(a) VOR/DME Basic Area. The area is 4 miles each side of the route centerline when the TPD is 102 miles or less and the TPD/ATD values do not exceed the limits of the 8 NM zone. The route width increases at an angle of 3.25° as the ATD increases for that portion of the area where the route centerline lies outside the 8 NM zone (see figure 15-4). When the TPD exceeds the 102-mile limit, the minimum width at the TP increases at a rate of 0.25 miles on each side of the route centerline for each 10 miles the TPD is beyond 102 miles. Methodology for joining route segments of differing widths is contained in paragraph 1510a(1). See table 15-2.

(b) Non-VOR/DME Basic Area. The area is 4 miles each side of the course centerline at all points, except for the 20-mile portion of the course just prior to the IAWP where it tapers linearly from 4 miles to 2 miles each side of centerline. Where a WP or a fix is located less than 20 miles prior to the IAWP, the taper begins at that point (see figure 15-10).

(2) Secondary Areas.

(a) VOR/DME Basic Areas. Secondary obstacle clearance areas extend laterally 2 miles on each side of the primary area and splay 4.9° in the region where the primary area splays at 3.25° (see figure 15-11 and paragraph 1512b(1)(a).

(b) Non-VOR/DME Basic Area. Non-VOR/DME secondary areas are a constant 2-mile lateral extension on each side of the primary area, except where the basic area tapers as specified in paragraph 1512b(1)(b). Over this area, the secondary area tapers linearly from 2 miles each side of the primary to 1 mile each side of the primary area.

(3) Obstacle Clearance. Paragraph 220 applies.

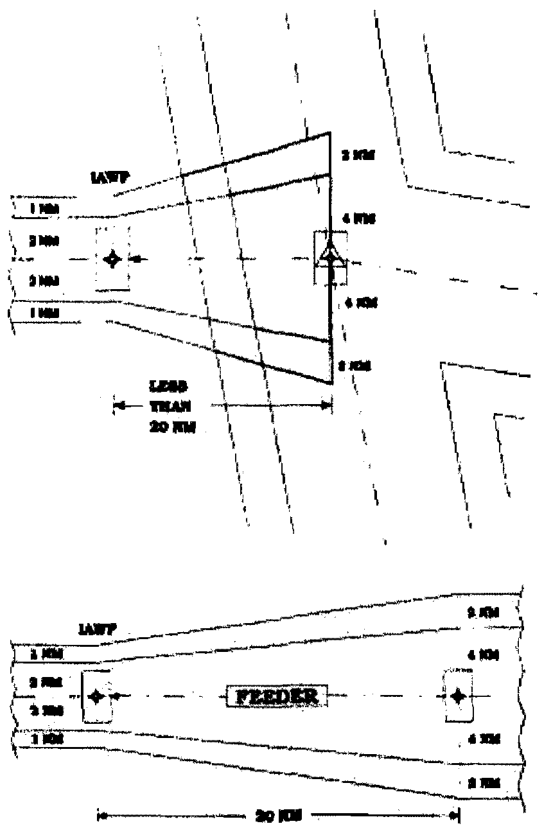


Figure 15-10. FEEDER ROUTES CONNECTING NON-VOR/DME BASIC AREAS. Par 1512b(1)(b).

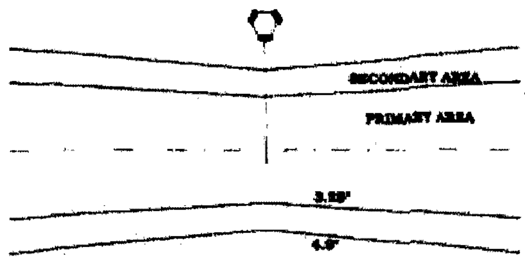


Figure 15-11. VOR/DME SECONDARY AREAS SPLAY 4.9°. Par 1512b(2)(a).

1513-1519. RESERVED.

SECTION 2. TERMINAL CRITERIA.

1520. TERMINAL TURNING AREA EXPANSION. Obstacle clearance areas shall be expanded to accommodate turn anticipation. Outside expansion is not required for terminal procedures. Inside expansion applies to all turns of more than 15° within SIAP's, except turns at the MAP. Paragraph 1534 satisfies early turn requirements for the MAP. Determine the expanded area at the inside of the turn as follows:

a. Determine the ATRK Fix Displacement Tolerance.

b. Locate a point on the edge of the primary area at a distance prior to the earliest point the WP can be received. The distance of turn anticipation (DTA) is measured parallel to the course leading to the fix and is determined by the turn anticipation formula:

$$DTA = 2 \times \tan(\text{turn angle} \div 2)$$

c. From this point, splay the primary area by an angle equal to one-half of the course change (see figure 15-12).

d. Secondary Area Boundary:

(1) When the obstacle clearance area boundaries of the preceding and following segments of the WP are parallel with the course centerline, construct the secondary area boundary, parallel with the expanded turn anticipation primary area boundary, using the width of the preceding segment secondary area.

(2) When the obstacle clearance area boundaries of the preceding and/or following segments taper, construct the secondary area boundary by connecting the secondary area at points abeam the primary expansion area where it connects to the preceding/following segments of the primary area boundaries.

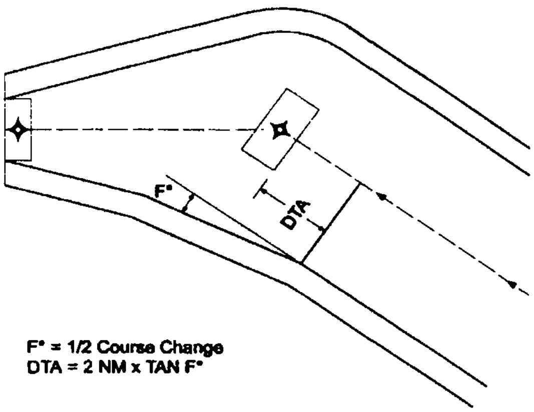


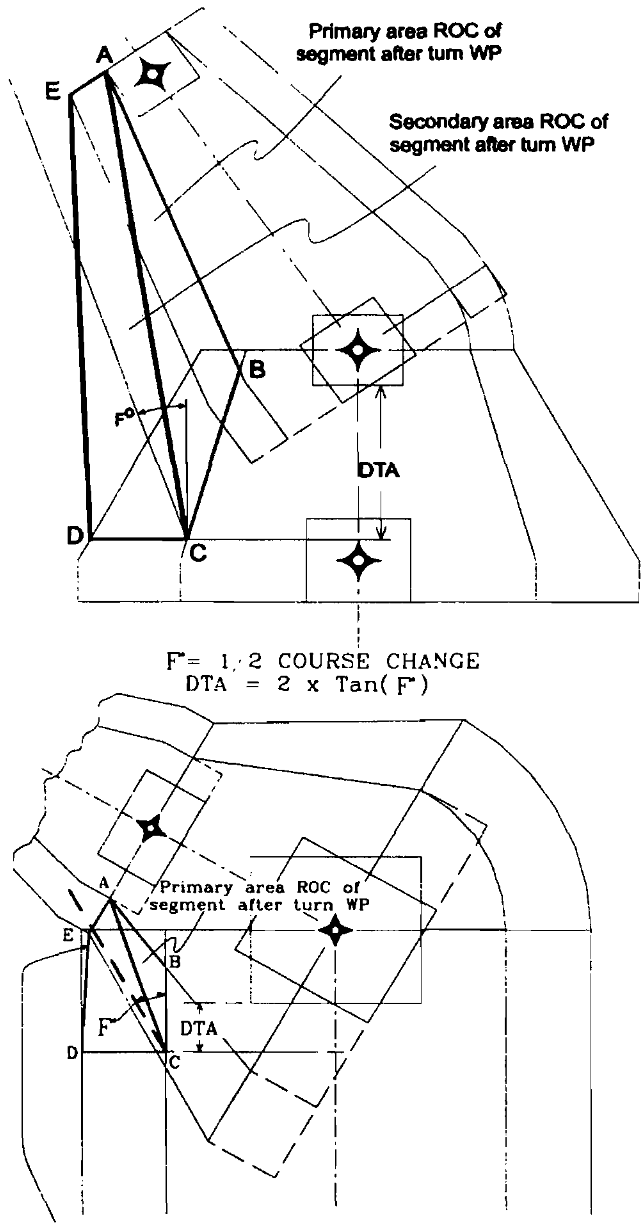
Figure 15-12. TURN ANTICIPATION SPLAY. Par 1520.

e. When the boundary of the expanding turn area will not connect with the boundary of the primary area of the following segment, join the expanded area at the boundary abeam the plotted position of the next WP or at the latest reception point of the RWY WP or APT WP, as appropriate (see figure 15-13).

f. Obstacle Evaluation of the Expanded Area. Evaluate the primary and secondary expansion areas using the ROC for the segment following the turn WP (see figures 15-13 and 15-14).

1521. INITIAL APPROACH SEGMENT. The initial approach segment begins at the IAWP and ends at the IWP. See figures 15-15, 15-16, and 15-17. For VOR/DME systems, the distance from the reference facility to the IAWP shall not exceed 53 miles, nor exceed the TPD or ATD values associated with the limits of the 8 NM zone (see figure 15-2).

a. Alignment. The angle of intercept between the initial and intermediate segment shall not exceed 120°.



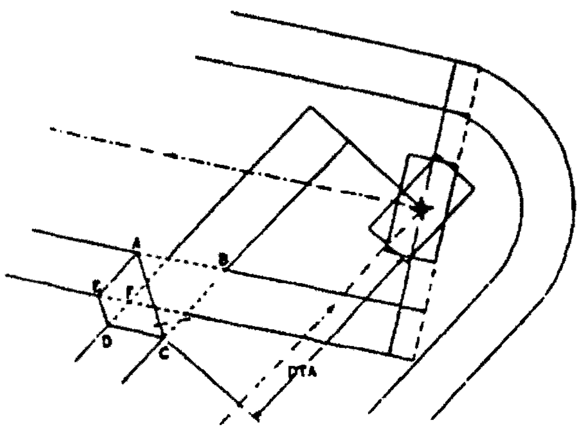
NOTE: Secondary area boundary line for expanded area Enclosed areas A, B, C are primary areas using ROC of segment following turn WP Enclosed areas A, C, D, E are secondary areas using ROC of segment following turn WP. Obstacle slope in these areas are perpendicular to lines AC

Figure 15-13. SHALLOW-ANGLED TURN ANTICIPATION ILLUSTRATIONS. TAPERING INTERMEDIATE AND CONSTANT WIDTH SEGMENT. ROC APPLICATIONS. Par 1520e and f.

b. Course Reversal. When the procedure requires a course reversal, a holding pattern shall be established in lieu of a PT. If holding is established over the FAF, paragraph 1507 applies. If holding is established over the FAF, the FAF shall be a WP, and paragraph 234e(1) applies. The course alignment shall be within 15° of the FAC. If holding is established over the IWP, paragraph 234e(2) applies. The course alignment shall be within 15° of the intermediate course. Where a feeder segment leads to the course reversal, the feeder segment shall terminate at the plotted position of the holding WP (see figure 15-15).

c. Area.

(1) Length. The initial approach segment has no standard length. It shall be sufficient to permit any altitude changes required by the procedure and shall not exceed 50 miles unless an operational requirement exists.



Enclosed area A, B, C is primary area ROC of segment following turn WP. Area A, C, D, E is secondary area ROC of segment following turn WP. Obstacle slope in this area is perpendicular to line A-C.

Figure 15-14. TURN ANTICIPATION AREAS. Par 1520f.

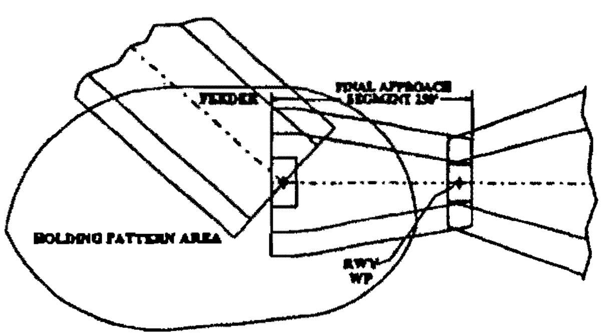


Figure 15-15. HOLDING PATTERN AND FINAL APPROACH, AND ASSOCIATED ROC. Par 1521b.

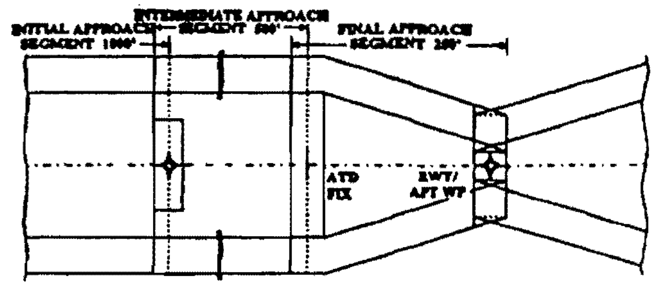


Figure 15-16. INITIAL, INTERMEDIATE, FINAL APPROACH, AND ASSOCIATED ROC. Par 1521, 1523.

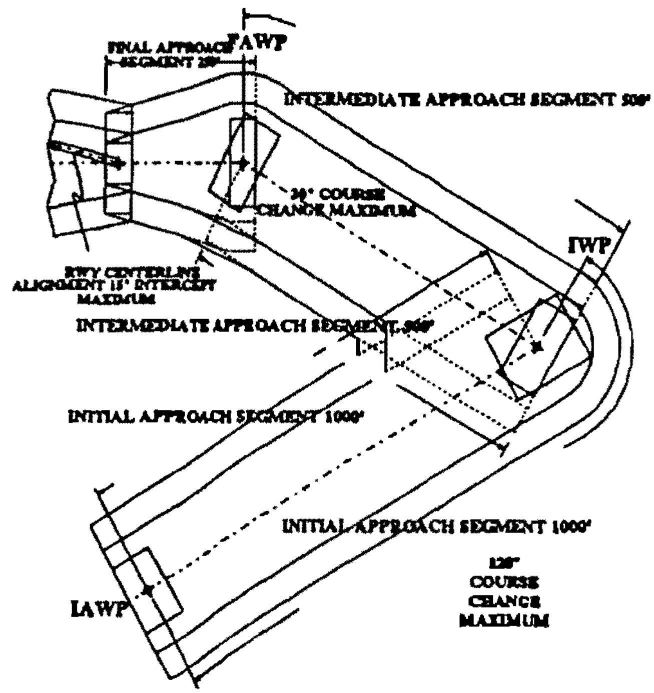


Figure 15-17. INITIAL, INTERMEDIATE, FINAL APPROACH, AND ASSOCIATED ROC. Par 1521, 1522.

(2) Width.

(a) Primary area:

1 VOR/DME. See figure 15-18.

a In the 8 NM zone, the area is 4 NM on each side of the centerline.

b In the 4 NM zone, the area is 2 NM on each side of the centerline.

c A 30° splay connects the area boundaries, beginning where the route centerline crosses the 4 NM zone and splaying out as the ATD increases until reaching 4 NM each side of the centerline. In addition:

(1) If the splay cuts across a portion of the WP fix displacement area, retain the width of the wider area and directly connect the wider area boundary with the narrower.

(2) If a short segment transits the 4 NM zone from the 8 NM zone and reenters the 8 NM zone, retain the 8 NM zone.

(3) If the initial approach and succeeding segments lie within the 4 NM zone, the 4 NM zone may be used.

(4) Segments shall not be decreased to 2 NM widths and then increased back to 4 NM widths.

(5) The width of the primary area at the earliest point the IAWP can be received is equal to the width at the plotted position.

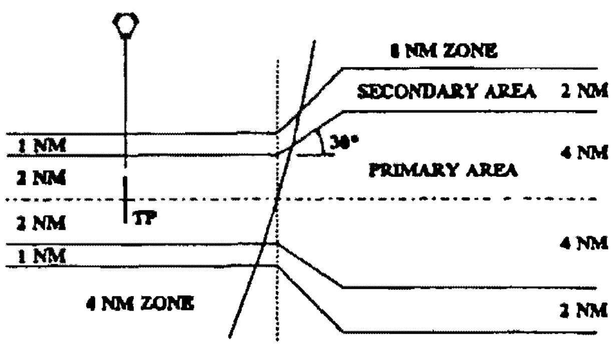


Figure 15-18. VOR/DME BASIC AREA. Par 1521c(2)(a)1.

2 Non-VOR/DME - 2 miles each side of centerline.

(b) Secondary area:

1 VOR/DME - The area is 1 mile each side of the primary area where the route centerline lies within the 4 NM zone. The area is 2 miles each side of the primary area where the route centerline lies within the 8 NM zone. The area boundaries are connected by straight lines abeam the same points where the primary area boundaries connect. The width of the secondary area at the earliest point the IAWP can be received is equal to the width at the plotted position.

2 *Non-VOR/DME* - 1 mile on each side of the primary area.

d. Obstacle Clearance. Paragraph 232c applies.

e. Descent Gradient. Paragraphs 232d and 288a apply.

1522. INTERMEDIATE SEGMENT. The intermediate segment begins at the IWP and ends at the FAWP or ATD fix serving as the FAF. For VOR/DME systems, the distance from the reference facility to the IWP shall not exceed 53 miles nor exceed the TPD or ATD values associated with the limits of the 8 NM zone (see figure 15-2).

a. Alignment. The course to be flown in the intermediate segment should be the same as the FAC. When this is not practical, the intermediate course shall not differ from the FAC by more than 30° and an FAWP shall be established at the turn WP (see figure 15-17).

b. Area.

(1) Length. The intermediate segment shall not be less than 5 miles, nor more than 15 miles in length. If a turn is more than 90° at the IWP, table 3, chapter 2, applies.

(2) Width.

(a) Primary area:

1 VOR/DME - The width of the intermediate primary area shall equal the width of the initial primary area at the IWP. It shall either taper from a point abeam the IWP linearly to ± 2 miles at the FAWP or ATD fix or shall be a constant ± 2 miles, as appropriate. The width at the earliest point the IWP can be received shall equal the width at the plotted position.

2 Non-VOR/DME - 2 miles on each side of centerline.

(b) Secondary area:

1 VOR/DME - The width of the intermediate secondary area shall be equal to the width of the initial secondary area at the IWP and shall either taper from a point abeam the IWP linearly to ± 1 mile at the FAWP or ATD fix or shall be a constant ± 1 mile, as appropriate. The width of the secondary area at the earliest point the IWP can be received shall equal the width at the plotted position.

2 Non-VOR/DME - 1 mile on each side of the primary area.

c. Obstacle Clearance. Paragraph 242c applies.

d. Descent Gradient. Paragraph 242d applies.

1523. FINAL APPROACH SEGMENT. The final approach segment begins at the FAWP or ATD fix and ends at the MAP. When the FAC is a continuation of the intermediate course, an ATD fix should be used in lieu of a FAWP with additional ATD fixes established, if necessary, as stepdown fixes or the MAP. For VOR/DME systems, the FAWP/ATD fix shall be limited to a TPD of 30 miles or less and must be within the limits of the 4 NM zone shown in figure 15-2.

a. Alignment. The FAC shall be aligned through the RWY or APT WP. For a straight-in approach, the alignment should be with the runway centerline. When the alignment exceeds 15°, straight-in minimums are not authorized. For a circling approach, the FAC should be aligned to the center of the landing area, but may be aligned to any portion of the usable landing surface.

b. Area. The area considered for obstacle clearance starts at the earliest point of the FAWP or ATD fix displacement area, and for straight-in approaches, ends at the latest point of the RWY WP fix displacement area. For circling approaches, the area ends at the latest point of the APT WP fix displacement area.

(1) Length. The optimum length of the final approach segment, measured between plotted fix positions, is 5 miles. The maximum length is 10 miles. The minimum length shall provide adequate distance for an aircraft to make the required descent and to regain course alignment when a turn is required over the FAWP. Table 15-4 shall be used to determine the minimum length of the final approach segment. Fix displacement area overlap restrictions stated in paragraph 1502 apply.

(2) Width.

(a) The final approach primary area is centered on the FAC. It is 2 miles wide on each side of the course at the earliest position the FAWP/ATD fix can be received. See figures 15-15 and 15-16. This width remains constant until the latest point the FAWP/ATD fix can be received. It then tapers to the width of the area of the XTRK fix displacement tolerance at the latest point the RWY WP or APT WP can be received. Fix displacement tolerance dimensions are shown in table 15-2 for VOR/DME systems and in table 15-3 for non-VOR/DME systems.

(b) A secondary area 1 mile wide is established on each side of the primary area (see figures 15-15 and 15-16).

c. Obstacle Clearance.

(1) Straight-In. The ROC in the primary area is 250 feet. In the secondary area, the ROC of the primary area is provided at the inner edge, tapering uniformly to zero at the outer edge.

(2) Circling. A minimum of 300 feet of ROC shall be provided in the circling approach area. Paragraph 260b applies.

d. Descent Gradient. Paragraph 252 applies.

e. Using Fixes for Descent. Paragraphs 288a, b, c(3), c(4)(a), and 289 apply.

f. RNAV Descent Angle Information. Paragraph 252 applies.

Figure 15-19 RESERVED

1524.-1529. RESERVED.

SECTION 3. MISSED APPROACH.

1530. GENERAL. For general criteria, refer to chapter 2, section 7. In the secondary areas, no obstacle may penetrate the 12:1 surface extending upward and outward from the 40:1 surface at the edge of the inner boundaries at a right angle to the missed approach course.

1531. MISSED APPROACH SEGMENT. The missed approach segment begins at the MAP and ends at a point designated by the clearance limit. These criteria consider two types of missed approaches. They are identified as RNAV and non-RNAV MAP's and defined as follows:

a. RNAV.

(1) **Route.** PCG provided by RNAV systems is required throughout the missed approach segment. The length of the segment is measured point-to-point between the respective (plotted position) WP's throughout the missed approach procedure.

(a) A WP is required at the MAP and at the end of the missed approach procedure. A turn WP may be included in the missed approach.

(b) A straight, turning, or combination straight and turning missed approach procedure may be developed. WP's are required for each segment within the missed approach procedure.

(c) Turns shall not exceed 120°.

(d) A minimum leg length is required to allow the aircraft's stabilization on course immediately after the MAP. See table 15-6 for minimum distances required for each category of aircraft based on course changes.

(e) For the combination straight and turning missed approach, the distance between the latest point the MAP can be received and the earliest point the turn WP can be received shall be sufficient to contain the length of turn anticipation distance required. This segment shall be aligned within 15° or less of the extended FAC.

(2) **Direct.** A direct missed approach may be developed to provide a method to allow the pilot to proceed to a WP that is not connected to the MAP by a specified course. PCG is not assumed during the entire missed approach procedure.

(a) An ATD fix may be specified as the MAP.

(b) A straight, turning, or combination straight and turning missed approach may be developed.

(c) The combination straight and turning missed approach procedure shall be a climb from the MAP to a specified altitude. The end of the straight section shall be established by an altitude, and this segment shall be aligned with the FAC. The length of the straight section shall be determined by subtracting the lowest MDA of the procedure from the height of the turning altitude in the missed approach and multiplying by 40. The distance is measured from the latest point the MAP can be received.

(d) Turns may exceed angles of 120°.

b. Non-RNAV Missed Approach Procedures. Chapter 2, section 7, is applicable for non-RNAV missed approach criteria with the following exceptions: the connection for the missed approach area and the origination points of the 40:1 evaluation obstruction slope at the MAP, and the area for early turns begin at the earliest point the WP or ATD fix can be received. The area connects at the MAP as described in paragraphs 1532, 1533, 1534, and 1535. The tie-backs and evaluations are established and conducted as outlined in this chapter of the RNAV missed approach criteria.

1532. MAP. The MAP shall be located on the FAC and is normally located at the RWY WP or APT WP, as appropriate. It may be designated by an ATD fix defined relative to the distance from the RWY or APT WP. The MAP shall be no further from the FAF than the RWY or APT WP, as appropriate. The area of the MAP ATRK displacement tolerance may overlap the plotted position of the RWY or APT WP. The lateral dimensions for the area of the ATD fix are considered the same as the lateral dimensions of the primary area.

1533. STRAIGHT MISSED APPROACH. Straight missed approach criteria are applied when the missed approach course does not differ more than 15° from the FAC.

a. Area.

(1) When the MAP is at the RWY WP or APT WP, the area starts at the earliest point the MAP can be received and has the same width as the area for the WP displacement tolerance at the RWY WP or APT WP, as appropriate. The secondary areas are 1 mile each side of the primary area at the earliest point the MAP can be received (see figure 15-20).

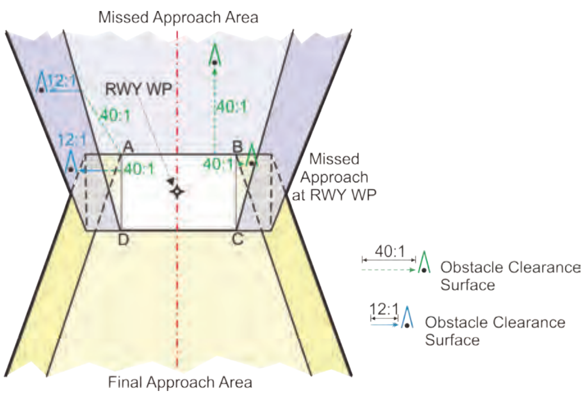


Figure 15-20. Straight Missed Approach at the RWY WP. Par 1533a(1).

(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.

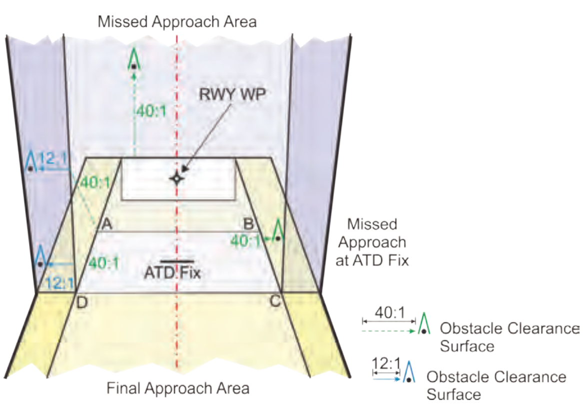


Figure 15-21. Straight Missed Approach at an ATD Fix. Par 1533a(2).

(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.

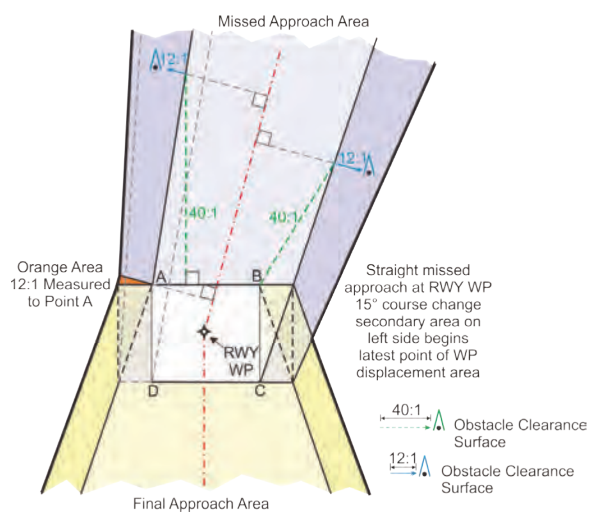


Figure 15-22. Construction of Straight Missed Approach When Turns ≤ 15° Cause Outside Boundary to Cross Inside MAP Fix Displacement Tolerance at RWY WP. Par 1533a(4).

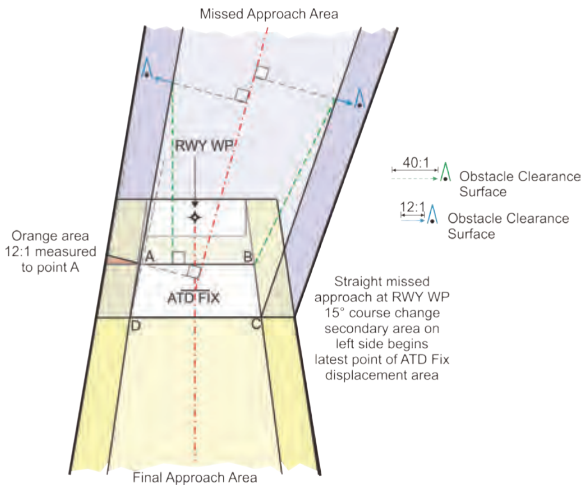


Figure 15-22. Construction of Straight Missed Approach When Turns ≤ 15° Cause Outside Boundary to Cross Inside MAP Fix Displacement Tolerance at an ATD Fix. Par 1533a(4).

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.

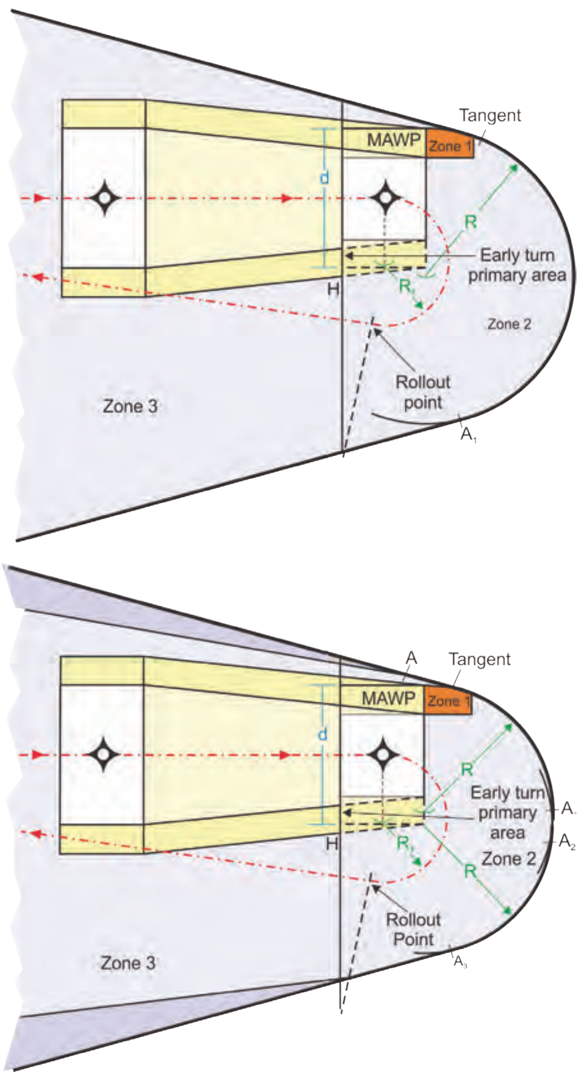


Figure 15-24. Wide and Narrow Missed Approach Methodology. Par 1534a(1) and (2).

(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.

1 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).

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

3 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.

1 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).

2 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).

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

4 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.

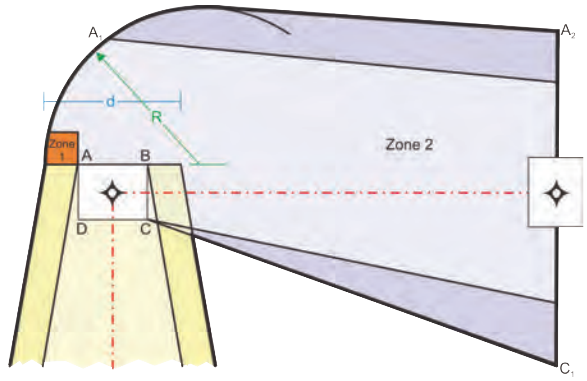


Figure 15-25. RNAV Turning Missed Approach, 90 degrees or Less. Par 1534a(2)(b)

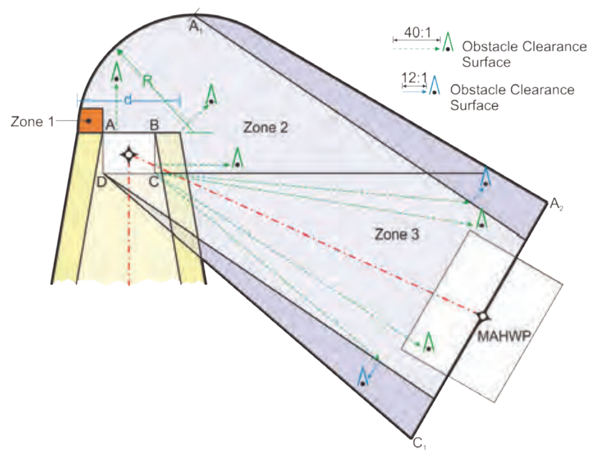


Figure 15-26. RNAV Turning Missed Approach, More than 90 degrees up to 120 degrees. Par 1534a(2)(b)

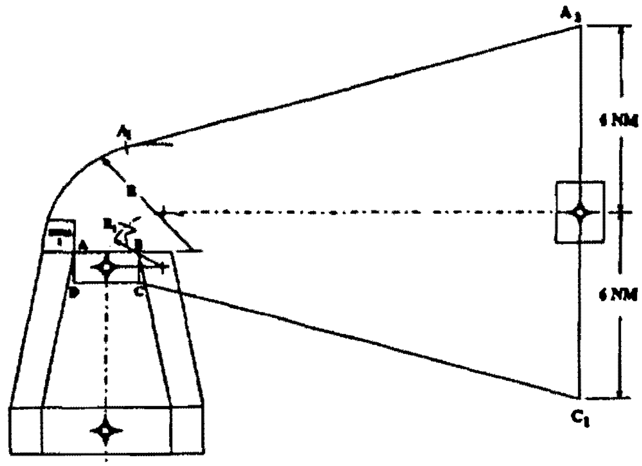
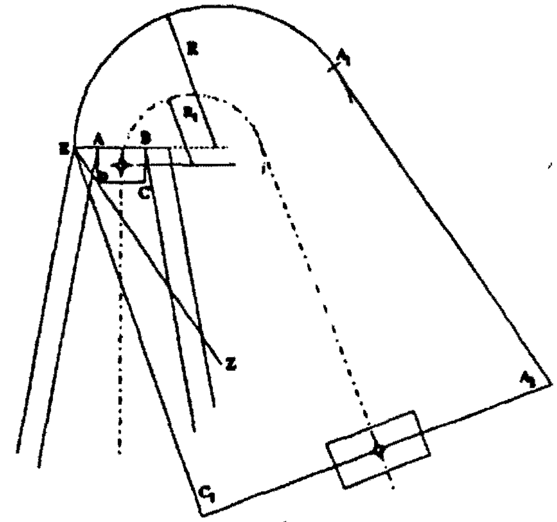


Figure 15-27. DIRECT TURNING MISSED APPROACH, ≤ 90° TIE-BACK POINT C_1 TO POINT C. Par 1534a(2)(b).



NOTE: Point C_1 connects to point E when C_1-E is outside of line E-Z. E-Z is established by drawing an extended line through D and E.

Figure 15-29. DIRECT TURNING MISSED APPROACH, > 90°. Par 1534a(2)(b).

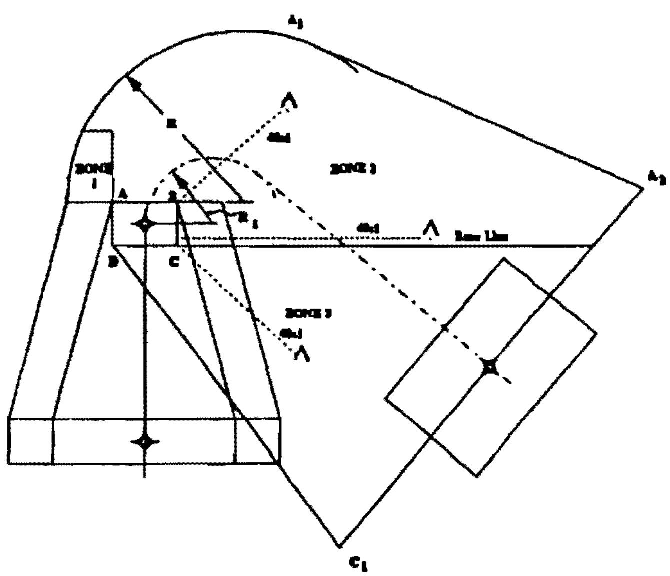
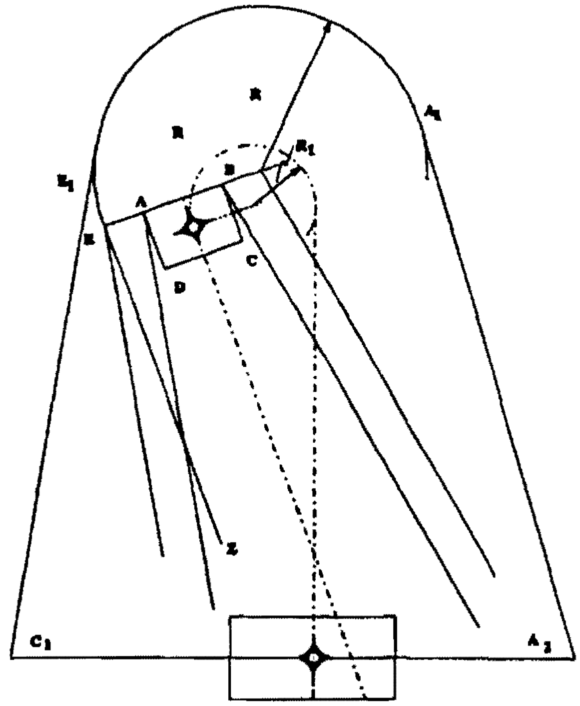


Figure 15-28. DIRECT TURNING MISSED APPROACH, > 90° TIE-BACK POINT C_1 TO POINT D. Par 1534a(2)(b).



NOTE: Point C_1 connects to E_1 tangent to arc when line C_1-E_1 is outside of line E-Z. E-Z is established parallel to final approach course line.

Figure 15-30. DIRECT TURNING MISSED APPROACH > 180°. Par 1534a(2)(b).

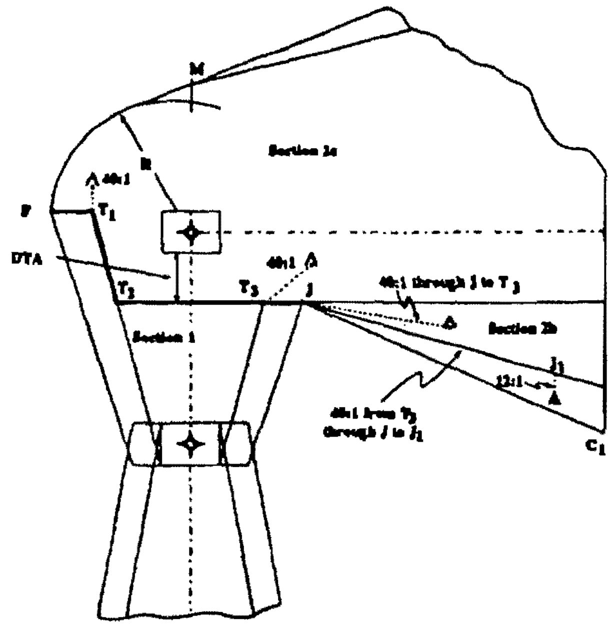


Figure 15-31. RNAV COMBINATION STRAIGHT AND TURNING MISSED APPROACH 90° TURN OR LESS. Par 1535a(2) and 1535b(1)(b).

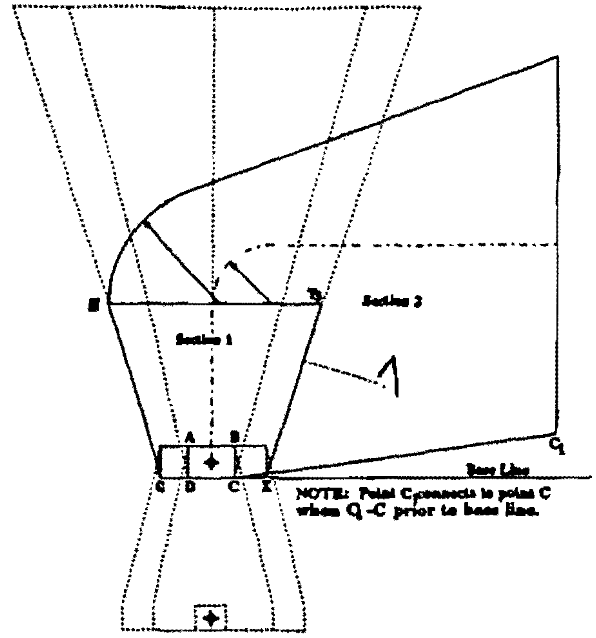


Figure 15-33. CLIMB TO ALTITUDE, STRAIGHT AND TURNING MISSED APPROACH, C_1 PRIOR TO BASE LINE. Par 1535a(3).

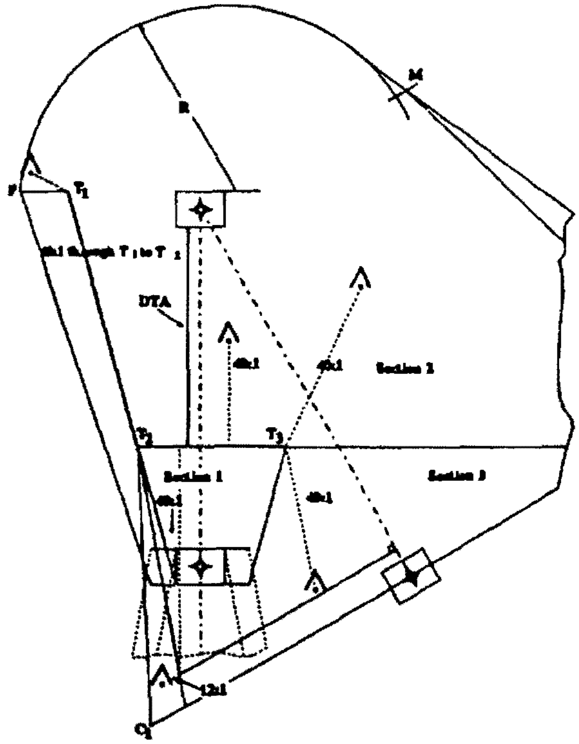


Figure 15-32. RNAV COMBINATION STRAIGHT AND TURNING MISSED APPROACH MORE THAN 90° UP TO 120°. Par 1535a(2)and b(3).

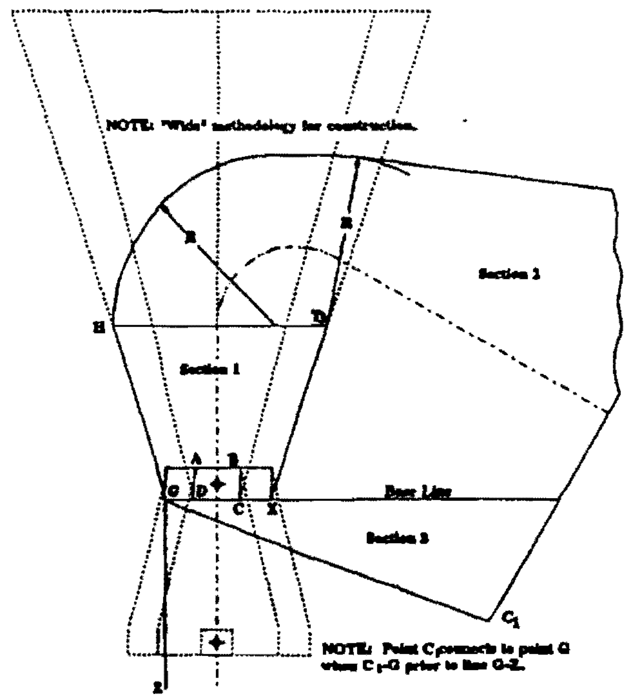


Figure 15-34. CLIMB TO ALTITUDE, STRAIGHT AND TURNING MISSED APPROACH > 90°. Par 1535a(3).

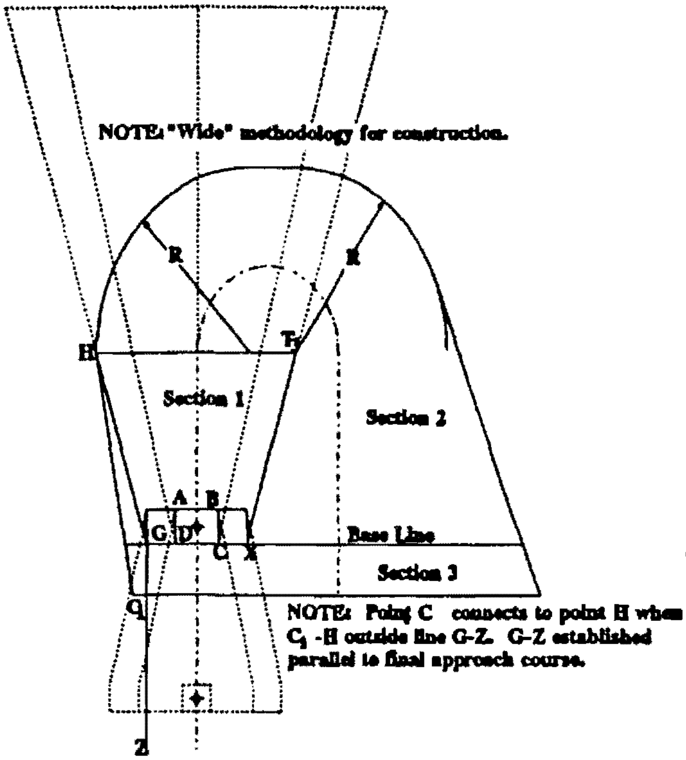


Figure 15-35. CLIMB TO ALTITUDE, STRAIGHT AND TURNING MISSED APPROACH > 90°. Par 1535a(3).

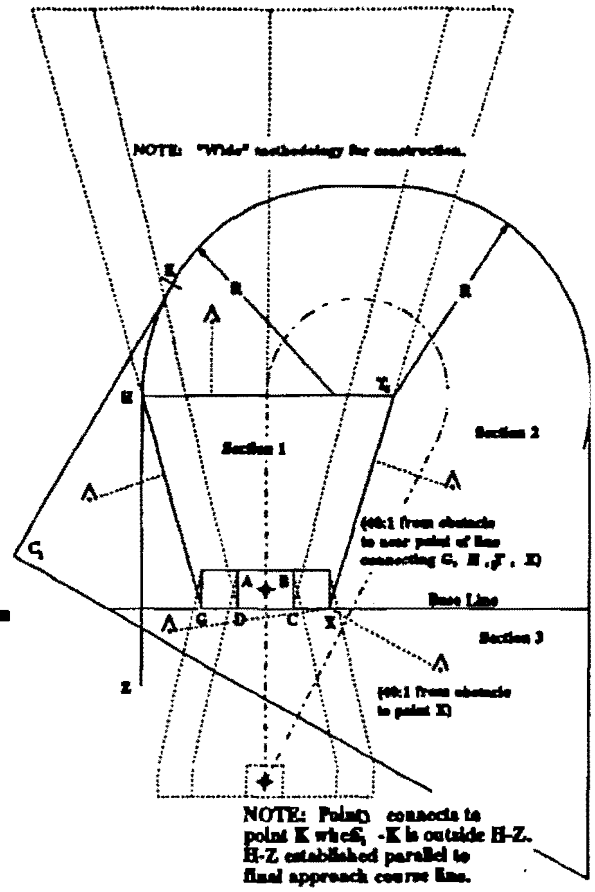


Figure 15-36. CLIMB TO ALTITUDE, STRAIGHT AND TURNING MISSED APPROACH > 180°. Par 1535a(3).

Table 15-1. VOR/DME EN ROUTE AND TERMINAL FIX DISPLACEMENT TOLERANCE.

FIX DISTANCE ALONGTRACK FROM TANGENT POINT

DISTANCE FROM TANGENT POINT TO VOR/DME

Terminal

		0	10	20	30	40	50	51
0	XTRK		13	17	22	28	34	35
	ATRK		08	08	07	08	09	09
10	XTRK	12	13	1.7	22	28	34	
	ATRK	08	0.8	0.9	09	10	11	
20	XTRK	12	14	18	23	28		
	ATRK	13	13	1.3	14	14		
30	XTRK	12	14	1.8	23	29		
	ATRK	18	18	19	19	20		
40	XTRK	13	15	18	23			
	ATRK	2.4	2.4	24	24			
50	XTRK	13	15					
	ATRK	29	3.0					
53	XTRK	13						
	ATRK	31						

Table may be interpolated -- or use next higher value.
XTRK/ATRK values are ±

J/V En Route (rows 0–70) / **Random En Route** (all rows)

		0	10	20	30	40	50
0	XTRK		13	17	22	28	34
	ATRK		08	08	07	08	09
10	XTRK	12	13	17	22	28	34
	ATRK	08	08	08	09	10	11
20	XTRK	12	14	18	23	28	34
	ATRK	13	13	13	14	14	15
30	XTRK	12	14	1.8	23	29	35
	ATRK	18	18	19	19	20	20
40	XTRK	13	15	18	23	29	35
	ATRK	24	24	24	24	25	25
50	XTRK	13	15	19	24	29	35
	ATRK	29	30	30	30	30	31
60	XTRK	14	16	19	24	30	36
	ATRK	35	35	35	36	36	36
70	XTRK	14	16	20	25	30	36
	ATRK	41	41	41	41	42	42
80	XTRK	15	17	2.1	25	31	36
	ATRK	46	47	47	47	47	48
90	XTRK	16	18	2.1	26	31	37
	ATRK	52	52	53	53	53	53
100	XTRK	17	18	22	26	32	37
	ATRK	58	58	58	59	59	59
110	XTRK	17	19	22	27	32	38
	ATRK	64	64	64	64	65	65
120	XTRK	18	20	23	28	33	38
	ATRK	69	70	70	70	70	71

Table application per segment

Segment	Table 15-1 J/V En Route	Random En Route	Terminal
En Route	X		
Feeder		X	
Feeder S/D		X	
IAFP			X
Initial S/D			X
IWP			X
Intermediate S/D			X
MA/Holding			X

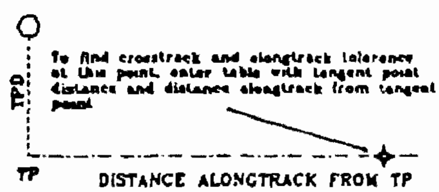


Table 15-2. FINAL/MISSED AREA FIX DISPLACEMENT TOLERANCE.

FIX DISTANCE ALONGTRACK FROM TANGENT POINT

TANGENT POINT DISTANCE (TPD) FINAL/MISSED		0	1	2	3	4	5	10	15	20	25	30
0	XTRK		0.7	0.7	0.7	0.8	0.8	1.0	1.2	1.5	1.8	2.1
	ATRK		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7
1	XTRK	0.7	0.7	0.7	0.7	0.8	0.8	1.0	1.2	1.5	1.8	2.1
	ATRK	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7
2	XTRK	0.7	0.7	0.7	0.7	0.8	0.8	1.0	1.2	1.5	1.8	2.1
	ATRK	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7
3	XTRK	0.7	0.7	0.8	0.8	0.8	0.8	1.0	1.2	1.5	1.8	2.1
	ATRK	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7
4	XTRK	0.8	0.8	0.8	0.8	0.8	0.8	1.0	1.2	1.5	1.8	2.1
	ATRK	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8
5	XTRK	0.8	0.8	0.8	0.8	0.8	0.8	1.0	1.2	1.5	1.8	2.1
	ATRK	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8
10	XTRK	0.8	0.8	0.8	0.8	0.8	0.8	1.0	1.2	1.5	1.8	2.1
	ATRK	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9
15	XTRK	0.8	0.8	0.8	0.8	0.8	0.9	1.0	1.2	1.5	1.8	2.1
	ATRK	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.2
20	XTRK	0.8	0.8	0.8	0.8	0.9	0.9	1.0	1.3	1.5	1.8	2.1
	ATRK	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4
25	XTRK	0.8	0.9	0.9	0.9	0.9	0.9	1.1	1.3	1.6	1.8	2.1
	ATRK	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.6
30	XTRK	0.9	0.9	0.9	0.9	0.9	0.9	1.1	1.3	1.6	1.9	2.1
	ATRK	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.9	1.9

INTERPOLATE TO THE NEAREST 0.1 MILE
XTRK/ATRK values are ±

Table application per segment

Segment	Table 15-2
En Route	
Feeder	
Feeder S/D	
IAWP	
Initial S/D	
IWP	
Intermediate S/D	
FAWP/ATD Fix	X
Final S/D	X
MAWP/ATD Fix	X
RWY WP/APT WP	X
MA Turn Point	X
MA/Holding	

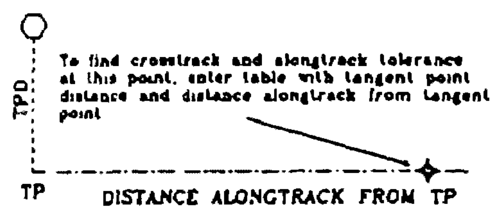


Table 15-3. NON-VOR/DME FIX DISPLACEMENT TOLERANCE.

	EN ROUTE	TERMINAL	APPROACH
XTRK	3.0	2 0	0 6
ATRK	2.8	1.7	0 3

XTRK/ATRK values are ±

Table application per segment

	TABLE 15-3		
Segment:	En Route	Terminal	Approach
En Route	X		
Feeder	X		
Feeder S/D	X		
IAWP		X	
Initial S/D		X	
IWP		X	
Intermediate S/D		X	
FAWP/ATD Fix			X
Final S/D			X
MAWP/ATD Fix			X
RWY WP/APT WP			X
MA Turn Point			X
MA Holding	X		

Table 15-4. MINIMUM LENGTH OF FINAL APPROACH SEGMENT (NM).

APPROACH CATEGORY	MAGNITUDE OF TURN OVER THE FINAL APPROACH WAYPOINT (FAWP)		
	0°-5°	>5°-10°	>10°-30°
A	1.8	1.8	2.0
B	1.8	2.0	2.5
C	2.0	2.5	3.0
D	2.5	3.0	3.5
E	3.0	3.5	4.0

Table 15-5. EFFECT OF XTRK TOLERANCE ON VISIBILITY MINIMUMS.

	XTRK TOLERANCE (NM)				
CAT	0.6 - 0.8	>0.8 - 1.0	>1.0 - 1.2	>1.2 - 1.6	>1.6
A	1	1	1	1	1
B	1	1	1	1.25	1.25
C	1	1	1.25	1.5	1.5
D	1	1.25	1.5	1.75	2
E	1	1.25	1.5	1.75	2

Table 15-6. MINIMUM LEG LENGTH FROM MAP TO NEXT WP USING RNAV MISSED APPROACH PROCEDURE.

	COURSE CHANGE AT MAP				
CAT	>15° ≤30°	≤45°	≤60°	≤90°	≤120°
	Minimum Leg Length, NM, between MAP and next WP				
A	3.0	4.0	5.0	5.9	6.9
B	3.0	4.0	5.2	6.2	7.2
C	3.0	4.2	5.5	6.5	7.6
D	3.0	4.5	6.0	7.3	8.5
E	3.0	5.5	7.8	9.5	11.3

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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.

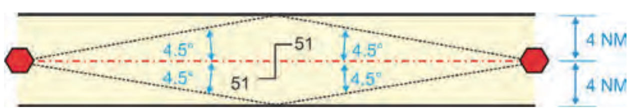


Figure 17-1. PRIMARY OBSTACLE CLEARANCE AREA. Par 1711a.

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.

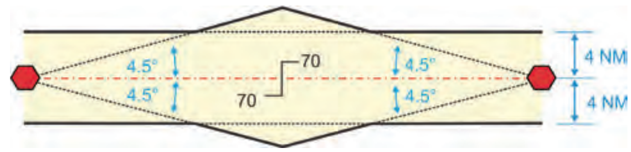


Figure 17-2. PRIMARY OBSTACLE CLEARANCE AREA. Application of System Accuracy. Par 1711b.

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.

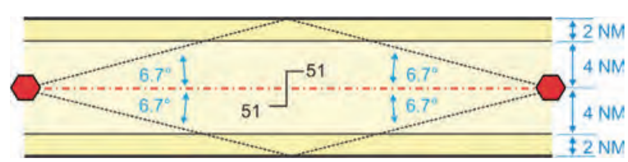


Figure 17-3. SECONDARY OBSTACLE CLEARANCE AREAS. Par 1712a.

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.

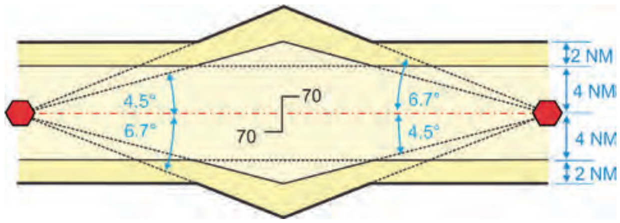


Figure 17-4. SECONDARY OBSTACLE CLEARANCE AREAS. Application of System Accuracy Lines. Par 1712b.

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.*

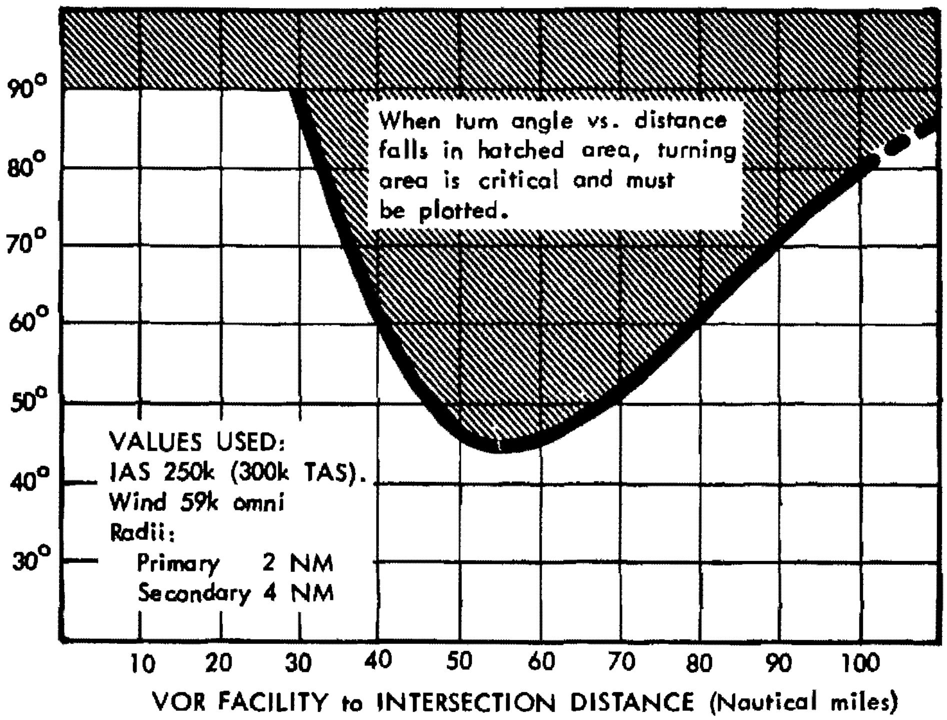


Figure 17-5 TURN ANGLE VS DISTANCE Par 1713 h (1) and (2)

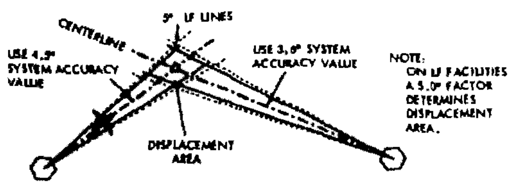


Figure 17-6 FIX DISPLACEMENT Par 1713 e

1714. APPLICATION OF TURNING AREA CRITERIA.

a. Techniques. Figures 17-8, 17-9, and 17-10 illustrate the application of the criteria. They also show areas which may be deleted from considerations when obstacle clearance is the deciding factor for establishing minimum enroute altitudes (MEAs) on airways or route segments.

b. Computations. Computations due to obstacles actually located in the turning areas will probably be indicated only in a minority of cases. These methods do, however, add to the flexibility of procedures specialists in resolving specific obstacle clearance problems without resorting to the use of waivers.

c. Minimum Turning Altitude (MTA). Where the application of the turn criteria obviates the use of an MEA with a cardinal altitude, the use of an MTA for a special direction of flight may be authorized. Where this is employed an appropriate notation shall be included on the * FAA Form 8260-2, Radio Fix and Holding Data Record, for the turning fix. *

1715. TURN AREA TEMPLATE. A turn area template has been designed for use on charts scaled at 1:500,000. See Figure 17-7. It is identified as "TA-1."

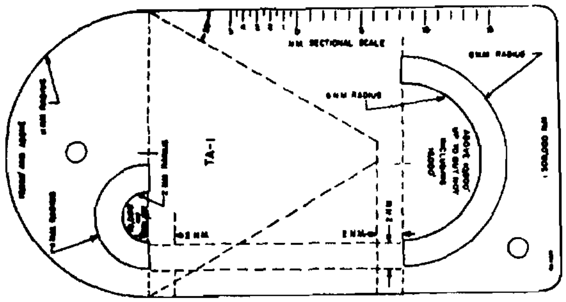


Figure 17-7. TURNING AREA TEMPLATE. Par 1715.

a. Use of Template-Intersection Fix.

(1) **Primary Area.** At an intersection fix the primary obstacle clearance area arc indexes are placed at the most adverse points of the fix displacement area as determined by the outer intersections of the enroute radial 4.5 degree lines (VOR) and the cross-radial 3.6 degree lines (VOR). See Figures 17-8 and 17-9. If LF signals are used the 5.0 degree system accuracy lines apply. The parallel dashed lines on the turn area template are aligned with the appropriate system accuracy lines and the curves are drawn.

(2) **Secondary Area "Outside" Curve.** The outside curve of the secondary turning area is the curve farthest from the navigation facility which provides the intersecting radial. This curve is indexed to the distance from the fix to the enroute facility as follows:

(a) Where the fix is less than 51 NM from the enroute facility, the secondary arc is started at a point 2 NM outside the primary index with the parallel dashed lines of the template aligned on the 4.5 degree line. See Figure 17-8.

(b) Where the fix is farther than 51 NM from the enroute station, the arc is started at the point of intersection of the 3.6 and 6.7 degree lines with the parallel dashed lines of the template aligned on the 6.7 degree line. See Figure 17-9.

(3) **Secondary Area "Inside" Curve.** The inside curve is the turning area arc which is nearest the navigation facility which provides the intersecting radial. This arc is begun 2 NM beyond the primary index and on the 3.6 degree line. The parallel dashed lines on the turning area template are aligned with the 4.5 degree line from the enroute station.

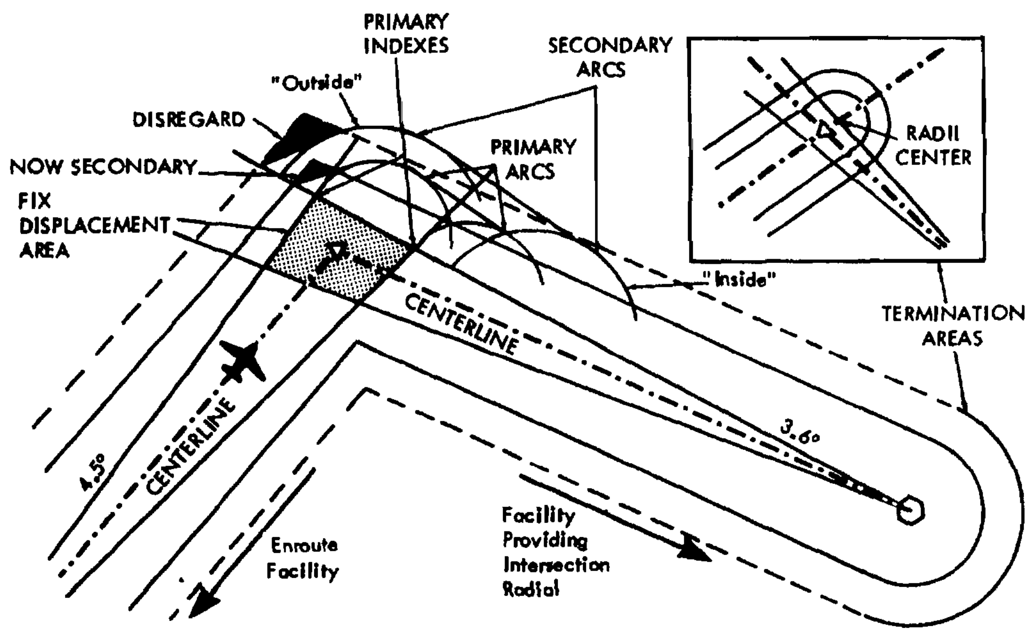


Figure 17-8 TURNING AREA, INTERSECTION FIX (Facility Distance Less than 51 NM) Par 1715 a and b

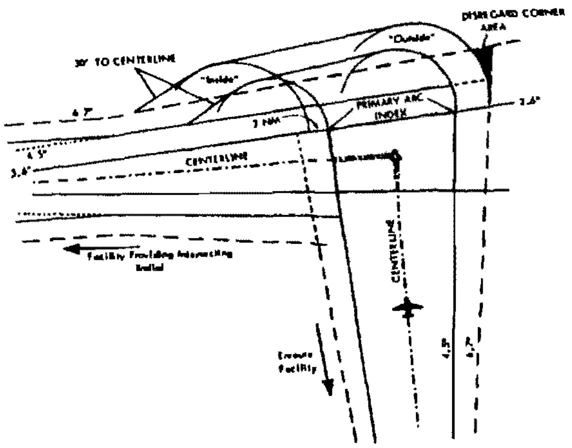


Figure 17-9. TURNING AREA, INTERSECTION FIX (Facility Distance Beyond 51 NM). Par 1715 a and b

(a) Where the fix is less than 51 NM from the enroute facility and the magnitude of the turn is less than 30 degrees, the "inside" curves do not affect the size of the secondary area.

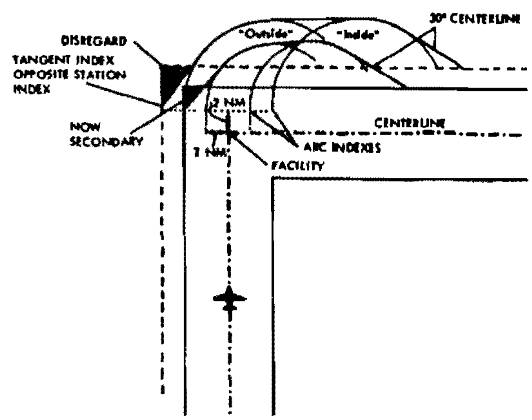
(b) Where the distance from the enroute facility to the fix is more than 51 NM but the magnitude of the turn is less than 45 degrees, the "inside" curves do not increase the size of the secondary area.

(c) Where the magnitude of the turn is greater than those stipulated in (a) and (b) above, the "inside" curves will affect the size of the secondary area.

(d) Whether the secondary area curves affect the size of the secondary obstacle clearance area or not, they must be drawn to provide reference points for the tangential lines described in (4) below.

(4) **Connecting Lines.** Tangential straight lines are now drawn connecting the two primary arcs and the two secondary arcs. The outer limits of both curves are symmetrically connected to the respective primary and secondary area boundaries in the direction of flight by lines drawn at a 30 degree angle to the airway or route centerline. See Figures 17-8 and 17-9.

b. Use of Template When Fix Overheads a Facility. See Figure 17-10. The geographical position of the fix is considered to be displaced laterally and longitudinally by 2 NM at all altitudes.



* Figure 17-10. TURNING AREA – OVERHEAD THE FACILITY Par 1715b. *

(1) **Primary Arcs.** The primary arcs are indexed at points 2 NM beyond the station and 2 NM on each side of the station. The parallel dotted lines on the template are aligned with the airway or route boundaries and the curves drawn.

(2) **Secondary Arcs.** The secondary arcs are indexed 2 NM outside the primary points, and on a line with them. The parallel dotted lines on the template are aligned with the airway or route boundaries, and the curves drawn.

(3) **Connection Lines.** Tangential straight lines are now drawn connecting the two primary and the two secondary arcs. The outer limits of both curves are connected to the primary and secondary area boundaries by intercept lines which are drawn 30 degrees to the airway or route centerline. The 30 degree lines on the template may be used to draw these intercept lines.

c. Deletion Areas. Irregular areas remain on the outer corners of the turn areas. See Figures 17-8, 17-9, and 17-10. These are the areas identified in paragraph 1714 which may be deleted from consideration when obstacle clearance is the deciding factor for determination of MEA on an airway or route segment.

(1) Where the "outside" secondary area curve is started within the airway or route secondary area boundary (see Figure 17-8), the area is blended by drawing a line from the point where the 3.6 degree (5.0 with LF facility) line meets the line which forms the enroute secondary boundary tangent to the "outside" secondary arc. Another line is drawn from the point where the same 3.6 (or 5.0) degree line meets the line which forms the primary boundary, tangent to the matching primary arc. These two lines now enclose the secondary area at the turn. The corner which was formerly part of the secondary area may be disregarded; the part which was formerly part of the primary area may now be considered secondary area. These areas are shaded in Figure 17-8.

(2) Where the secondary curve is indexed on the secondary area boundary formed by the 6.7 degree lines, the arc itself cuts the corner and prescribes the deleted area. See Figure 17-9. This condition occurs when the radio fix is over 51 NM from the enroute navigation facility.

(3) When overheading the facility, the secondary area corner deletion area is established by drawing a line from a point opposite the station index at the secondary area boundary, tangent to the secondary "outside" curve. See Figure 17-10. A similar line is drawn from a point opposite the station index at the primary area boundary, tangent to the primary turning arc. The corner formerly part of the primary area now becomes secondary area. The deletion areas are shown in Figure 17-10 by shading.

1716. CHANGEOVER POINTS (COP). Points have been defined between navigation facilities along airway/route segments which are called "changeover points (COP)." These points indicate that the pilot using the airway/route should "change over" his navigation equipment to receive course guidance from the facility ahead of the aircraft instead of the one behind. These COP divide a segment and assure continuous reception of navigation signals at the prescribed minimum enroute IFR altitude (MEA). They also assure that aircraft operating within the same portion of an airway or route segment will not be using azimuth signals from two different navigation facilities. Where signal coverage from two facilities overlaps at the MEA, the COP will normally be designated at the midpoint. Where radio frequency interference or other navigation signal problems exist, the COP will be at the optimum location, taking into consideration the signal strength, alignment error, or any other known condition which affects reception. The effect of COP on the primary and secondary obstacle clearance areas is as follows:

a. Short Segments. If the airway or route segment is less than 102 NM long and the COP is placed at the midpoint, the obstacle clearance areas are not affected. See Figure 17-11.

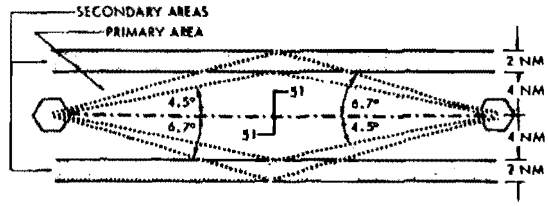


Figure 17-11. COP EFFECT Short Airway or Route Segment
Par 1716 a

b. Long Segments. If the distance between two facilities is over 102 NM and the COP is placed at the midpoint, the system accuracy lines extend beyond the minimum widths of 8 and 12 NM, and a flare results at the COP. See Figure 17-12.

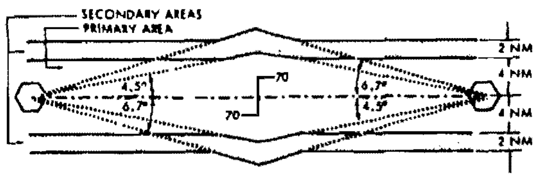


Figure 17-12. COP EFFECT Long Airway or Route Segment
Par 1716 b

c. Offset COP. If the changeover point is offset due to facility performance problems, the system accuracy lines must be carried from the farthest facility to a position abeam the changeover point, and these lines on each side of the airway or route segment at the COP are joined by lines drawn directly from the nearer facility. In this case the angles of the lines drawn from the nearer facility have no specific angle. See Figure 17-13.

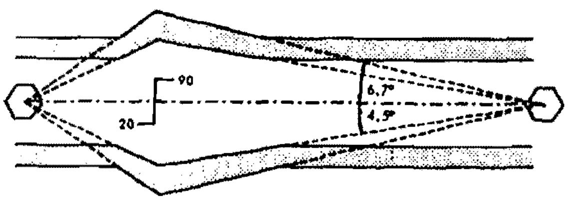


Figure 17-13 OFFSET COP. Par 1716 c

d. Dogleg Segment. A dogleg airway or route segment may be treated in a manner similar to that given offset COPs. The system accuracy lines will be drawn to meet at a line drawn as the bisector of the dogleg "bend" angle and the boundaries of the primary and secondary areas extended as required. See Figure 17-14.

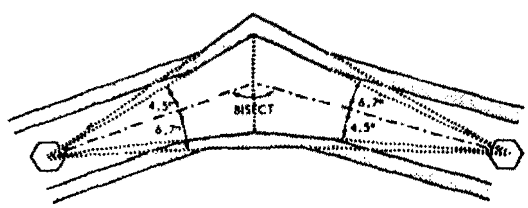


Figure 17-14 DOGLEG SEGMENT. Par 1716 d.

1717. COURSE CHANGE EFFECT. The complexity of defining the obstacle clearance areas is increased when the airway or route becomes more complex. Figure 17-15 shows the method of defining the primary area when a radio fix and a COP are involved. Note that the system accuracy lines are drawn from the farthest facility

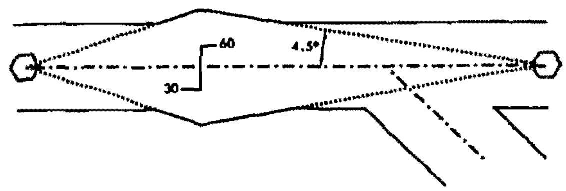
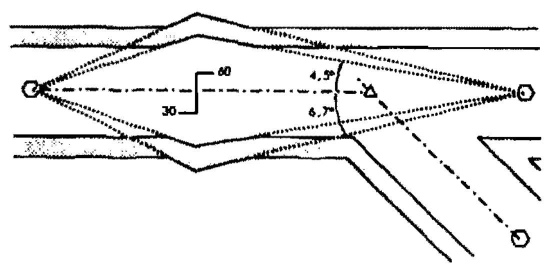


Figure 17-15 COURSE CHANGE EFFECT Par 1717.

first, and govern the width of the airway or route at the COP. The application of secondary area criteria results in a segment similar to that depicted in Figure 17-16.



* Figure 17-16 APPLICATION OF SECONDARY AREAS Par 1717 *

1718. MINIMUM ENROUTE INSTRUMENT ALTITUDES (MEA). An MEA will be established for each segment of an airway/route from radio fix to radio fix. The MEA will be established based upon obstacle clearance over the terrain or over manmade objects, adequacy of navigation facility performance, and communications requirements. Segments are designated West to East and South to North. Altitudes will be established to the nearest 100 foot increment; i.e., 2049 feet becomes 2000, and 2050 feet becomes 2100.

NOTE: Care must be taken to insure that all MEAs based upon flight inspection information have been corrected to and reported as true altitudes above mean sea level (MSL).

1719. PROTECTED ENROUTE AREAS. As previously established, the enroute areas which must be considered for obstacle clearance protection are identified as primary, secondary, and turn areas. The overall consideration of these areas is necessary when determining obstacle clearances.

Section 2. VHF Obstacle Clearance

1720. OBSTACLE CLEARANCE, PRIMARY AREA.

a. Nonmountainous Areas. The minimum obstacle clearance over areas NOT designated as mountainous under FAR 95 will be 1000 feet over the highest obstacle.

b. Mountainous Areas. Owing to the action of Bernoulli Effect and of atmospheric eddies, vortices, waves, and other phenomena which occur in conjunction with the disturbed airflow attending the passage of strong winds over mountains, pressure deficiencies manifested as very steep horizontal pressure gradients develop over such regions. Since downdrafts and turbulence are prevalent under these conditions, the hazards to air navigation are multiplied. Except as set forth in (1) and (2) below, the minimum obstacle clearance over terrain and manmade obstacles, within areas designated in FAR 95 as "mountainous" will be 2000 feet.

(1) Obstacle clearance may be reduced to not less than 1500 feet above terrain in the designated mountainous areas of the Eastern United States, Commonwealth of Puerto Rico, and the land areas of the State of Hawaii; and may be reduced to not less than 1700 feet above terrain in the designated mountainous areas of the Western United States and the State of Alaska. Consideration must be given to the following points before any altitudes providing less than 2000 feet of terrain clearance are authorized.

(a) Areas characterized by precipitous terrain.

(b) Weather phenomena peculiar to the area.

(c) Phenomena conducive to marked pressure differentials.

(d) Type of and distance between navigation facilities.

(e) Availability of weather services throughout the area.

(f) Availability and reliability of altimeter resetting points along airways/routes in the area.

(2) Altitudes providing at least 1000 feet of obstacle clearance over towers and/or other manmade obstacles may be authorized within designated mountainous areas provided such obstacles are NOT located on precipitous terrain where Bernoulli Effect is known or suspected to exist.

NOTE: When approving MEAs with less than 2000 feet of obstacle clearance in designated mountainous areas, a record of such approval will be maintained by the Flight Inspection Field Office.

1721. OBSTACLE CLEARANCE, SECONDARY AREAS. In all areas, mountainous and nonmountainous, obstacles which are located in the secondary areas will be considered as obstacles to air navigation when they extend above the secondary obstacle clearance plane. This plane begins at a point 500 feet above the obstacles upon which the primary obstacle clearance area MOCA is based, and slants upward at an angle which will cause it to intersect the outer edge of the secondary area at a point 500 feet higher. See Figure 17-17. Where an obstacle extends above this plane, the normal MOCA shall be increased by adding to the MSL height of the highest penetrating obstacle in the secondary area the required clearance (C), computed with the following formula:

$$\frac{D^1}{D^2} = \frac{500}{C} \text{ or } C = \frac{500 \times D^2}{D^1}$$

D^1 is the total width of the secondary area.

D^2 is the distance from the obstacle to the OUTER edge of the secondary area.

NOTE: Add an extra 1000 feet in mountainous areas except where MEAs in enroute airspace *areas are reduced under the provisions of paragraph 1720. In these cases, where the primary area MOCA has been reduced to 1700 feet, add 700 feet to the secondary obstacle clearance, and where the primary area MOCA has been reduced to 1500 feet, add 500 feet to the secondary area clearance value.*

D¹ has a total width of 2 NM, or 12,152 feet out to a distance of 51 NM from the enroute facility, and then increases at a rate of 236 feet for each additional NM.

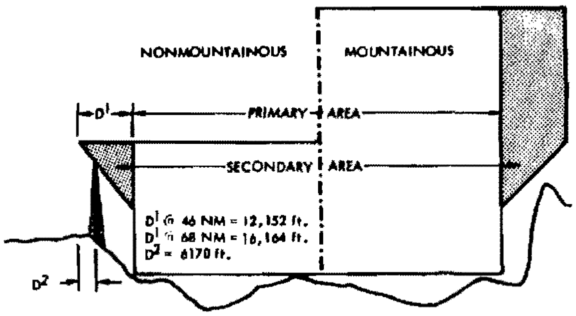


Figure 17-17 CROSS SECTION, SECONDARY AREA OBSTACLE CLEARANCES. Par 1721.

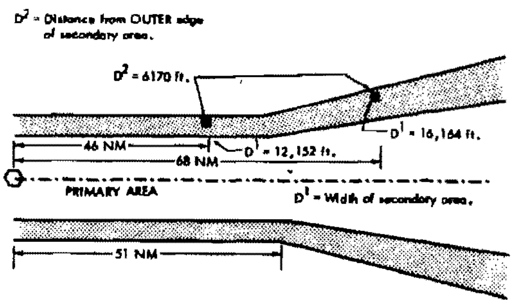


Figure 17-18. PLAN VIEW, SECONDARY AREA OBSTACLE CLEARANCES. Par 1721.

Example: An obstacle which reaches 1875 feet MSL is found in the secondary area 6170 feet inside the outer secondary area boundary and 46 NM from the facility. See Figures 17-17 and 17-18.

D¹ is 12,152 feet.
D² is 6170 feet.

$$\frac{500 \times 6170}{12{,}152} = 253.8 \text{ (254 feet)}$$

Obstacle height (1875) + 254 = 2129.
MOCA is 2100 feet.

1722. OBSTACLE CLEARANCE GRAPH. Figure 17-19 is a secondary area obstacle clearance graph, designed to allow the determination of clearance requirements without using the formula. The left axis shows the required obstacle clearance; the lower axis shows the distance from the outer edge of the secondary area to the obstacle. The slant lines are facility distance references.

Facility distances which fall between the charted values may be found by interpolation along the vertical distance lines.

a. *Application.* To use the secondary area obstacle clearance chart, enter with the value representing the distance from the outer edge of the secondary area to the obstacle. In the problems above this distance was 6170 feet. Proceed up to the "51 NM or less" line and read the clearance requirement from the left axis. The chart reads 254 feet, the same as was found using the formula. To solve the second problem, reenter the chart at 6170 feet and move vertically to find 68 NM between the 60 and 70 NM facility distance slant lines. The clearance requirement shown to the left is 191 feet, the same as found using the formula.

b. *Finding the MOCA.* The required clearance, found by using the graph, is now added to the MSL height of the obstacle to get the MOCA:

(1) 46 NM from facility:
254 + 1875 = 2129 (2100 MSL).

(2) 68 NM from facility:
191 + 1875 = 2066 (2100 MSL).

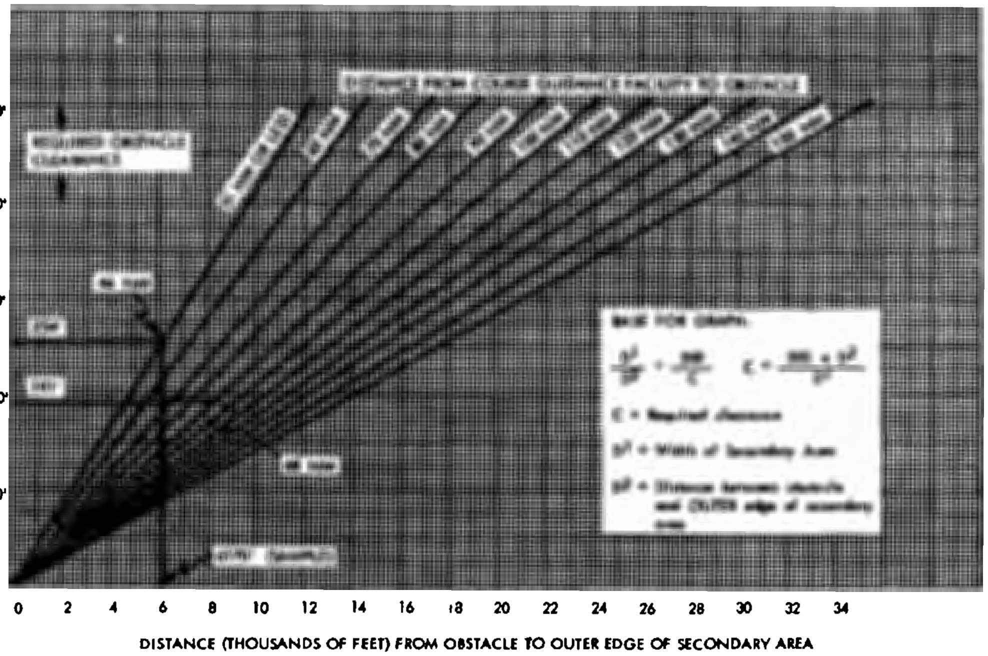


Figure 17-19 SECONDARY AREA OBSTACLE CLEARANCE Par 1722

1723.-1729. RESERVED.

Section 3. Altitudes

1730. MINIMUM CROSSING ALTITUDES (MCA). It is necessary to establish MCAs in all cases where obstacles intervene to prevent a pilot from maintaining obstacle clearance during a normal climb to a higher MEA after the aircraft passes a point beyond which the higher MEA applies. The same vertical obstacle clearance requirement for the primary and secondary areas must be considered in the determination of the MCA. See paragraph 1718. The standard for determining the MCA shall be based upon the following climb rates, and is computed from the flight altitude:

SL through 5000 feet	150 ft/NM
5000 through 10,000 feet	120 ft/NM
10,000 feet and over	100 ft/NM

a. To determine the MCA, the distance from the obstacle to the radio fix shall be computed from the point where the centerline of the en route course in the direction of flight intersects the farthest displacement from the fix. See Figures 17-20 and 17-21.

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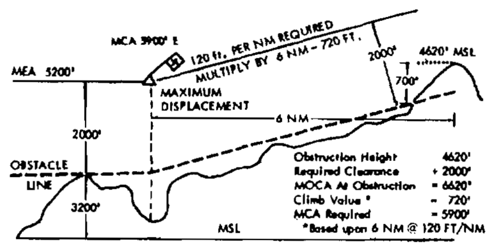

Figure 17-20 MCA DETERMINATION POINT. Par 1730

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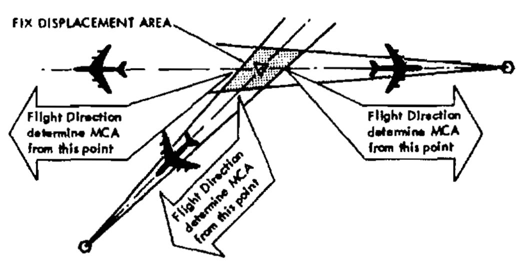

Figure 17-21. DETERMINATION OF MCA Par 1730.

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).

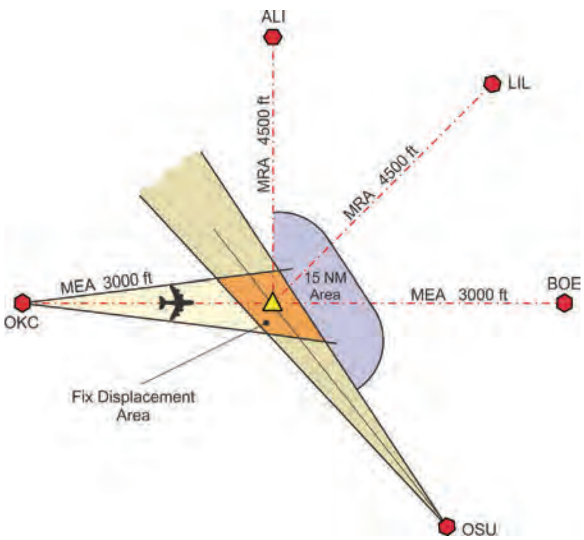

Figure 17-22. MEA WITH NAVIGATION GAP AT TURNING POINT. Par 1740b(2)

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

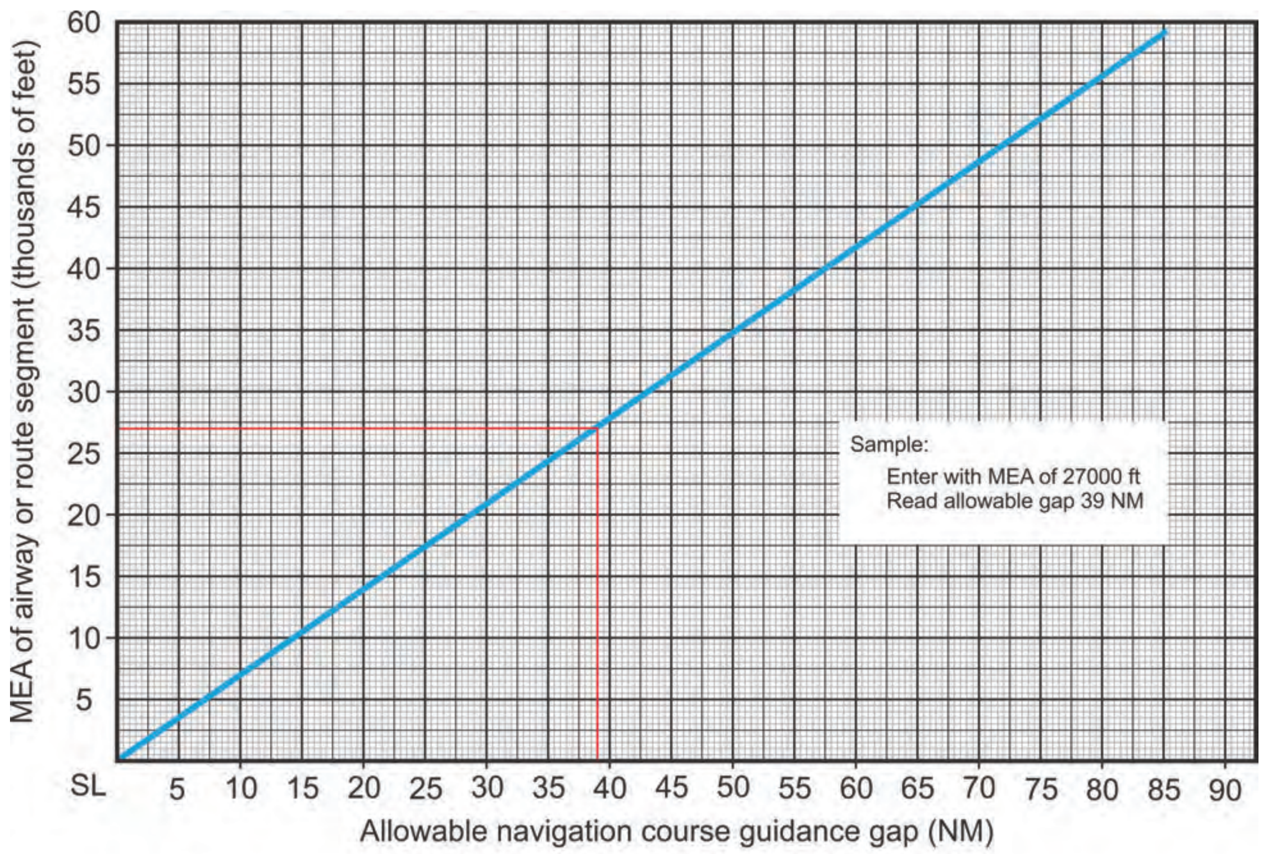

Figure 17-23. NAVIGATION COURSE GUIDANCE GAPS. Par 1740.

"steps." These steps may be established at increments of not less than 2000 feet below 18,000 feet MSL, or not less than 4000 feet at 18,000 feet MSL and above, provided that a total gap does not exist for the segment within the airspace structure. MEA steps shall be limited to one step between any two facilities to eliminate continuous or repeated changes of altitude in problem areas. MEA changes shall be identified by designated radio fixes.

d. Gaps. Allowable navigational gaps may be determined by reference to the graph in Figure 17-23.

Example: The problem drawn on the chart shows the method used to determine the allowable gap on a route segment with a proposed MEA of 27,000 feet. Enter the graph at the left edge with the MEA of 27,000 feet. Move to the right to the *interception of the diagonal line. Move to the bottom of the graph to read the allowable gap.* In the problem drawn, a 39 NM gap is allowable.

1741.-1749. RESERVED.

Section 5. Low Frequency Airways or Routes

1750. LF AIRWAYS OR ROUTES.

a. Usage. LF navigation facilities may be used to establish enroute airway/route segments. Then use will be limited to those instances where an operational requirement exists.

b. Obstacle Clearance Areas. See Figures 17-24 and 17-25.

(1) The primary obstacle clearance area boundaries *of LF segments are lines drawn* 4.34 NM (5 statute miles) on each side of and parallel to the segment centerline. These boundaries will be affected by obstacle clearance area factors shown in c. below.

(2) The LF secondary obstacle clearance areas extend laterally for an additional 4.34 NM on each side of the primary area. The boundaries of the secondary areas are also affected by the obstacle clearance area *factors shown* in c. below.

c. Obstacle Clearance Area Factors. See Figures 17-24 and 17-25.

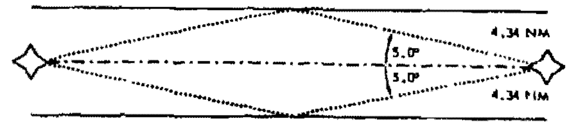

Figure 17-24 LF SEGMENT PRIMARY OBSTACLE CLEARANCE AREA Par 1750 b

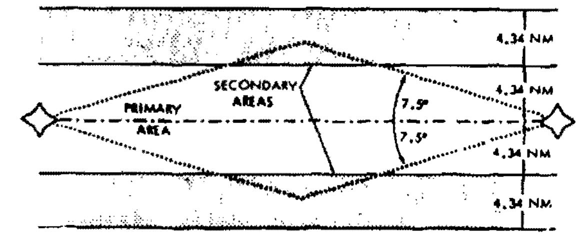

Figure 17-25. LF SEGMENT SECONDARY OBSTACLE CLEARANCE AREA Par 1750 b

(1) The primary area of LF segments is expanded in the same way as for VHF airways/routes. Lines are drawn at 5 degrees off the course centerline from each facility. These lines meet at the midpoint of the segment. Penetration of the 4.34 NM boundary occurs 49.66 (50) NM *from the facility.*

(2) The secondary areas are expanded in the same manner as the secondary areas for VHF airways/routes. Lines are drawn 7.5 degrees on each side of the segment centerline. These 7.5 degree lines will intersect the original 8.68 NM secondary area boundaries at 65.93 (66) NM from the facility.

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d. Obstacle Clearance.

(1) Obstacle clearance in the primary area of LF airways or routes is the same as that required for VOR airways/routes. The areas over which the clearances apply are different, as shown in paragraph 1750.c.

(2) Secondary area obstacle clearance requirements for LF segments are based upon distance *from the facility* and location of the obstacle relative to the inside boundary of the secondary area.

(a) Within 25 NM of the facility the obstacle clearance is based upon a 50:1 plane drawn from the primary area boundary 500 feet above the obstacle which dictates its MOCA and extending to the edge of the secondary area. When obstacles penetrate this 50:1 plane, the MOCA for the segment will be increased above that dictated for the primary area obstacle as follows:

Distance from Primary Boundary	Add to Height of Obstacle
0 - 1 statute miles	500 feet
1 - 2 statute miles	400 feet
2 - 3 statute miles	300 feet
3 - 4 statute miles	200 feet
4 - 5 statute miles	100 feet

NOTE: See Figure 17-26 for cross section view. Also see (c) below.

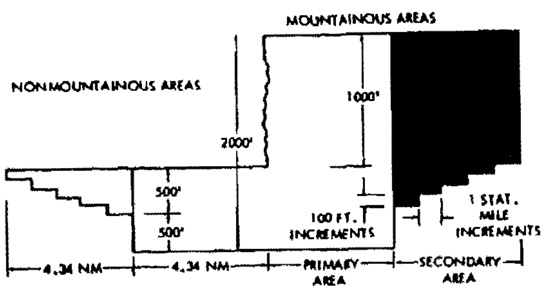

Figure 17-26 LF SEGMENT OBSTACLE CLEARANCE WITHIN 25 NM OF ENROUTE FACILITY
Par 1750 d

(b) Beyond the 25 NM distance from the facility, the secondary obstacle clearance plane is flat. This plane is drawn from the primary area boundary 500 feet above the obstacle which dictates its MOCA and extending to the edge of the secondary area. If an obstacle penetrates this surface the MOCA for the segment will be increased so as to provide 500 feet of clearance over the obstacle. See Figure 17-27. Also see (c) below.

(c) Obstacle clearance values shown in (a) and (b) above are correct for nonmountainous areas only. For areas designated as mountainous add 1000 feet.

1751.-1759. RESERVED.

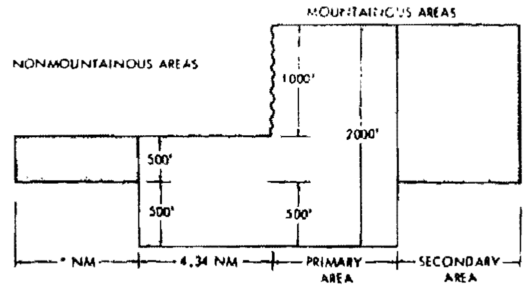

Figure 17-27 LF SEGMENT OBSTACLE CLEARANCE OVER 25 NM FROM ENROUTE FACILITY
Par 1750 d

Section 6. Minimum Divergence Angles

1760. GENERAL.

a. *Governing Facility.* The governing facility for determining the minimum divergence angle depends upon how the fix is determined.

(1) Where the fix is predicated on an off-course radial or bearing, the distance from the fix to the facility providing the off-course radial or bearing is used.

(2) Where the fix is predicated on the radials or bearings of two intersecting airways or routes, the distance between the farthest facility and the fix will be used to determine the angle.

b. *Holding.* Where holding is to be authorized at a fix, the minimum divergence angle is 45 degrees.

1761. VHF FIXES.

a. The minimum divergence angles for those fixes formed by intersecting VHF radials are determined as follows:

(1) When both radio facilities are located within 30 NM of the fix, the minimum divergence angle is 30 degrees.

(2) When the governing facility is over 30 NM from the fix, the minimum allowable angle will be increased at the rate of 1 degree per NM up to 45 NM (45 degrees).

(3) Beyond 45 NM, the minimum divergence angle increases at the rate of 1/2 degree per NM.

Example: Distance from fix to governing facility is 51 NM. 51 − 45 = 6 NM. 6 × 1/2 = 3 additional degrees. Add to the 45 degrees required at 45 NM and get 48 degrees minimum divergence angle at 51 NM.

b. A graph (Figure 17-28) may be used to define minimum divergence angles. Using the foregoing example, enter the chart at the bottom with the facility distance (51 NM). Move up to the "VHF Fix" conversion line. Then move to the left to read the angle – 48 degrees.

1762. LF OR VHF/LF FIXES.

a. Minimum divergence angles for LF or integrated (VHF/LF) fixes are determined as follows:

(1) When the governing facility is within 30 NM of the fix, the minimum divergence angle is 45 degrees.

(2) Beyond 30 NM the minimum angle must be increased at the rate of 1 degree for each NM, except for fixes on long overwater routes where the fix will be used for reporting purposes and not for traffic separation.

Example: The distance from the governing facility is 51 NM. 51 − 30 = 21 NM. 21 × 1 = 21. Add 21 to 45 degrees required at 30 NM to get the required divergence angle of 66 degrees.

b. The graph (Figure 17-28) may be used to define minimum angles for LF or VHF/LF fixes. Using the foregoing example, enter at the bottom of the chart with the 51 NM distance between facility and fix. Move up to the "LF or INTEGRATED FIX" conversion line, then left to read the required divergence angle, 66 degrees.

1763.-1799. RESERVED.

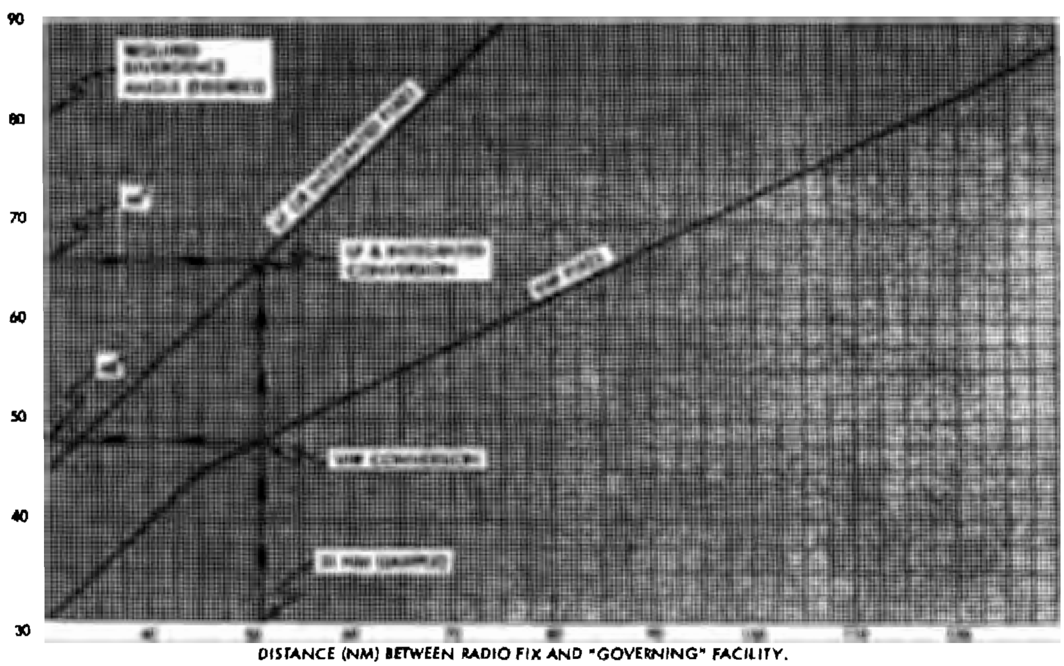

Figure 17-28 MINIMUM DIVERGENCE ANGLE FOR RADIO FIX Par 1761 b and 1762 b

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APPENDIX 1. APPENDIX APPLICATION, GLOSSARY, ACRONYMS, AND ABBREVIATIONS

Policy Memo Dec 28 2007

1. APPENDIX APPLICATION. The material contained in these appendices supports criteria contained in several chapters of this order. Appendix material includes:

a. Appendix 1, paragraph 2. Glossary. A listing of special terms and abbreviations to explain their meaning and application to procedures and criteria.

b. Appendix 1, paragraph 3. Acronyms and Abbreviations. A listing of all acronyms and abbreviations used in this order.

c. Appendix 2. RESERVED

d. Appendix 3. References. This appendix contains a list of referenced publications.

e. Appendix 4. Table of Tangents. A complete list of tangents for angles from 0.0 to 9.0 degrees in hundredths of degrees for application in solving glide slope problems.

f. Appendix 5. Approach Lighting.Systems. This appendix contains descriptions of standard approach lighting systems and lists of other systems which may be given the same visibility credit in the development of military procedures.

g. Appendix 6. Alphabetical Index.

2. GLOSSARY. Definitions shown in the glossary apply to terminal instrument procedures criteria in this order.

AL Approach and Landing (Chart).

Angle of Divergence (Minimum). The smaller of the angles formed by the intersection of two courses, radials, bearings, or combinations thereof.

ASBL Approach Surface Baseline. An imaginary horizontal line at threshold elevation.

Approving Authority. Headquarters representative of the various signatory authorities shown in the Foreword, Page iv.

BC Back Course (Localizer).

Circling Approach Area. The area in which aircraft circle to land under visual conditions after completing an instrument landing approach.

Controlling Obstacle. The highest obstacle relative to a prescribed plane within a specified area.

NOTE: In precision approach procedures where obstacles penetrate the approach surface, the controlling obstacle is the one which results in the requirement for the highest decision height (DH).

Dead Reckoning. The estimating or determining of position by advancing an earlier known position by the application of direction and speed data. For example, flight based on a heading from one VORTAC azimuth and distance fix to another is dead reckoning.

Diverse Vector. An instruction issued by a radar controller to fly a specific course, which is not a part of a predetermined radar pattern. Also referred to as a "random vector."

DH Decision Height. The height, specified in mean sea level (MSL), above the highest runway elevation in the touchdown zone at which a missed approach must be initiated if the required visual reference has not been established. This term is used only in procedures where an electronic glide slope provides the reference for descent, as in an instrument landing system (ILS) or precision approach radar (PAR).

DME Distance Measuring Equipment Arc. A course, indicated as a constant DME distance, around a navigation facility which provides distance information.

DME Distance. The line of sight distance (slant range) from the source of the DME signal to the receiving antenna.

FAC Final Approach Course.

FAF Final Approach Fix.

Flight Inspection. In-flight investigation and certification of certain operational performance characteristics of electronic and visual navigation facilities by an authorized inspector in conformance with Order 8200.1, U. S. Standard Flight Inspection Manual.

Gradient. A slope expressed in feet per mile, or as a ratio of the horizontal to the vertical distance. For example, 40:1 means 40 feet horizontally to 1 foot vertically.

GPI Ground Point of Intercept. A point in the vertical plane on the runway centerline at which it is assumed that the straight line extension of the glide slope intercepts the runway approach surface baseline.

HAA Height above airport elevation.

HAT Height above touchdown zone elevation.

IAC Initial Approach Course.

IAF Initial Approach Fix.

IC Intermediate Course.

IF Intermediate Fix

JAL High Altitude Approach and Landing (Chart).

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

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

LPV - Lateral Precision Performance with Vertical Guidance

MAP Missed Approach Point (paragraph 272).

MDA Minimum Descent Altitude (paragraph 310)

MHA Minimum Holding Altitude.

NDB (ADF) Non Directional Beacon (Airborne Automatic Direction Finder). A combined term which indicates that an NDB provides an electronic signal for use with ADF equipment.

Obstacle. An existing object, object of natural growth, or terrain at a fixed geographical location which may be expected at a fixed location within a prescribed area, with reference to which vertical clearance is or must be provided during flight operation. For example, with reference to mobile objects, a moving vehicle 17 feet high is assumed to be on an Interstate Highway, 15 feet high on other highways, and 23 feet high on a railroad track, except where limited to certain heights controlled by use or construction. The height of a ship's mast is assumed according to the types of ships known to use an anchorage.

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

Obstacle Clearance Boxes [500]. When used in figures which depict approach segments, these boxes indicate the obstacle clearance requirements in feet.

Operational Advantage. An improvement which benefits the users of an instrument procedure. Achievement of lower minimums or authorization for a straight-in approach with no derogation of safety is an example of an operational advantage. Many of the options in TERPS are specified for this purpose. For instance, the flexible final approach course alignment criteria may permit the ALS to be used for reduced visibility credit by selection of the proper optional course.

Optimum Most Favorable. As used in TERPS, optimum identifies the value, which should be used wherever a choice is available.

Positive Course Guidance. A continuous display of navigational data which enable an aircraft to be flown along a specific course line.

Precipitous Terrain. Terrain characterized by steep or abrupt slopes.

Precision and Nonprecision. These terms are used to differentiate between navigational facilities which provide a combined azimuth and glide slope guidance to a runway (Precision) and those that do not. The term nonprecision refers to facilities without a glide slope, and does not imply an unacceptable quality of course guidance.

Primary Area. The area within a segment in which full obstacle clearance is applied.

ROC Required Obstacle Clearance.

Runway Environment. The runway threshold or approved lighting aids or other markings identifiable with the runway.

Secondary Area. The area within a segment in which ROC is reduced as distance from the prescribed course is increased.

Segment. The basic functional division of an instrument approach procedure. The segment is oriented with respect to the course to be flown. Specific values for determining course alignment, obstacle clearance areas, descent gradients, and obstacle clearance requirements are associated with each segment according to its functional purpose.

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

TCH Threshold Crossing Height. The height of the straight line extension of the glide slope above the runway at the threshold.

TDZ Touchdown Zone. The first 3,000 feet of runway beginning at the threshold.

TDZE Touchdown Zone Elevation. The highest runway centerline elevation in the touchdown zone.

Transition Level. The flight level below which heights are expressed in feet MSL and are based on an approved station altimeter setting.

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

3. ACRONYMS AND ABBREVIATIONS. Many acronyms and abbreviations for old and new aviation terms are used throughout this order. Users of this order can refer to the following alphabetical listing of frequently used acronyms and abbreviations:

AAF	Airway Facilities Service
ABM	abeam
AC	Advisory Circular
ADF	automatic direction finder
AFM	Airplane Flight Manual
AFS	Flight Standards Service
AFSS	Automated Flight Service Station
AGL	above ground level
AIM	Aeronautical Information Manual
ALPA	Air Line Pilots Association
ALSF-1	approach lighting system with sequenced flashing lights (CAT I Configuration)
ALSF-2	approach lighting system with sequenced flashing lights (CAT II Configuration)
AOPA	Aircraft Owners and Pilots Association
APV	approach with vertical guidance (ICAO)
ARA	airborne radar approach
ARC	Airport Reference Code
ARDH	achieved reference datum height
ARINC	Aeronautical Radio, Inc.
ARP	airport reference point
ARSR	air route surveillance radar
ARTCC	Air Route Traffic Control Center
ASBL	approach surface baseline
ASOS	automated surface observing system
ASR	airport surveillance radar
AT	Air Traffic
ATA	Air Transport Association
ATC	Air Traffic Control
ATD	along track distance
ATRK	along track
ATS	Air Traffic Service
AVN	Aviation System Standards
AWO	all weather operations
AWOP	All Weather Operations Panel
AWO/PM	All Weather Operations/Program Manager
AWOS	automated weather observation system
AWS	Aviation Weather System
Baro VNAV	Barometric vertical navigation
BC	back course
CAT	Category
CF	course to fix
CFIT	controlled flight into terrain
CFR	Code of Federal Regulations
CG	climb gradient
CGL	circling guidance light
CHDO	Certificate Holding District Office
CIH	climb-in-hold
CMO	Certificate Management Office
CMT	Certificate Management Team
CONUS	Continental United States
COP	changeover point
CRM	collision risk model
CW	course width
CWSU	Center Weather Service Unit
CY	Calendar Year
DA	decision altitude
dB	decibel
DCG	desired climb gradient
DER	departure end of runway
DF	direct to fix

DF	direction finder
DG	descent gradient
DH	decision height
DME	distance measuring equipment
DOD	Department of Defense
DOT	Department of Transportation
DP	departure procedure
DR	dead reckoning
DRL	departure reference line
DRP	departure reference point
DTA	distance turn anticipation
DVA	diverse vector area
EARTS	en route automated radar tracking system
EDA	elevation differential area
ESA	emergency safe altitudes
ESV	expanded service volume
FAA	Federal Aviation Administration
FAATC	FAA Technical Center
FAC	final approach course
FAF	final approach fix
FAP	final approach point
FAR	Federal Aviation Regulations
FAS	final approach segment
FATO	final approach and takeoff area
FAWP	final approach waypoint
FDC	Flight Data Control
FDR	Flight Data Record
FDT	fix displacement tolerance
FEP	final end point
FIFO	Flight Inspection Field Office
FMS	flight management system
FPAP	flight path alignment point
FPCP	flight path control point
FPO	Flight Procedures Office
FR	Federal Register
FSDO	Flight Standards District Office
FSS	Flight Service Station
FTE	flight technical error
FTIP	Foreign terminal instrument procedure
FTP	fictitious threshold point
GA	general Aviation
GCA	ground controlled approach
GH	Geoid Height
GLONASS	Global Orbiting Navigation Satellite System
GLS	GNSS Landing System
GNSS	Global Navigation Satellite System
GP	glidepath
GPA	glidepath angle
GPI	ground point of intercept
GPS	Global Positioning System
GRI	group repetition interval
GS	glide slope
HAA	height above airport
HAE	height above ellipsoid
HAH	height above helipoint
HAI	Helicopter Association International
HAL	height above landing area elevation
HAS	height above surface
HAT	height above touchdown
HATh	height above threshold
HCH	heliport crossing height
HF	high frequency
HIRL	high intensity runway lights
HRP	heliport reference point
HUD	heads-up display
IAC	initial approach course
IAF	initial approach fix
IAP	instrument approach procedure
IAPA	instrument approach procedure automation
IC	intermediate course
ICA	initial climb area
ICAB	ICA baseline
ICAE	ICA end-line
ICAO	International Civil Aviation Organization
ICWP	initial course waypoint
IDF	initial departure fix
IF	intermediate fix
IF	initial fix
IF/IAF	intermediate/initial approach fix
IFR	instrument flight rules
ILS	instrument landing system
IMC	instrument meteorological conditions
INS	inertial navigation system
IPV	instrument procedure with vertical guidance
IRU	inertial reference unit
ISA	International Standard Atmosphere
kHz	kilohertz
KIAS	knots indicated airspeed
LAAS	Local Area Augmentation System
LAB	landing area boundary
LAHSO	land and hold short operations
LDA	localizer type directional aid
LDIN	lead-in lighting system
LF	low frequency
LIRL	low intensity runway lights
LNAV	lateral navigation
LPV	Lateral Precision Performance with Vertical Guidance
LOA	Letter of Agreement
LOB	lines of business
LOC	localizer
LOM	locator outer marker
LORAN	long range navigation system
LTP	landing threshold point
MALS	minimum intensity approach lighting system
MALSF	minimum intensity approach lighting system with sequenced flashing

MALSR	minimum intensity approach lighting system with runway alignment indicator lights
MAP	missed approach point
MCA	minimum crossing altitude
MDA	minimum descent altitude
MEA	minimum en route altitude
MHA	minimum holding altitude
MHz	megahertz
MIA	minimum IFR altitudes
MIRL	medium intensity runway lights
MLS	Microwave Landing System
MM	middle marker
MOA	Memorandum of Agreement
MOA	military operations area
MOC	minimum obstacle clearance
MOCA	minimum obstruction clearance altitude
MOU	Memorandum of Understanding
MRA	minimum reception altitude
MSA	minimum safe/sector altitude
MSL	mean sea level
MTA	minimum turn altitude
MVAC	minimum vectoring altitude chart
NAD	North American Datum
NAS	National Airspace System
NAVAID	navigational aid
NAWAU	National Aviation Weather Advisory Unit
NBAA	National Business Aviation Association
NDB	nondirectional radio beacon
NFDC	National Flight Data Center
NFDD	National Flight Data Digest
NFPO	National Flight Procedures Office
NM	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NOTAM	Notice to Airmen
NOZ	normal operating zone
NPA	nonprecision approach
NTSB	National Transportation Safety Board
NTZ	no transgression zone
NWS	National Weather Service
OC	obstruction chart
OCA	obstacle clearance altitude
OCH	obstacle clearance height
OCS	obstacle clearance surface
ODALS	omnidirectional approach lighting system
OEA	obstruction evaluation area
OE/AAA	Obstruction Evaluation/Airport Airspace Analysis
OFA	object free area
OIS	obstacle identification surface
OM	outer marker
ORE	obstacle rich environment
OSAP	off-shore approach procedure
PA	precision approach

PAPI	precision approach path indicator
PAR	precision approach radar
PCG	positive course guidance
PDA	preliminary decision altitude
PFAF	precision final approach fix
PGPI	pseudo ground point of intercept
PinS	point-in-space
PLS	precision landing system
POC	point of contact
PRM	precision runway monitor
PT	procedure turn
PVG	positive vertical guidance
PVGSI	pseudo visual glide slope indicator
RA	radio altimeter
RAA	Regional Airline Association
RAIL	runway alignment indicator lights
RAPCON	radar approach control
RASS	remote altimeter setting source
RCL	runway centerline
RDP	reference datum point
REIL	runway end identifier lights
RF	radio frequency
RF	radius to fix
RNAV	area navigation
RNP	required navigation performance
ROC	required obstacle clearance
RPI	runway point of intercept
RRP	runway reference point
RTCA	Radio Technical Commission for Aeronautics
RVR	runway visual range
RWP	runway threshold waypoint
RWT	runway threshold
RWTE	runway threshold evaluation
RWY	runway
SALS	short approach lighting system
SATNAV	satellite navigation
SCG	standard climb gradient
SDF	simplified directional facility
SDF	step-down fix
SER	start end of runway
SIAP	standard instrument approach procedure
SID	standard instrument departure
SM	statute mile
SSALF	short simplified approach lighting system with sequenced flashers
SSALR	short simplified approach lighting system with runway alignment indicator lights
STAR	standard terminal arrival route
STOL	short takeoff and landing
TAA	terminal arrival area
TACAN	tactical air navigational aid
TCH	threshold crossing height
TD	time difference
TDP	touchdown point
TDZ	touchdown zone

TDZE	touchdown zone elevation
TDZL	touchdown zone lights (system)
TERPS	terminal instrument procedures
TF	track to fix
TL	Transmittal Letter
TLOF	touchdown and life-off area
TLS	transponder landing system
TORA	takeoff runway available
TP	tangent point
TPD	tangent point distance
TRACON	terminal radar approach control facility
TSO	technical standard order
TWP	turn waypoint
UHF	ultra high frequency
USA	U.S. Army
USAF	U.S. Air Force
USCG	U.S. Coast Guard
USMC	U.S. Marine Corps
USN	U.S. Navy
VA	heading to altitude
VASI	visual approach slope indicator
VCA	visual climb area
VCOA	visual climb over airport
VDA	vertical descent area
VDP	visual descent point
VFR	visual flight rules
VGA	vertically guided approach
VGSI	visual glide slope indicator
VHF	very high frequency
VLF	very low frequency
VMC	visual meteorological conditions
VNAV	vertical navigation
VOR	very high frequency omnidirectional radio range
VOR/DME	very high frequency omnidirectional radio range collocated with distance measuring equipment
VORTAC	very high frequency omnidirectional radio range collocated with tactical air navigation
VPA	vertical path angle
VSDA	visual segment descent angle
VTOL	vertical take-off and landing
WAAS	Wide Area Augmentation System
WCH	wheel crossing height
XTRK	crosstrack

1. REFERENCES

a. Federal Aviation Regulations.

FAR 77	Objects Affecting Navigable Airspace.
FAR 97	Standard Instrument Approach Procedures.
FAR 121	Certification & Operations: Air Carriers and Commercial Operators of Large Aircraft.
FAR 171	Non-Federal Navigation Facilities.

b. FAA Advisory Circulars.

AC 70/7460–1D	Obstruction Marking and Lighting.
AC 90–45A	Approval of Area Navigation Systems for Use in the U.S. National Airspace System.
AC 90–70	Straight-in nonprecision instrument approach procedures visual descent point (VDP).
AC 91–14B	Altimeter Setting Sources
AC 91–16	Category II Operations – General Aviation Airplanes.
AC 95–1	Airway and Route Obstruction Clearances.
AC 120–28A	Criteria for Approval of Category IIIa Landing Weather Minima.
AC 120–29	Criteria for Approving Category I and Category II Landing Minima for FAR 121 Operators.
AC 150/5300–2C	Airport Design Standards – Site Requirements for Terminal Navigational Facilities.
AC 150/5340–1D	Marking of Paved Areas on Airports.
AC 150/5340–4B	Installation Details for Runway Centerline and TDZ Lighting Systems.
AC 150/5340–13B	High Intensity Lighting Systems.
AC 150/5340–14B	Economy Approach Lighting Aids.
AC 150/5340–16B	MIRL System and Visual Approach Slope Indicators for Utility Airports.

c. FAA Directives.

1010.3A	Selection Order; Runway CL & TDZ Lighting.
1010.11	Selection Order; Separation of Parallel Runways for Simultaneous ILS Approaches.
1010.39A	Selection Order; Category II ALS.
1010.43	Selection Order; MALS.
1010.52	Selection Order; Lead-In Lighting System.
1010.55	Selection Order; US National Aviation System for the VORTAC System.
6700.1	Non-Federal Navigational Facilities.
6700.10B	Non-Federal Navigational Facilities.
6700.12B	Criteria for FAA Assumption of Non-federal Navigational and Air Traffic Control Facilities.
6850.2	Visual Guidance Lighting System.
6990.3	Implementation of Standard FAA STD-008 "Siting and Installation Standards for RVR Equipment for Category I & II Operations."
7130.3	Holding Pattern Criteria.
7230.13	U.S. Air Force Special Training Instrument Approach Procedures.
7232.5D	Reduced Hours of Operation for Airport Traffic Control Towers.
7400.2B	Procedures for Handling Airspace Cases.
OA P 8200.1	U.S. Standard Flight Inspection Manual.
8200.28A	Simplified Directional Facilities.
8260.1	Designated RVR Runway.
8260.15A	U.S. Army Terminal Instrument Procedures Service.
8260.18A	Establishing Requirements for Visual Approach Aids.
8260.19	Flight Procedures and Airspace.
8260.24B	Category I ILS Threshold Crossing Height.

8260.26	Establishing and Scheduling Instrument Approach Procedure Effective Dates
8260.27	Effect of Runway Markings on SIAP Visibility Minimums.
8260.28	IFR Approval of the Interim Standard Microwave Landing System (ISMLS).
8430.1A	Operations Inspection & Surveillance Procedures – Air Taxi Operators & Commercial Operators of Small Aircraft.
8430.6A	Air Carrier Operations Inspector's Manual.
8430.10B	IFR Approval of Private-Use Microwave Landing Systems.

d. Other

IACC No. 4	U.S. Government Specifications for Flight Information Publications – Low Altitude Instrument Approach Procedure.

BACK

1. TABLE OF TANGENTS

Degrees	Tangent	Degrees	Tangent	Degrees	Tangent	Degrees	Tangent
0.0 =	.00000	1.36=	.02374	1.82=	.03178	2.28=	.03981
0.1 =	.00175	1.37=	.02392	1.83=	.03195	2.29=	.03999
0.2 =	.00349	1.38=	.02409	1.84=	.03213	2.3 =	.04016
0.3 =	.00524	1.39=	.02426	1.85=	.03230	2.31=	.04034
0.4 =	.00698	1.4 =	.02444	1.86=	.03247	2.32=	.04051
0.5 =	.00873	1.41=	.02461	1.87=	.03265	2.33=	.04069
0.6 =	.01047	1.42=	.02479	1.88=	.03282	2.34=	.04086
0.7 =	.01222	1.43=	.02496	1.89=	.03300	2.35=	.04104
0.8 =	.01396	1.44=	.02514	1.9 =	.03317	2.36=	.04121
0.9 =	.01571	1.45=	.02531	1.91=	.03335	2.37=	.04139
1.0 =	.01746	1.46=	.02549	1.92=	.03352	2.38=	.04156
1.01=	.01763	1.47=	.02566	1.93=	.03370	2.39=	.04174
1.02=	.01780	1.48=	.02584	1.94=	.03387	2.4 =	.04191
1.03=	.01798	1.49=	.02601	1.95=	.03405	2.41=	.04209
1.04=	.01815	1.5 =	.02619	1.96=	.03422	2.42=	.04226
1.05=	.01833	1.51=	.02636	1.97=	.03440	2.43=	.04244
1.06=	.01850	1.52=	.02654	1.98=	.03457	2.44=	.04261
1.07=	.01868	1.53=	.02671	1.99=	.03475	2.45=	.04279
1.08=	.01885	1.54=	.02688	2.0 =	.03492	2.46=	.04296
1.09=	.01903	1.55=	.02706	2.01=	.03510	2.47=	.04314
1.1 =	.01920	1.56=	.02723	2.02=	.03527	2.48=	.04331
1.11=	.01938	1.57=	.02741	2.03=	.03545	2.49=	.04349
1.12=	.01955	1.58=	.02758	2.04=	.03562	2.5 =	.04366
1.13=	.01972	1.59=	.02776	2.05=	.03579	2.51=	.04384
1.14=	.01990	1.6 =	.02793	2.06=	.03597	2.52=	.04401
1.15=	.02007	1.61=	.02811	2.07=	.03614	2.53=	.04419
1.16=	.02025	1.62=	.02828	2.08=	.03632	2.54=	.04436
1.17=	.02042	1.63=	.02846	2.09=	.03649	2.55=	.04454
1.18=	.02060	1.64=	.02863	2.1 =	.03667	2.56=	.04471
1.19=	.02077	1.65=	.02881	2.11=	.03684	2.57=	.04489
1.2 =	.02095	1.66=	.02898	2.12=	.03702	2.58=	.04506
1.21=	.02112	1.67=	.02916	2.13=	.03719	2.59=	.04523
1.22=	.02130	1.68=	.02933	2.14=	.03737	2.6 =	.04541
1.23=	.02147	1.69=	.02950	2.15=	.03754	2.61=	.04558
1.24=	.02165	1.7 =	.02968	2.16=	.03772	2.62=	.04576
1.25=	.02182	1.71=	.02985	2.17=	.03789	2.63=	.04593
1.26=	.02199	1.72=	.03003	2.18=	.03807	2.64=	.04611
1.27=	.02217	1.73=	.03020	2.19=	.03824	2.65=	.04628
1.28=	.02234	1.74=	.03038	2.2 =	.03842	2.66=	.04646
1.29=	.02252	1.75=	.03055	2.21=	.03859	2.67=	.04663
1.30=	.02269	1.76=	.03073	2.22=	.03877	2.68=	.04681
1.31=	.02287	1.77=	.03090	2.23=	.03894	2.69=	.04698
1.32=	.02304	1.78=	.03108	2.24=	.03912	2.7 =	.04716
1.33=	.02322	1.79=	.03125	2.25=	.03929	2.71=	.04733
1.34=	.02339	1.8 =	.03143	2.26=	.03946	2.72=	.04751
1.35=	.02357	1.81=	.03160	2.27=	.03964	2.73=	.04768

Degrees	Tangent	Degrees	Tangent	Degrees	Tangent	Degrees	Tangent
2.74=	.04786	3.22=	.05626	3.7 =	.06467	4.18=	.07308
2.75=	.04803	3.23=	.05643	3.71=	.06484	4.19=	.07326
2.76=	.04821	3.24=	.05661	3.72=	.06502	4.2 =	.07344
2.77=	.04838	3.25=	.05678	3.73=	.06519	4.21=	.07361
2.78=	.04856	3.26=	.05696	3.74=	.06537	4.22=	.07379
2.79=	.04873	3.27=	.05713	3.75=	.06554	4.23=	.07396
2.8 =	.04891	3.28=	.05731	3.76=	.06572	4.24=	.07414
2.81=	.04908	3.29=	.05748	3.77=	.06589	4.25=	.07431
2.82=	.04926	3.3 =	.05766	3.78=	.06607	4.26=	.07449
2.83=	.04943	3.31=	.05783	3.79=	.06624	4.27=	.07466
2.84=	.04961	3.32=	.05801	3.8 =	.06642	4.28=	.07484
2.85=	.04978	3.33=	.05818	3.81=	.06660	4.29=	.07501
2.86=	.04996	3.34=	.05836	3.82=	.06677	4.3 =	.07519
2.87=	.05013	3.35=	.05854	3.83=	.06695	4.31=	.07537
2.88=	.05031	3.36=	.05871	3.84=	.06712	4.32=	.07554
2.89=	.05048	3.37=	.05889	3.85=	.06730	4.33=	.07572
2.9 =	.05066	3.38=	.05906	3.86=	.06747	4.34=	.07589
2.91=	.05083	3.39=	.05924	3.87=	.06765	4.35=	.07607
2.92=	.05101	3.4 =	.05941	3.88=	.06782	4.36=	.07624
2.93=	.05118	3.41=	.05959	3.89=	.06800	4.37=	.07642
2.94=	.05136	3.42=	.05976	3.9 =	.06817	4.38=	.07659
2.95=	.05153	3.43=	.05994	3.91=	.06835	4.39=	.07677
2.96=	.05171	3.44=	.06011	3.92=	.06852	4.4 =	.07695
2.97=	.05188	3.45=	.06029	3.93=	.06870	4.41=	.07712
2.98=	.05206	3.46=	.06046	3.94=	.06887	4.42=	.07730
2.99=	.05223	3.47=	.06064	3.95=	.06905	4.43=	.07747
3.0 =	.05241	3.48=	.06081	3.96=	.06923	4.44=	.07765
3.01=	.05258	3.49=	.06099	3.97=	.06940	4.45=	.07782
3.02=	.05276	3.5 =	.06116	3.98=	.06958	4.46=	.07800
3.03=	.05293	3.51=	.06134	3.99=	.06975	4.47=	.07817
3.04=	.05311	3.52=	.06151	4.0 =	.06993	4.48=	.07835
3.05=	.05328	3.53=	.06169	4.01=	.07010	4.49=	.07853
3.06=	.05346	3.54=	.06186	4.02=	.07028	4.5 =	.07870
3.07=	.05363	3.55=	.06204	4.03=	.07045	4.51=	.07888
3.08=	.05381	3.56=	.06221	4.04=	.07063	4.52=	.07905
3.09=	.05398	3.57=	.06239	4.05=	.07080	4.53=	.07923
3.1 =	.05416	3.58=	.06256	4.06=	.07098	4.54=	.07940
3.11=	.05433	3.59=	.06274	4.07=	.07115	4.55=	.07958
3.12=	.05451	3.6 =	.06291	4.08=	.07133	4.56=	.07976
3.13=	.05468	3.61=	.06309	4.09=	.07151	4.57=	.07993
3.14=	.05486	3.62=	.06327	4.1 =	.07168	4.58=	.08011
3.15=	.05503	3.63=	.06344	4.11=	.07186	4.59=	.08028
3.16=	.05521	3.64=	.06362	4.12=	.07203	4.6 =	.08046
3.17=	.05538	3.65=	.06379	4.13=	.07221	4.61=	.08063
3.18=	.05556	3.66=	.06397	4.14=	.07238	4.62=	.08081
3.19=	.05573	3.67=	.06414	4.15=	.07256	4.63=	.08099
3.2 =	.05591	3.68=	.06432	4.16=	.07273	4.64=	.08116
3.21=	.05608	3.69=	.06449	4.17=	.07291	4.65=	.08134

Degrees	Tangent	Degrees	Tangent	Degrees	Tangent	Degrees	Tangent
4.66=	.08151	5.14=	.08995	5.62=	.09840	6.1 =	.10687
4.67=	.08169	5.15=	.09013	5.63=	.09858	6.11=	.10705
4.68=	.08186	5.16=	.09030	5.64=	.09876	6.12=	.10722
4.69=	.08204	5.17=	.09048	5.65=	.09893	6.13=	.10740
4.7 =	.08221	5.18=	.09066	5.66=	.09911	6.14=	.10758
4.71=	.08239	5.19=	.09083	5.67=	.09928	6.15=	.10775
4.72=	.08257	5.2 =	.09101	5.68=	.09946	6.16=	.10793
4.73=	.08274	5.21=	.09118	5.69=	.09964	6.17=	.10811
4.74=	.08292	5.22=	.09136	5.7 =	.09981	6.18=	.10828
4.75=	.08309	5.23=	.09154	5.71=	.09999	6.19=	.10846
4.76=	.08327	5.24=	.09171	5.72=	.10017	6.2 =	.10863
4.77=	.08345	5.25=	.09189	5.73=	.10034	6.21=	.10881
4.78=	.08362	5.26=	.09206	5.74=	.10052	6.22=	.10899
4.79=	.08380	5.27=	.09224	5.75=	.10069	6.23=	.10916
4.8 =	.08397	5.28=	.09242	5.76=	.10087	6.24=	.10934
4.81=	.08415	5.29=	.09259	5.77=	.10105	6.25=	.10952
4.82=	.08432	5.3 =	.09277	5.78=	.10122	6.26=	.10969
4.83=	.08450	5.31=	.09294	5.79=	.10140	6.27=	.10987
4.84=	.08468	5.32=	.09312	5.8 =	.10158	6.28=	.11005
4.85=	.08485	5.33=	.09330	5.81=	.10175	6.29=	.11022
4.86=	.08503	5.34=	.09347	5.82=	.10193	6.3 =	.11040
4.87=	.08520	5.35=	.09365	5.83=	.10211	6.31=	.11058
4.88=	.08538	5.36=	.09382	5.84=	.10228	6.32=	.11075
4.89=	.08555	5.37=	.09400	5.85=	.10246	6.33=	.11093
4.9 =	.08573	5.38=	.09418	5.86=	.10263	6.34=	.11111
4.91=	.08591	5.39=	.09435	5.87=	.10281	6.35=	.11128
4.92=	.08608	5.4 =	.09453	5.88=	.10299	6.36=	.11146
4.93=	.08626	5.41=	.09470	5.89=	.10316	6.37=	.11164
4.94=	.08643	5.42=	.09488	5.9 =	.10334	6.38=	.11181
4.95=	.08661	5.43=	.09506	5.91=	.10352	6.39=	.11199
4.96=	.08679	5.44=	.09523	5.92=	.10369	6.4 =	.11217
4.97=	.08696	5.45=	.09541	5.93=	.10387	6.41=	.11234
4.98=	.08714	5.46=	.09558	5.94=	.10405	6.42=	.11252
4.99=	.08731	5.47=	.09576	5.95=	.10422	6.43=	.11270
5.0 =	.08749	5.48=	.09594	5.96=	.10440	6.44=	.11287
5.01=	.08766	5.49=	.09611	5.97=	.10457	6.45=	.11305
5.02=	.08784	5.5 =	.09629	5.98=	.10475	6.46=	.11323
5.03=	.08802	5.51=	.09647	5.99=	.10493	6.47=	.11341
5.04=	.08819	5.52=	.09664	6.0 =	.10510	6.48=	.11358
5.05=	.08837	5.53=	.09682	6.01=	.10528	6.49=	.11376
5.06=	.08854	5.54=	.09699	6.02=	.10546	6.5 =	.11394
5.07=	.08872	5.55=	.09717	6.03=	.10563	6.51=	.11411
5.08=	.08890	5.56=	.09735	6.04=	.10581	6.52=	.11429
5.09=	.08907	5.57=	.09752	6.05=	.10599	6.53=	.11447
5.1 =	.08925	5.58=	.09770	6.06=	.10616	6.54=	.11464
5.11=	.08942	5.59=	.09787	6.07=	.10634	6.55=	.11482
5.12=	.08960	5.6 =	.09805	6.08=	.10652	6.56=	.11500
5.13=	.08978	5.61=	.09823	6.09=	.10669	6.57=	.11517

Degrees	Tangent	Degrees	Tangent	Degrees	Tangent	Degrees	Tangent
6.58=	.11535	7.06=	.12385	7.54=	.13236	8.02=	.14090
6.59=	.11553	7.07=	.12402	7.55=	.13254	8.03=	.14107
6.6 =	.11570	7.08=	.12420	7.56=	.13272	8.04=	.14125
6.61=	.11588	7.09=	.12438	7.57=	.13290	8.05=	.14143
6.62=	.11606	7.1 =	.12456	7.58=	.13307	8.06=	.14161
6.63=	.11623	7.11=	.12473	7.59=	.13325	8.07=	.14179
6.64=	.11641	7.12=	.12491	7.6 =	.13343	8.08=	.14196
6.65=	.11659	7.13=	.12509	7.61=	.13361	8.09=	.14214
6.66=	.11677	7.14=	.12527	7.62=	.13378	8.1 =	.14232
6.67=	.11694	7.15=	.12544	7.63=	.13396	8.11=	.14250
6.68=	.11712	7.16=	.12562	7.64=	.13414	8.12=	.14268
6.69=	.11730	7.17=	.12580	7.65=	.13432	8.13=	.14286
6.7 =	.11747	7.18=	.12597	7.66=	.13449	8.14=	.14303
6.71=	.11765	7.19=	.12615	7.67=	.13467	8.15=	.14321
6.72=	.11783	7.2 =	.12633	7.68=	.13485	8.16=	.14339
6.73=	.11800	7.21=	.12651	7.69=	.13503	8.17=	.14357
6.74=	.11818	7.22=	.12668	7.7 =	.13521	8.18=	.14375
6.75=	.11836	7.23=	.12686	7.71=	.13538	8.19=	.14392
6.76=	.11853	7.24=	.12704	7.72=	.13556	8.2 =	.14410
6.77=	.11871	7.25=	.12722	7.73=	.13574	8.21=	.14428
6.78=	.11889	7.26=	.12739	7.74=	.13592	8.22=	.14446
6.79=	.11907	7.27=	.12757	7.75=	.13609	8.23=	.14464
6.8 =	.11924	7.28=	.12775	7.76=	.13627	8.24=	.14481
6.81=	.11942	7.29=	.12793	7.77=	.13645	8.25=	.14499
6.82=	.11960	7.3 =	.12810	7.78=	.13663	8.26=	.14517
6.83=	.11977	7.31=	.12828	7.79=	.13681	8.27=	.14535
6.84=	.11995	7.32=	.12846	7.8 =	.13698	8.28=	.14553
6.85=	.12013	7.33=	.12864	7.81=	.13716	8.29=	.14571
6.86=	.12031	7.34=	.12881	7.82=	.13734	8.3 =	.14588
6.87=	.12048	7.35=	.12899	7.83=	.13752	8.31=	.14606
6.88=	.12066	7.36=	.12917	7.84=	.13769	8.32=	.14624
6.89=	.12084	7.37=	.12934	7.85=	.13787	8.33=	.14642
6.9 =	.12101	7.38=	.12952	7.86=	.13805	8.34=	.14660
6.91=	.12119	7.39=	.12970	7.87=	.13823	8.35=	.14678
6.92=	.12137	7.4 =	.12988	7.88=	.13841	8.36=	.14695
6.93=	.12154	7.41=	.13005	7.89=	.13858	8.37=	.14713
6.94=	.12172	7.42=	.13023	7.9 =	.13876	8.38=	.14731
6.95=	.12190	7.43=	.13041	7.91=	.13894	8.39=	.14749
6.96=	.12208	7.44=	.13059	7.92=	.13912	8.4 =	.14767
6.97=	.12225	7.45=	.13076	7.93=	.13930	8.41=	.14785
6.98=	.12243	7.46=	.13094	7.94=	.13947	8.42=	.14802
6.99=	.12261	7.47=	.13112	7.95=	.13965	8.43=	.14820
7.0 =	.12278	7.48=	.13130	7.96=	.13983	8.44=	.14838
7.01=	.12296	7.49=	.13147	7.97=	.14001	8.45=	.14856
7.02–	.12314	7.5 =	.13165	7.98=	.14018	8.46=	.14874
7.03=	.12332	7.51=	.13183	7.99=	.14036	8.47=	.14892
7.04=	.12349	7.52=	.13201	8.0 =	.14054	8.48=	.14909
7.05=	.12367	7.53=	.13219	8.01=	.14072	8.49=	.14927

Degrees	Tangent	Degrees	Tangent	Degrees	Tangent	Degrees	Tangent
8.5 =	.14945	8.63=	.15177	8.76=	.15409	8.89=	.15642
8.51=	.14963	8.64=	.15195	8.77=	.15427	8.9 =	.15660
8.52=	.14981	8.65=	.15213	8.78=	.15445	8.91=	.15677
8.53=	.14999	8.66=	.15231	8.79=	.15463	8.92=	.15695
8.54=	.15016	8.67=	.15249	8.8 =	.15481	8.93=	.15713
8.55=	.15034	8.68=	.15266	8.81=	.15499	8.94=	.15731
8.56=	.15052	8.69=	.15284	8.82=	.15517	8.95=	.15749
8.57=	.15070	8.7 =	.15302	8.83=	.15534	8.96=	.15767
8.58=	.15088	8.71=	.15320	8.84=	.15552	8.97=	.15785
8.59=	.15106	8.72=	.15338	8.85=	.15570	8.98=	.15803
8.6 =	.15124	8.73=	.15356	8.86=	.15588	8.99=	.15821
8.61=	.15141	8.74=	.15374	8.87=	.15606	9.0 =	.15838
8.62=	.15159	8.75=	.15392	8.88=	.15624		

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1. APPROACH LIGHTING SYSTEMS. An approach lighting system is a configuration of signal lights disposed symmetrically about the extended runway centerline starting at the landing threshold and extending outward into the approach zone. Several systems are designed with rows of lightbars, wing lightbars, and distinguishable crossbars to provide visual cues for runway alignment, height perception, roll guidance, and horizon references. Some systems are augmented with a single row of flashing lights aligned on the extended runway centerline. When a single row of flashing lights is employed as an independent system, only the runway alignment cue is provided. At civil airports, systems used in conjunction with precision approaches (such as an ILS) shall be a minimum length of 2,400 feet at locations which have a glide slope of 2.75° or higher. Locations which have a glide slope less than 2.75° require a 3,000 foot system. For nonprecision approaches, the systems are 1,400 feet. Detailed configurational layouts and specifications are depicted in FAA Handbooks 6850.2 and 6850.5 for U.S. standard installations. For military airports, see applicable service directives.

a. Sequenced Flashers. Those approach lighting systems designated with flashing lights are augmented with a system of sequenced flashing lights. Such lights are installed at each centerline bar normally starting 1,000 feet from the threshold out to the end of the system. These lights emit a bluish-white light and flash in sequence toward the threshold at a rate of twice per second.

b. RAIL. Runway Alignment Indicator Lights. RAIL consists of sequenced flashing lights installed on the extended runway centerline beyond the associated approach lighting system. The first light is located 200 feet from the lightbar farthest from the runway threshold. Successive units are spaced 200 feet apart outward into the approach zone for a specified distance.

2. NONSTANDARD SYSTEMS. Approach lighting systems other than the U.S. standard installations may be considered equivalent to the standard systems for the purpose of formulating minimums authorized for military procedures, provided requirements of paragraph 344 are met. This appendix illustrates several non-U.S. standard systems and is offered as a guide to the determination of equivalency.

3. ALSF-1 (Type A_1)*. Approach Lighting System with Sequenced Flashing Lights, Category I Configuration.

a. System Description. The category I ALSF (ALSF-1) consists of a centerline lightbar approximately 13 1/2 feet long with five equally spaced lights at each 100-foot interval, starting 300 feet from the runway threshold and continuing out to 2,400 or 3,000 feet from the threshold. The centerline lightbar at 1,000 feet from the threshold is 100 feet long and contains 21 lights. All of the aforementioned lights are white. The lightbar 200 feet from the threshold is 50 feet long, contains 11 red lights, and is called the terminating bar. Two lightbars, each containing five red lights, are located 100 feet from the threshold, one on either side of the centerline, and are called wingbars. A row of green lights on 5-foot centers is located near the threshold and extends across the runway threshold and outwards a distance of approximately 45 feet from the runway edge on either side of the runway. See Figure 134.

b. Equivalent Systems. When the characteristics described in paragraph 3a exist in the following systems, the appropriate visibility reductions may be applied to MILITARY instrument approach procedures and FAR 121 operations at foreign airports.

Type*	Description
B	U. S. Configuration B
BN	Former NATO Standard C
BP	NATO Standard
J	Calvert (United Kingdom)
O	Centerline High Intensity (Europe)
T	Centre Row DOT Standard High Intensity (Canada)

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*NOTE: *"Type" refers to the system identification letters assigned to approach lighting as shown in the Interagency Air Cartographic Committee (IACC) Specification IACC No. 4. These identification letters are shown on the Approach Lighting Legend Sheets published with Civil and Military Instrument Approach Procedures.*

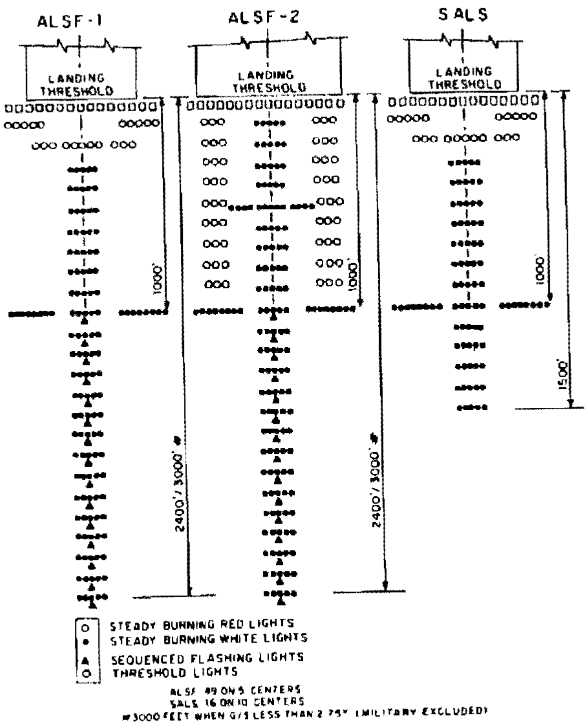


Figure 134 APPROACH LIGHTING SYSTEMS.

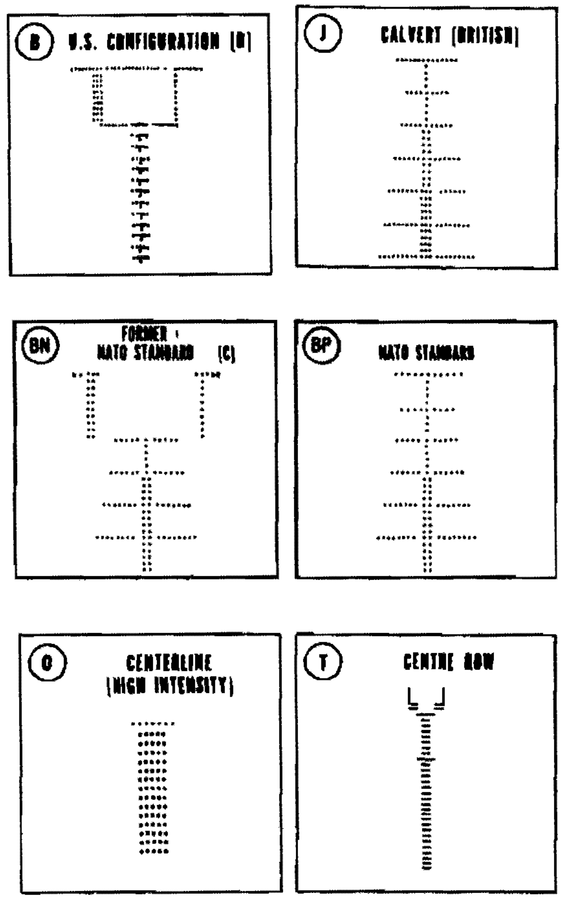


Figure 135. SYSTEMS EQUIVALENT TO U.S STANDARD A,, ALSF—1

4. ALSF-2 (Type A). Approach Lighting System with Sequenced Flashing Lights.

a. System Description. The category II ALSF (ALSF-2) differs from the category I configuration only in the inner 1,000 feet (nearest the threshold) of the system. The outer 1,400 or 2,000 feet of both systems are identical. The 2,400-foot system is authorized by Order 6850.9 when the glide slope angle is 2.75° or higher, while the 3,000-foot system is authorized when the glide slope angle is less than 2.75°. The terminating bar and wingbars of the category I configuration are replaced with centerline bars of five white lights each. In addition, there are lightbars (three red lights each) on either side of the centerline bars at each light station in the inner 1,000 feet. These are called siderow bars. Also there is an additional bar 500 feet from the threshold. These lights form a crossbar referred to as the 500-foot bar. The category II configuration is shown in Figure 134.

b. Equivalent Systems. None.

* **5. SALS. (Type A_2) Short Approach Light System.**

a. System Description. The Short Approach Light System is an installation which consists of the inner 1,500 feet of the standard ALSF-1 TYPE A_1 described in paragraph 3 of this appendix. The system provides roll guidance, a distinctive marker at 1,000 feet from the threshold, and distinctive threshold. See Figure 134.

NOTE: *SALS is programed to be phased out or retrofitted.*

b. Equivalent Systems. When the characteristics described in paragraph 5a exist in the following systems, the appropriate visibility reductions may be applied to MILITARY instrument approach procedures and to FAR 121 operations at foreign airports. See Figure 136.

Type	Description
AI	Centerline and Bar (South America)
I	Air Force Overrun (U.S.)
N	Narrow Multi–Cross (British)
E	Two Parallel Rows (U.S.)
AF	Overrun Centerline High Intensity (Europe)
D	Navy Parallel Row and Crossbar (U.S.)

6. SSALS, SSALF, and SSALR. (Type A_3). Short Simplified Approach Lighting System; Short Simplified Approach Lighting System with Sequenced Flashers; and, Short Simplified Approach Lighting System with Runway Alignment Indicator Lights, respectively. See Figure 137.

NOTE: *SSALS and SSALF are being phased out.*

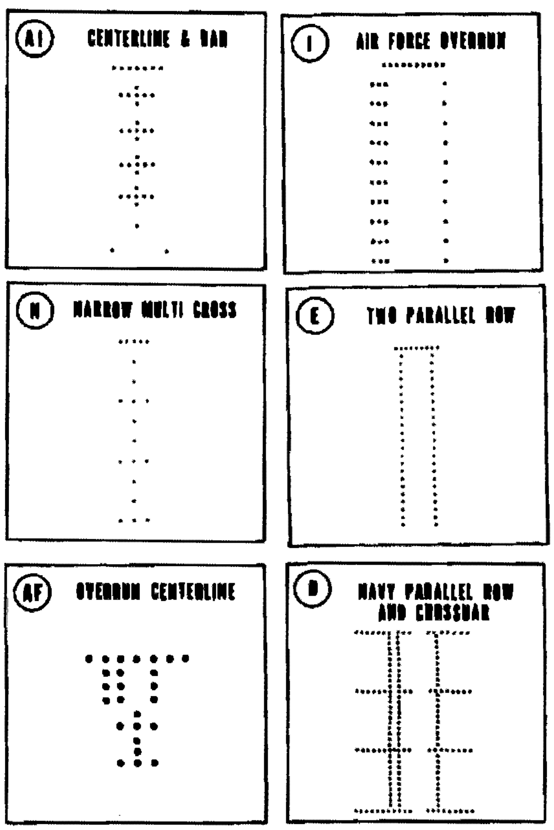


Figure 136. SYSTEMS EQUIVALENT TO SALS, SSALS, SSALF, MALS, AND MALSF.

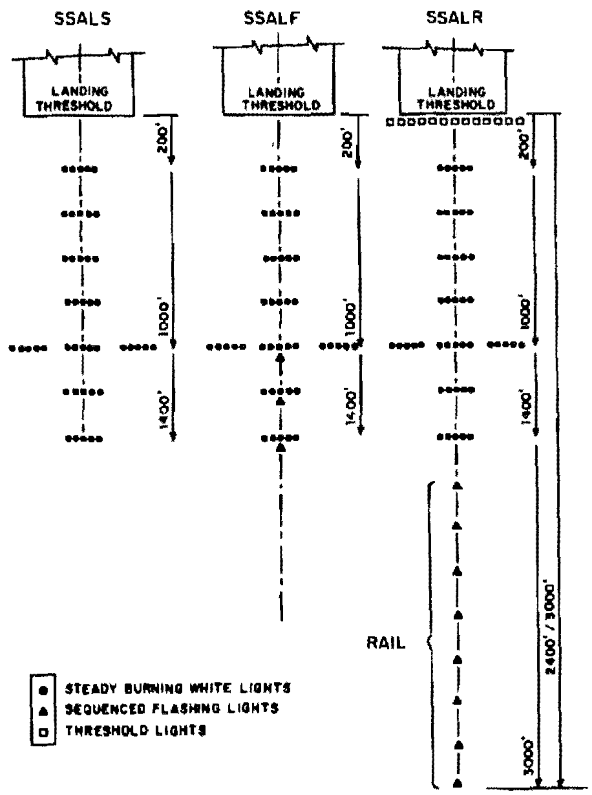


Figure 137. SIMPLIFIED SHORT APPROACH LIGHTING SYSTEMS *

a. Systems Description.

(1) **SSALS.** The SSALS consists of seven five–light bars located on the extended runway centerline with the first bar located 200 feet from the runway threshold. Two additional five–light bars are located one on each side of the centerline bar, 1,000 feet from the runway threshold, forming a crossbar 70 feet long. All lights of the system are white.

(2) **SSALF.** The SSALF consists of a SSALS with three sequenced flashers that are located at the last three lightbar stations.

(3) **SSALR.** The RAIL portion of the SSALR consists of five or eight sequenced flashers located on the extended runway centerline. The first flasher is located 200 feet from the approach end of the SSALS with successive units located at each 200–foot interval out to 2,400 or 3,000 feet from the runway threshold.

b. Equivalent Systems.

(1) **SSALS and SSALF.** When the characteristics described in paragraphs 6a (1) and (2) exist in the systems shown in Figure 136, the appropriate visibility reduction may be applied to MILITARY instrument approach procedures.

(2) SSALR. When the characteristics described in paragraphs 6a (1) and (3) exist in the systems shown in Figure 138, the appropriate visibility reduction may be applied to MILITARY instrument approach procedures.

Type	Description
BQ	Centre and Double Row RCAF Standard (Canada)
BO	Centre Row Modified Calvert (Canada)

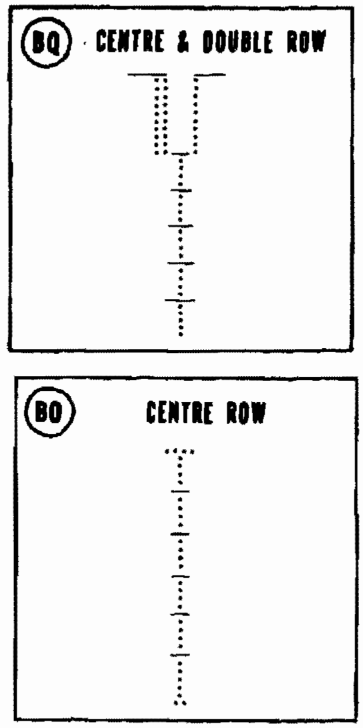


Figure 138. SYSTEMS EQUIVALENT TO SSALR AND MALSR.

7. MALS, MALSF (Type A_4), and MALSR (Type A_5). Medium Intensity Approach Lighting System; Medium Intensity Approach Lighting System with Sequenced Flashers; and, Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights, respectively. See Figure 139.

a. Systems Description.

(1) **MALS.** The MALS consists of seven five–light bars located on the extended runway centerline with the first bar located 200 feet from the runway threshold and at each 200–foot interval out to 1,400 feet from the threshold. Two additional five–light bars, one on each side of the centerline bar, 1,000 feet from the runway threshold form a crossbar 66 feet long.

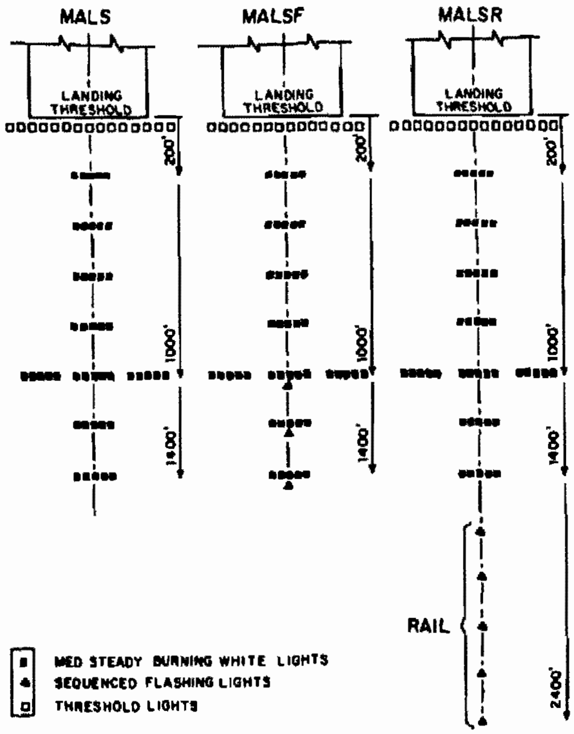


Figure 139. MEDIUM INTENSITY APPROACH LIGHTING SYSTEMS.

(2) **MALSF.** The MALSF consists of a MALS with three sequenced flashers located at the last three lightbar stations.

(3) **MALSR.** The RAIL portion of the MALSR consists of five or eight sequenced flashers located on the extended runway centerline. The first flasher is located 200 feet from the approach end of the MALS with successive units located at each 200–foot interval out to 2,400 feet from the runway threshold.

b. *Equivalent Systems.*

(1) **MALS and MALSF.** When the characteristics described in paragraphs 7a (1) and (2) exist in the systems shown in Figure 136, the appropriate visibility reductions may be applied to MILITARY instrument approach procedures.

(2) **MALSR.** When the characteristics described in paragraphs 7a (1) and (3) exist in the systems shown in Figure 138, the appropriate visibility reductions may be applied to MILITARY instrument approach procedures.

8. ODALS. Omnidirectional Approach Lighting System.

a. *System Description.* The system consists of seven strobe lights located in the approach area of a runway. Five of these strobes are located on the extended runway centerline starting 300 feet from the runway landing threshold and each 300–foot interval out to and including 1,500 feet from the threshold. The other two strobes are located on the sides of the runway threshold. The strobe lights flash in sequence toward the runway at a rate of once per second with the two units located at the runway end flashing simultaneously. The strobes have three intensity steps. See Figure 140.

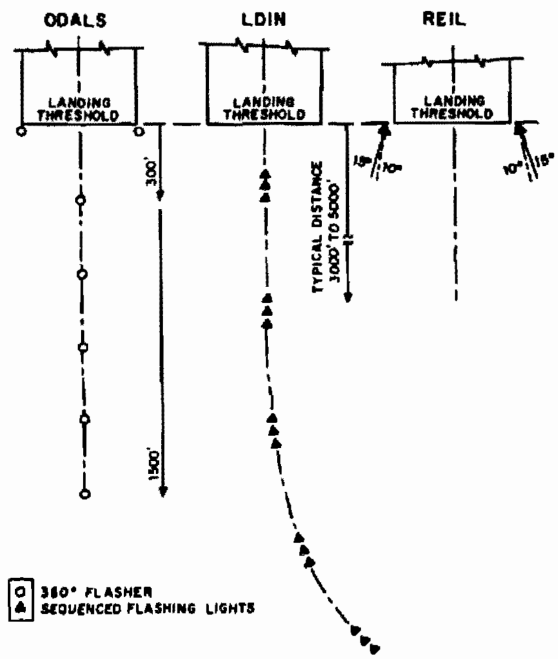


Figure 140. OMNIDIRECTION, LEAD-IN, AND RUNWAY END IDENTIFIER LIGHTING SYSTEMS

b. *Equivalent Systems.* When the characteristics described in paragraph 8a exist in the systems shown in Figure 141, the appropriate visibility reductions may be applied to MILITARY instrument approach procedures. *

Type	Description
BG	Left Single Row (Canada)
BR	Centre Row RCAF (Canada)
S	Cross (Europe–Africa)
M	Single Row Centerline (Europe–Asia–South America)
BF	Centre Row RCAF (Canada)
X	Centerline, Two Crossbars (Europe–Africa)

9. LDIN, Lead-In Lighting System.

a. System Description. The LDIN is usually installed as a supplement to a MALS or SSALS. This portion of the facility consists of a number of sequenced flashing lights beginning at a distance from the threshold determined by the need and terrain. These lights flash twice per second in sequence toward the threshold, have no intensity control, and operate on all brightness steps of the controlling system. The LDIN configuration is shown in Figure 140.

b. Equivalent Systems. The Hong Kong Curve (British), Type BE, is equivalent to the LDIN system. See Figure 142.

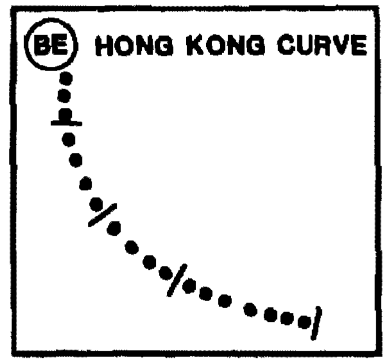


Figure 142. SYSTEM EQUIVALENT TO LDIN.

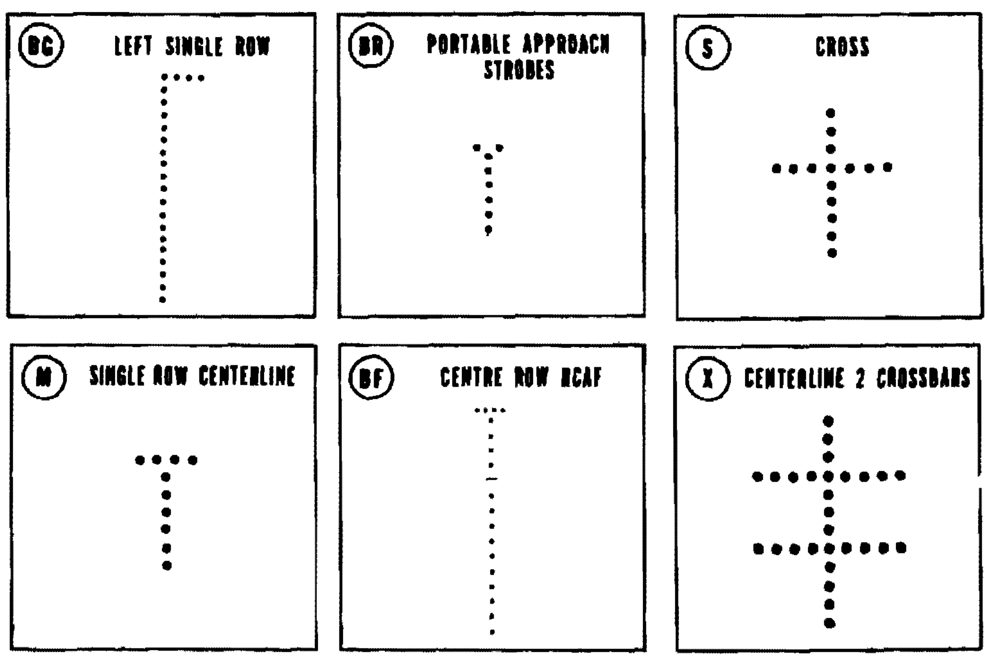


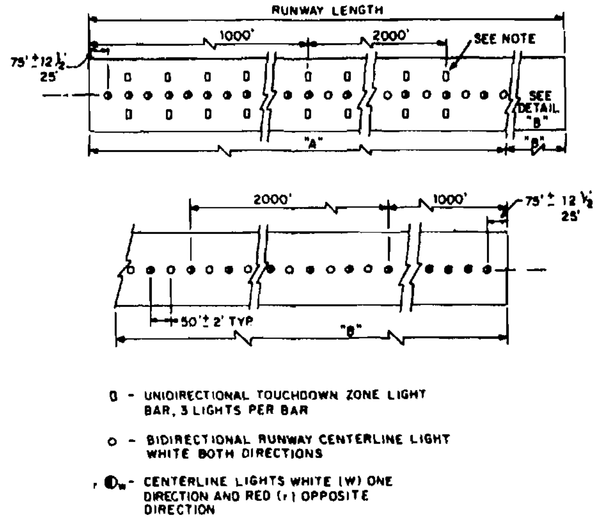
Figure 141. SYSTEMS EQUIVALENT TO U.S. ODALS paragraph 8, appendix 5.

* **10. REIL.** The Runway End Identifier Lights consist of a pair of condenser discharge fixtures identical to the sequenced flasher light system. The optimum location for the fixtures is at the runway threshold, 40 feet out on each side, measured from the runway edge. See Figure 140.

11. HIRL. High Intensity Runway Lights are used to outline the edges of paved runways during periods of darkness and low visibility. The light units are elevated and equipped with lenses which project two main light beams. Standards for design, installation, and maintenance are found in AC–150/5340–24.

12. MIRL. Medium Intensity Runway Lights are elevated and omnidirectional fixtures, with clear lenses. They may be used to light paved runways or unpaved landing strips. Standards for design, installation, and maintenance may be found in AC–150/5340–24.

13. TDZ/CL. Runway Centerline and Touchdown Zone Lighting. This system consists of touchdown zone lights and runway centerline lights. In the touchdown zone, two rows of transverse lightbars are located symmetrically about the runway centerline. The bars are spaced longitudinally at 100–foot intervals. Each lightbar consists of three unidirectional lights facing the landing threshold. The rows of lightbars extend to a distance of 3,000 feet, or one–half the runway length for runways less than 6,000 feet, from the threshold with the first lightbar located 100 feet from the threshold. The runway centerline lighting system consists of bidirectional fixtures installed at 50–foot intervals along the entire length of the runway centerline. The last 3,000–foot portion of the lighting system is color coded to warn pilots of the impending runway end. Alternate red and white lights are installed as seen from 3,000 feet to 1,000 feet from the runway end, and red lights are installed in the last 1,000–foot portion. Installation details may be found in AC 150/5340–4C.



NOTE: *The touchdown zone lightbars are not required to be located at the same stations as the centerline lights.*

Figure 143. TOUCHDOWN ZONE CENTERLINE LIGHTS. *

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Army TM 95-226
Navy OPNAV Inst. 3722.16C
Coast Guard CG 318
Air Force AFMAN 11-226(I)

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FEDERAL AVIATION ADMINISTRATION

FAA ORDER **8260.3B**

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Navy OPNAV Inst. 3722.16C
Coast Guard CG 318
Air Force AFMAN 11-226(I)

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Dec 28 2007

VOLUME 3

Precision Approach (PA) and Barometric Vertical Navigation (Baro VNAV) Approach Procedure Construction

U. S. DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

Chapter 1. General Information

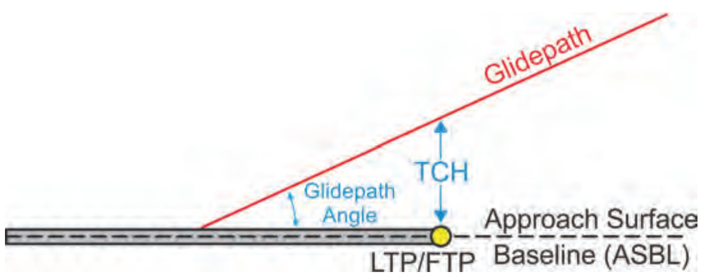
1.0. Purpose. This volume contains criteria applicable to conventional instrument approach procedures with vertical guidance. Apply these criteria to approaches based on instrument landing system (ILS), mobile microwave landing system (MMLS), precision approach radar (PAR), and Localizer Directional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

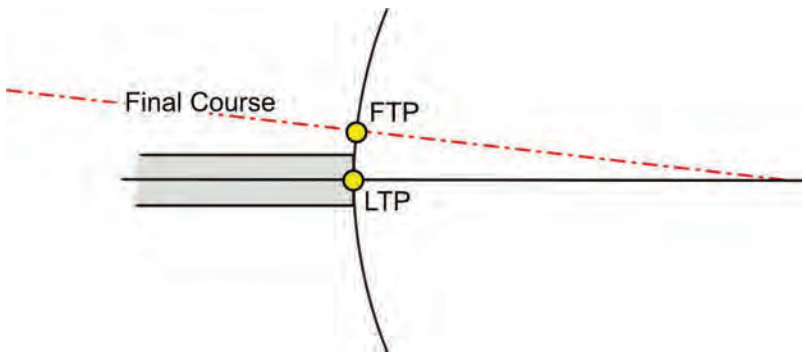
d. Glidepath Angle (GPA). The angular displacement of the glidepath from a horizontal plane that passes through the LTP/FTP. This angle is published on approach charts (e.g., 3.00 degrees, 3.20 degrees, etc.).

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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1.2.12 Height Above Ellipsoid (HAE). [RNAV Only]

A height expressed in feet above the WGS-84 ellipsoid. This value differs from a height expressed in feet above the geoid (essentially MSL) because the reference surfaces (WGS-84 Ellipsoid and the Geoid) do not coincide. To convert an MSL height to an HAE height, algebraically add the geoid height value to the MSL value. HAE elevations are not used for instrument procedure construction, but are documented for inclusion in airborne receiver databases.

EXAMPLE:	Given:	KOUN RWY 35	Runway ID
		N 35 14 31.65	Latitude
		W 97 28 22.84	Longitude
		1177.00	MSL Elevation
		-87.29 feet (-26.606 m)	Geoid Height (GH)

HAE = MSL + GH

HAE = 1177 + (-87.29)

HAE = 1089.71

1.2.13 Height Above Touchdown (HAT).

The HAT is the height of the DA above touchdown zone elevation (TDZE).

1.2.14 Inner-Approach Obstacle Free Zone (OFZ).

The airspace above a surface centered on the extended runway centerline. It applies to runways with an approach lighting system.

1.2.15 Inner-Transitional OFZ.

The airspace above the surfaces located on the outer edges of the runway OFZ and the inner-approach OFZ. It applies to runways with approach visibility minimums less than ¾ statute mile.

1.2.16 Landing Threshold Point (LTP).

The LTP is a 3D point at the intersection of the runway centerline and the runway threshold. It is defined by WGS-84/NAD-83 latitude, longitude, MSL elevation, and geoid height (see figure 1-1). It is used in conjunction with the FPAP and the geometric center of the WGS-84 ellipsoid to define the vertical plane of an RNAV final approach course. LTP elevation applies to the FTP when the final approach course is offset from runway centerline.

1.2.17 Lateral Navigation (LNAV). [RNAV Only]

Azimuth navigation without positive vertical guidance. This type of navigation is associated with nonprecision approach procedures.

1.2.18 Microwave Landing System/Mobile Microwave Landing System (MLS/MMLS). [DOD Only)

MLS/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" MLS locations to meet the capability of standard MLS avionics receiver equipment. Aircraft that will use MLS/MMLS procedures configured as a "Collocated Site" must have a special MLS 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."

1.2.19 Object Free Area (OFA).

An area on the ground centered on a runway, taxiway, or taxilane centerline provided to enhance the safety of aircraft operations by having the area free of objects, except for objects that need to be located in the OFA for air navigation or aircraft ground maneuvering purposes.

1.2.20 Obstacle Clearance Surface (OCS).

An inclined obstacle evaluation surface associated with a glidepath. The separation between this surface and the glidepath angle at any given distance from GPI defines the MINIMUM required obstruction clearance at that point.

1.2.21 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 obstruction clearance is based.

1.2.22 Precision Approach (PA).

An approach based on a navigation system that provides positive course and vertical path guidance conforming to ILS or MLS system performance standards contained in ICAO Annex 10. To achieve lowest minimums, the ground infrastructure must meet requirements contained in AC 150/5300-13 and TERPS Volume 3.

1.2.23 Precision Approach Radar (PAR).

A ground radar system displaying an aircraft on final approach in plan and profile views in relation to glidepath and course centerlines. Air traffic controllers issue course line and glidepath information to the pilot. The pilot alters course and rate of descent in response to gain course and glidepath alignment. Military pilots may achieve 100′ HAT and 1/4 mile visibility minimums with PAR.

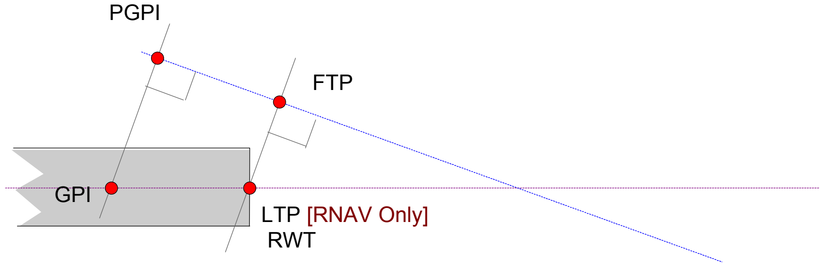
1.2.24 Precision Final Approach Fix (PFAF). Applicable to all PA approach procedures.

A 2D point located on the final approach course at a distance from LTP/FTP where the GPA intercepts the intermediate segment altitude (glidepath intercept altitude). The PFAF marks the outer end of the PA final segment.

1.2.25 Pseudo Ground Point of Intercept (PGPI).

Phantom location abeam the GPI when the approach course is offset. PGPI elevation is the same as ASBL (see figure 1-5).

Figure 1-5. PGPI and FTP Locations



1.2.26 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.

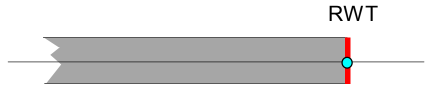
1.2.27 Required Navigation Performance (RNP).

A statement of the navigation performance accuracy necessary for operation within a defined airspace. Note that there are additional requirements, beyond accuracy, applied to a particular RNP type.

1.2.28 Runway Threshold (RWT).

The RWT marks the beginning of that part of the runway usable for landing (see figure 1-6). It extends the full width of the runway. The RWT geographic coordinates identify the point the runway centerline crosses the RWT.

Figure 1-6. Threshold



1.2.29 Three-Dimensional (3D) Point/Waypoint. [RNAV Only]

A waypoint defined by WGS-84 latitude and longitude coordinates, MSL elevation, and GH.

1.2.30 Touchdown Zone Elevation (TDZE).

The highest elevation in the first 3,000 feet of the landing surface.

1.2.31 Two-Dimensional (2D) Point/Waypoint. [RNAV Only]

A waypoint defined by WGS-84 latitude and longitude coordinates.

1.2.32 Wide Area Augmentation System (WAAS). [RNAV Only]

A method of navigation based on the GPS. Ground correction stations transmit position corrections that enhance system accuracy and add VNAV features.

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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:

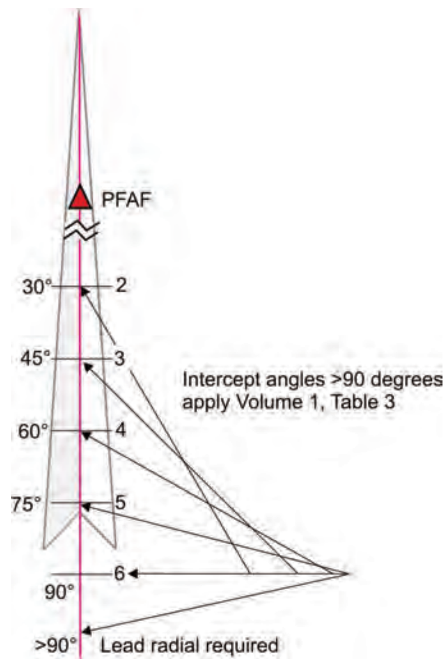
Formula 2-1. Minimum Intermediate Segment Length

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

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).

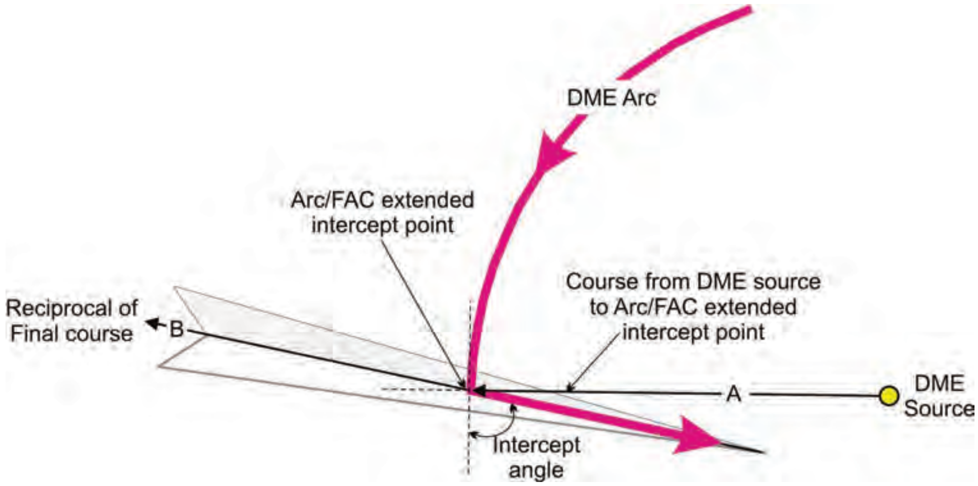
Formula 2-2. FAC intercept angle, DME Source on Arc Side

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

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

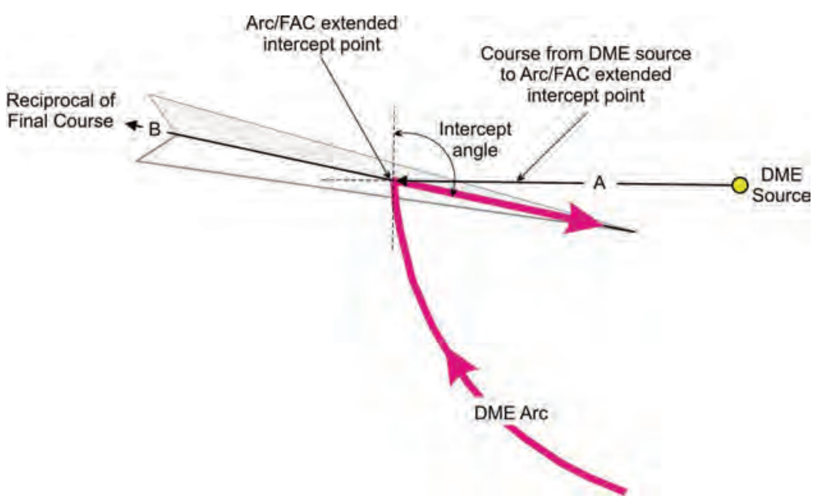
$$90 + |A-B| = \text{Intercept Angle}$$

where

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

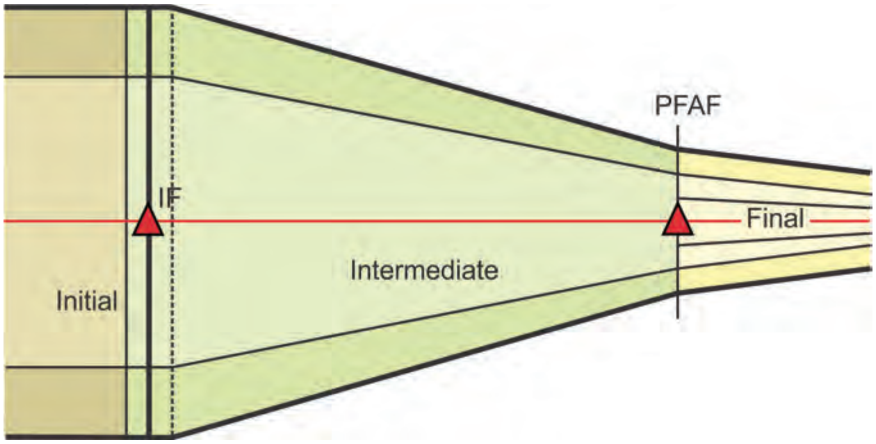
Example: 90 +|270–285|= 105°

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

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

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

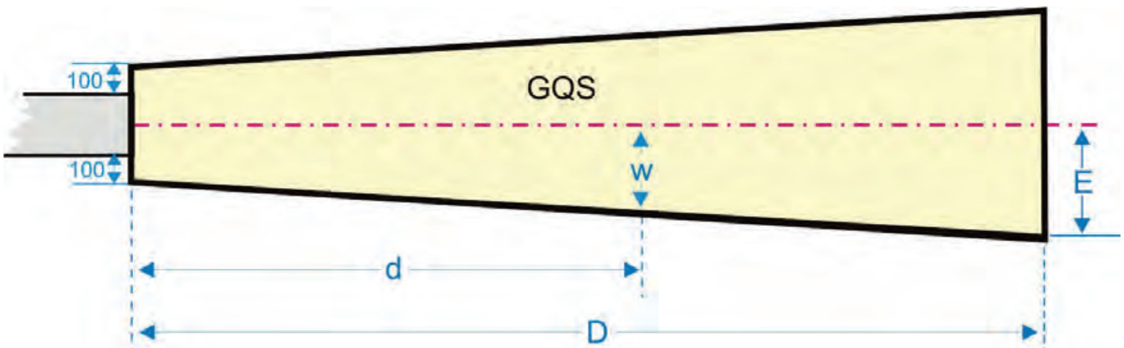
D = LTP to DA point distance (ft)

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.”

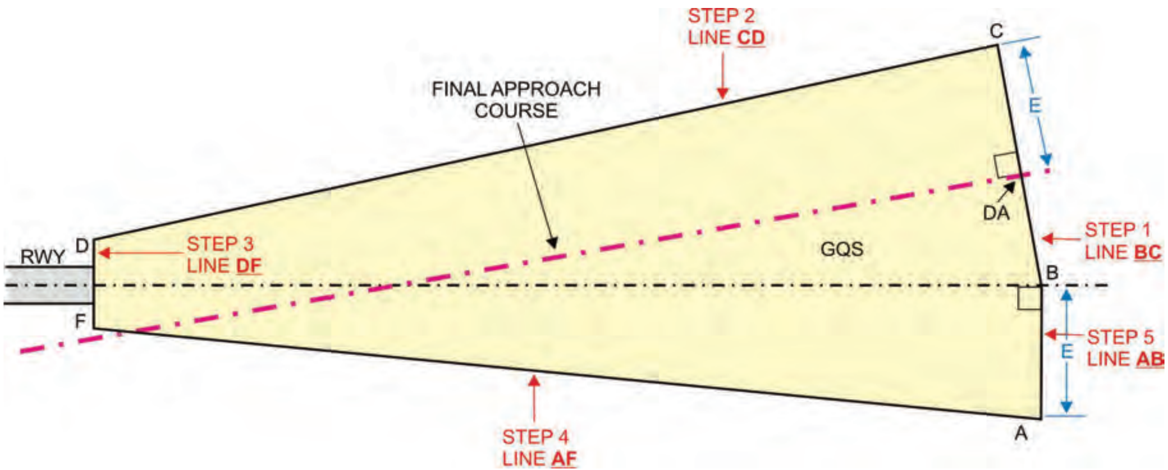
(b) Step 2 - Construct line “CD.” Locate point “D” abeam the LTP on a line perpendicular to runway centerline at a point 100 feet from the runway edge. Connect points “C” and “D.”

(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

$E = 0.036D + 392.8$

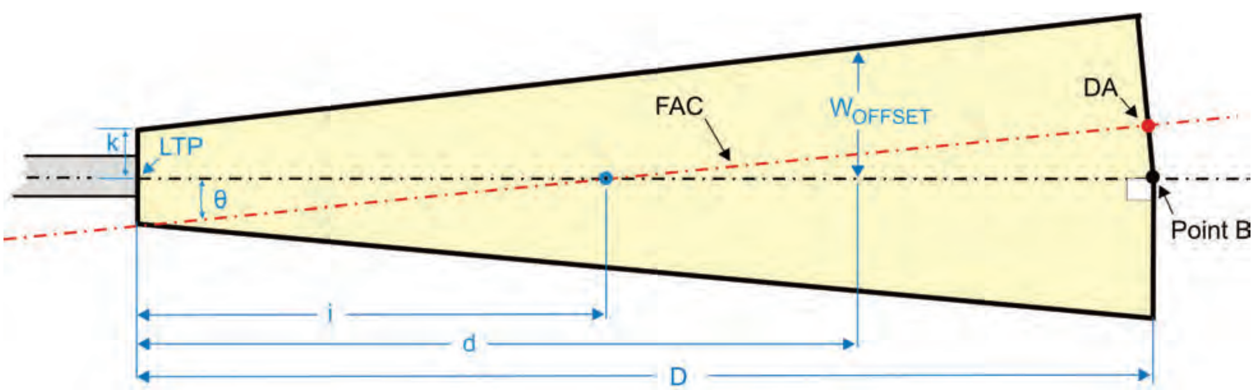
$$k = \frac{RWY_{WIDTH}}{2} + 100$$

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.

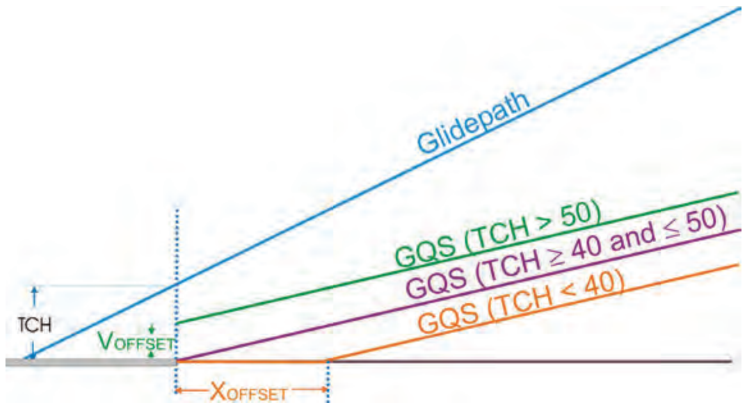
a. Origin. The surface origin and height is based on TCH. See figure 2-5C.

(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 ≥ 40 feet and ≤ 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

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

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

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

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

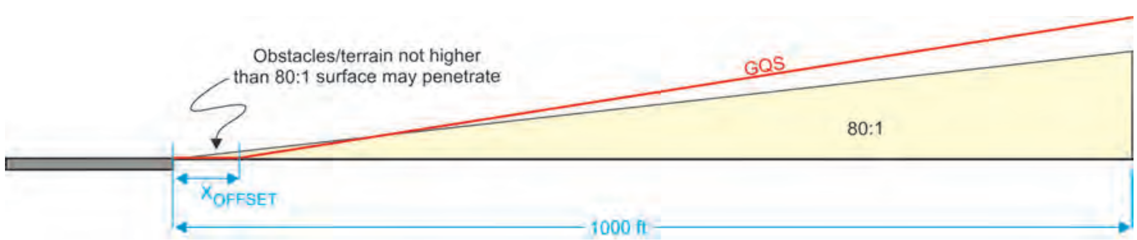


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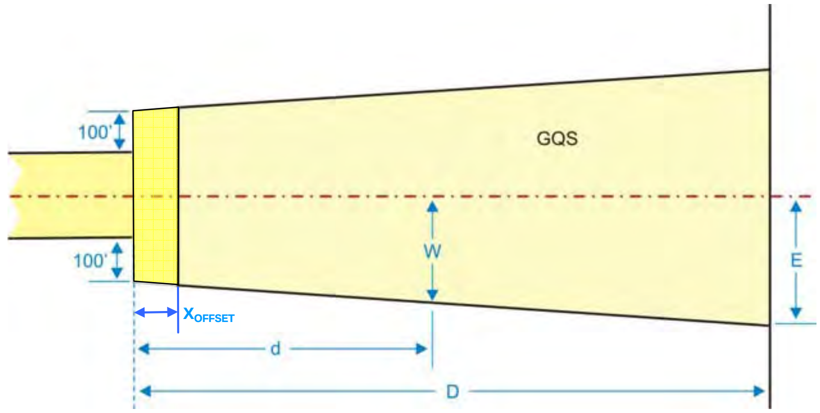
Figure 2-5c. Example: TCH < 40 ft.



Calculate the GQS half-width "**E**" at the DA point measured along the runway centerline extended using formula 2-2a.

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

$$E = 0.036D + 392.8$$

where

D = RWT to DA point distance (ft) measured along RCL extended

Calculate the GQS half-width at RWT using formula 2-2b.

Formula 2-2b. GQS Half-Width at RWT.

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

where

RWY_{width} = *Runway width (ft)*

Calculate the GQS half-width (**w**) at any distance "d" from RWT coordinates using formula 2-2c.

Formula 2-2c. GQS Half-Width, any distance (d).

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

where

D = RWT coordinates to DA point dist.(ft)
d = desired distance(ft)from RWT coordinates
E = Formula 2-2a output
k = Formula 2-2b output

2.11.1 c. **If 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 figures 2-5d and 2-5e:

STEP 1. Construct **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 RWT coordinates. Locate point "**C**" at distance "**E**" on a line perpendicular to the final approach course. Connect points "**B**" and "**C.**"

STEP 2. Construct **CD**. Locate point "**D**" abeam the RWT coordinates on a line perpendicular to runway centerline at a point 100 ft from the runway edge. Connect points "**C**" and "**D**."

STEP 3. Construct **DF**. Locate point "**F**" abeam the RWT coordinates on a line perpendicular to runway centerline at a point 100 ft from the runway edge. (opposite point "**D**"). Connect points "**D**" and "**F**."

STEP 4. Construct **AF**. Locate point "**A**" on a line perpendicular to the runway centerline extended at distance "**E**" from point "**B**". Connect points "**A**" and "**F**."

STEP 5. Construct **AB**. Connect points "**A**" and "**B**."

Figure 2-5d. Example: TCH ≥ 40 ft.

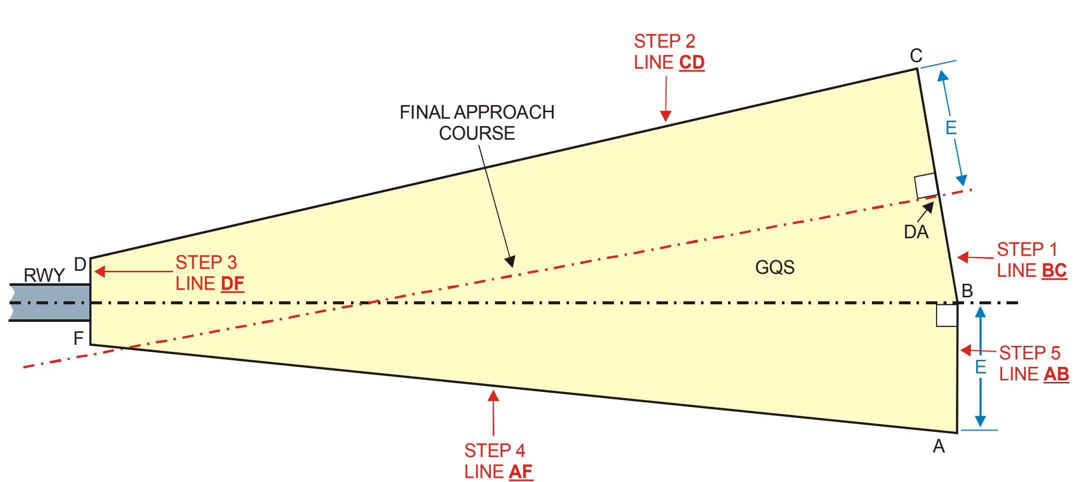
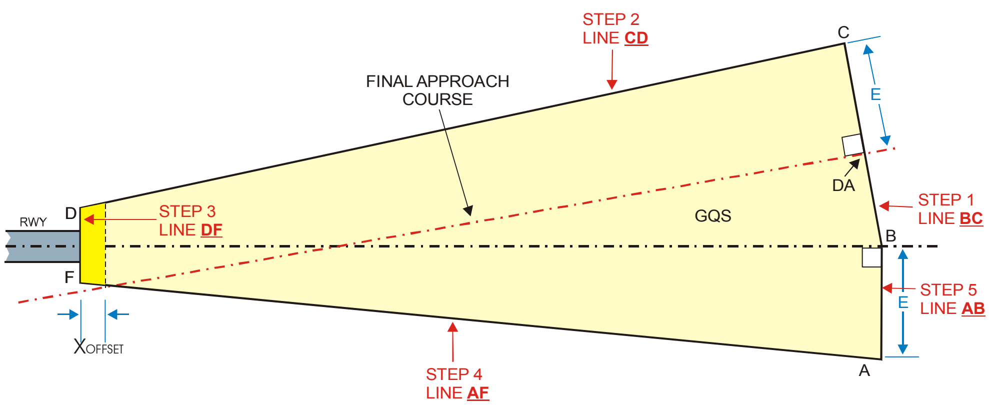


Figure 2-5e. Example: TCH < 40 ft.



Calculate the width of the **offset side** of the GQS trapezoid using formula 2-2d (see Vol. 3, chapter 2, figure 2-5f). Calculate the width of the **non-offset side** using formula 2-2a, except "D" = distance from RWT to Point B.

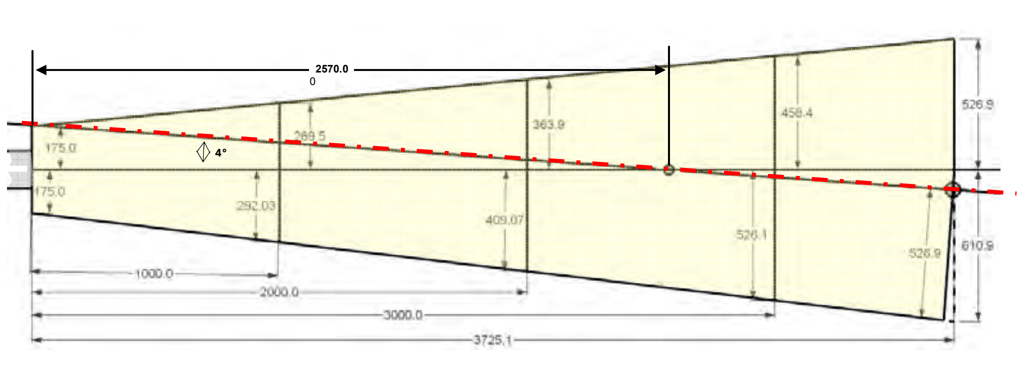
Formula 2-2d. GQS Offset Side Width, any distance (d).

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

where

d = desired distance (ft) from RWT coordinates
cos = Cosine
sin= Sine
θ = FAC offset (degrees)
D = RWT coordinates to Point "B" distance (ft)
i = RWT coordinates to FAC intersect. dist.(ft)
E = Formula 2-2a output
k = Formula 2-2b output

Figure 2-5f. Offset Calculation Example.



2.11.1 **d. Clearance Surface.** See Vol. 3, chapter 2, figure 2-5a. The GQS vertical characteristics reflect the glidepath characteristics of the procedure (e.g., the ILS/GLS/MLS/TLS/LPV vertical path is a straight line in space and the baro-VNAV vertical path (RNAV and RNP LNAV/VNAV) is a curved line in space). Obstacles must not penetrate the GQS [see paragraph Vol. 3, chapter 2, paragraph 2.11.1d exceptions]. Calculate the height of the sloping GQS above THRe at any distance “d” (greater than X_{OFFSET}) measured from runway threshold (RWT) coordinates along runway centerline (RCL) extended to a point abeam the obstacle using the appropriate formula:

Formula 2-3a. GQS Elevation ILS/GLS/MLS/TLS or LPV.

$$Z_{ILS} = \frac{(r + F + V_{OFFSET})\cos\left(\frac{2\theta}{3} \cdot \frac{\pi}{180}\right)}{\cos\left(\frac{d - X_{OFFSET}}{r} + \frac{2\theta}{3} \cdot \frac{\pi}{180}\right)} - r$$

where

r = mean earth radius (ft)
F = THRe or LTP elevation
V_{OFFSET} *= per paragraph 2.11.1a*
cos = cosine
d = distance (ft) from RWT coordinates (greater than X_{OFFSET}*)*
X_{OFFSET} *= per paragraph 2.11.1a*
θ = GPA

Formula 2-3b. GQS Elevation
LNAV/VNAV or RNP.

$$Z_{Baro} = e^{\frac{\left(d - X_{OFFSET}\right)\cdot \tan\left(\frac{2\theta}{3}\cdot\frac{\pi}{180}\right)}{r}} \cdot \left(r + LTP_{elev} + V_{OFFSET}\right) - r$$

where

e = base of the natural logarithm (Napier's constant)
d = distance (ft) from RWT coordinates (greater than X_{OFFSET})
X_{OFFSET} = per paragraph 2.11.1a
tan = tangent
θ = GPA
r = mean earth radius (ft)
LTP_{elev} = LTP elevation
V_{OFFSET} = per paragraph 2.11.1a

2.11.1 d. (1) For LPV (and ILS/GLS/MLS/TLS) procedures, the OCS is a flat plane (does not follow earth curvature); therefore, the height of the GQS at any point is equal to the height of surface on the runway centerline abeam it. Since the earth's surface also curves away on the lateral as well as the longitudinal axis, the MSL elevation (OBS_{MSL}) of an obstacle is reduced to account for earth curvature. This reduced value is termed the obstacle effective MSL elevation (O_{EE}). Calculate O_{EE} using formula 2-4 and compare to GQS height above THRe or LTP.

Formula 2-4. EC Adjusted Obstacle MSL Elevation.

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

where

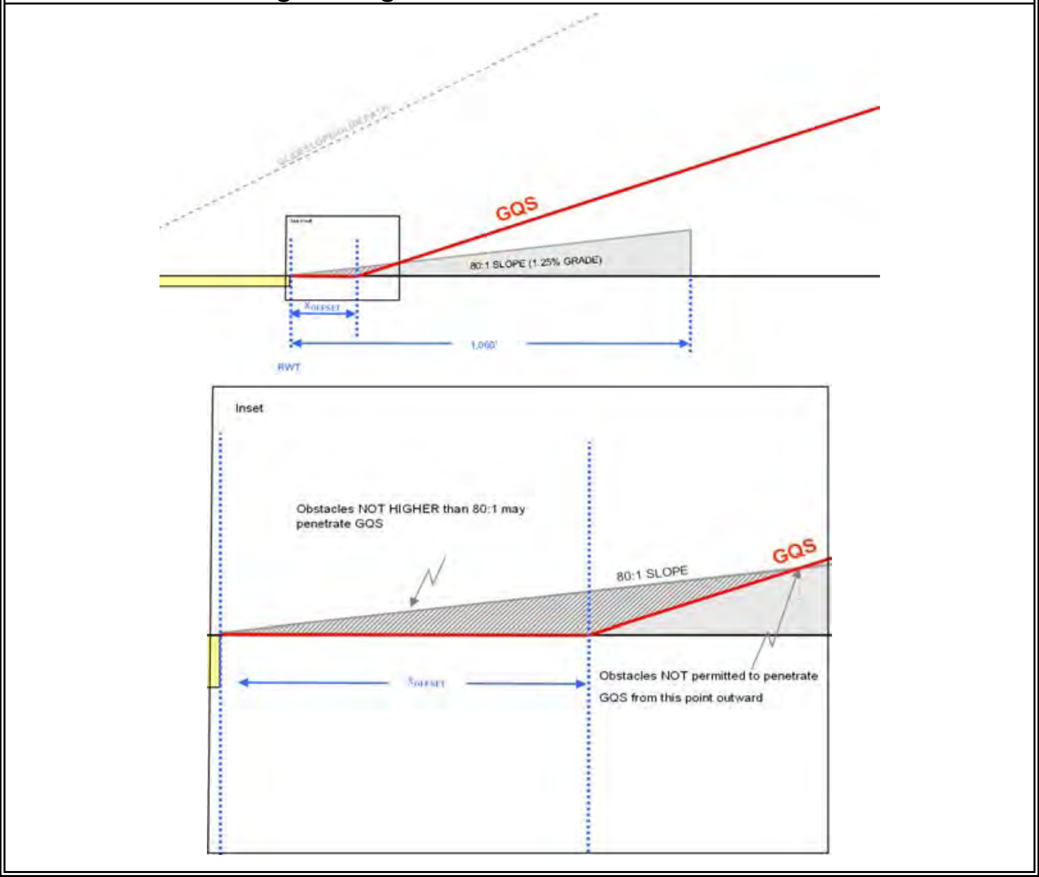
OBS_{MSL} = obstacle MSL elevation
r = mean earth radius (ft)
F = THRe or LTP elevation
cos = cosine
OBS_Y = perpendicular dist.(ft) from runway centerline to obstacle

2.11.1 d. (2) Obstacles permitted by AC 150/5300-13, Airport Design (or equivalent DoD airport design standard at military airfields) are excluded from GQS evaluation as follows.

2.11.1 d. (2) a. Obstacles with an effective height at or below an 80:1 surface (or DoD equivalent) originating at RWT coordinates (at THRe) and extending a distance of 1,000-ft (figure 2-5g) are considered acceptable obstacles.

2.11.1 d. (2) b. Above-ground objects permitted by the airport design standard (e.g., AC 150/5300-13 paragraphs 305 and 308 or applicable DoD directive) are considered acceptable obstacles and are excluded from GQS evaluation.

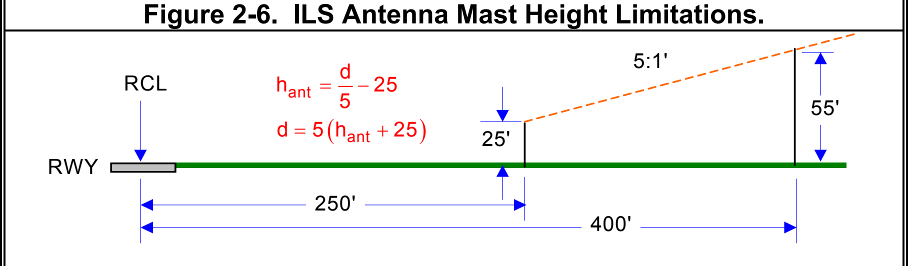
Figure 2-5g. Allowable GQS Penetrations.



2. 12 ILS ANTENNA MAST HEIGHT LIMITATIONS FOR OBSTACLE CLEARANCE.

The standard for locating the ILS antenna mast or monitor is a MINIMUM distance of 400 ft from the runway measured perpendicular to RCL. The antenna mast should not exceed 55 ft in height above the elevation of the runway centerline nearest it (see figure 2-6). At locations where it is not feasible for technical or economic reasons to meet this standard, the height and location of the antenna is restricted according to the following formula:

Figure 2-6. ILS Antenna Mast Height Limitations.



Where h_{ant} = **maximum** height of mast above RCL abeam mast
d = perpendicular distance from RCL (250' MINIMUM)

Formula 2-1. *Sloping OCS Origin X_{OFFSET} (TCH<40).*

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

where

TCH = Threshold Crossing Height associated with procedure
tan = tangent
θ = GPA

*(40-TCH)/tan(θ*π/180)*

Calculator

TCH	*15.000*	Click here to calculate
θ	*3°*	
X_{OFFSET}	*477.03*	

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Formula 2-2a. *GQS Half-Width at DA.*

$$E = 0.036D + 392.8$$

where
D = RWT to DA point dist (ft) measured along RCL extended

0.036*D+392.8

Calculator

D	3,720.000	Click here to calculate
E	526.720	

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Formula 2-2b. *GQS Half-Width at RWT.*

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

where
RWY_{width} = Runway width (ft)

RWYwidth/2+100

Calculator

RWYwidth	150.000	Click here to calculate
k	175.000	

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Formula 2-2c. *GQS Half-Width, any distance (d)*.

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

where

D = RWT coordinates to DA point dist.(ft)
d = desired distance(ft)from RWT coordinates
E = Formula 2-2a output
k = Formula 2-2b output

*((E-k)/D*d)+k*

Calculator

E	*526.720*	Click here to calculate
k	*175.000*	
D	*2,766.760*	
d	*1,800.000*	
w	*403.822*	

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Formula 2-2d. *GQS Offset Side Width, any distance (d).*

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

where

- d = desired distance (ft) from RWT coordinates
- cos = Cosine
- sin= Sine
- θ = FAC offset (degrees)
- D = RWT coordinates to Point "B" distance (ft)
- i = RWT coordinates to FAC intersect. dist.(ft)
- E = Formula 2-2a output
- k = Formula 2-2b output

d*((cos(θ *π/180)*(sin(θ*π/180)*(D-i)+E)-k)/
(D-sin(θ*π/180)*(sin(θ*π/180)*(D-i)+E)))+k

Calculator

d	3,682.700	Click here to calculate
θ	4°	
D	3,725.100	
i	2,570.000	
E	526.900	
k	175.000	
W_{OFFSET}	605.993	

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Formula 2-3a. *GQS Elevation ILS/GLS/MLS/TLS or LPV.*

$$Z_{ILS} = \frac{\left(r + F + V_{OFFSET}\right)\cos\left(\frac{2\theta}{3} \cdot \frac{\pi}{180}\right)}{\cos\left(\frac{d - X_{OFFSET}}{r} + \frac{2\theta}{3} \cdot \frac{\pi}{180}\right)} - r$$

where

- r = mean earth radius (ft)
- F = THRe or LTP elevation
- V_{OFFSET} = per paragraph 2.11.1a, otherwise 0
- cos = cosine
- d = desired distance (ft) from RWT coordinates
- X_{OFFSET} = per paragraph 2.11.1a, otherwise 0
- θ = GPA

$((r+F+V_{OFFSET})*\cos(2*\theta/3*\pi/180))/$
$(\cos((d-X_{OFFSET})/r+2*\theta/3*\pi/180))-r$

Calculator

F	1,012.000	Click here to calculate
V_{OFFSET}	0.000	
d	390.000	
θ	3°	
X_{OFFSET}	290.000	
r	20890537	
Z_{ILS}	1,015.492	

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Formula 2-3b. *GQS Elevation LNAV/VNAV or RNP.*

$$Z_{Baro} = e^{\frac{\left(d - X_{OFFSET}\right) \cdot \tan\left(\frac{2\theta}{3} \cdot \frac{\pi}{180}\right)}{r}} \cdot \left(r + LTP_{elev} + V_{OFFSET}\right) - r$$

where

- e = base of the natural logarithm (Napier's constant)
- d = desired distance (ft) from RWT coordinates
- X_{OFFSET} = per paragraph 2.11.1a, otherwise 0
- tan = tangent
- θ = GPA
- r = mean earth radius (ft)
- LTP_{elev} = LTP elevation
- V_{OFFSET} = per paragraph 2.11.1a, otherwise 0

$e^{((d-X_{OFFSET})*\tan(2*\theta/3*\pi/180)/r)*(r+LTP_{elev}+V_{OFFSET})-r}$

Calculator

d	3,000.000	Click here to calculate
X_{OFFSET}	190.000	
θ	3°	
r	20890537	
LTP_{elev}	1,012.000	
V_{OFFSET}	0.000	
Z_{BARO}	1,110.132	

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Formula 2-4. *EC Adjusted Obstacle MSL Elevation.*

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

where

OBS_{MSL} = obstacle MSL elevation

r = mean earth radius (ft)

F = THRe or LTP elevation

cos = cosine

OBS_Y = perpendicular dist.(ft)from Rwy centerline to obstacle

$OBS_{MSL}-(r+F)*(1/cos(OBS_Y/r)-1)$

Calculator

OBS_{MSL}	5,000.000	Click here to calculate
r	20890537	
F	4,999.00	
OBS_Y	500.000	
O_{EE}	4,999.994	

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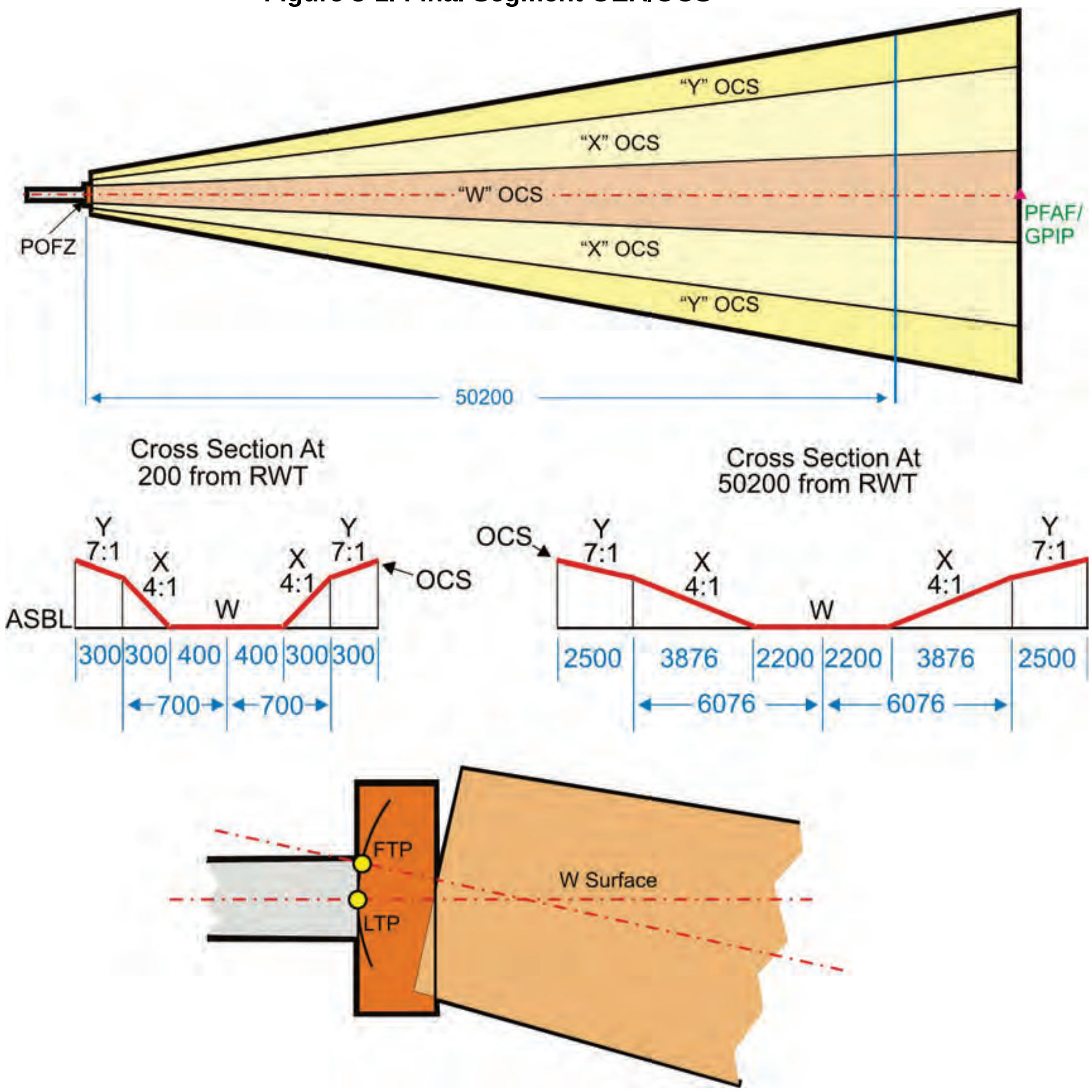
CHAPTER 3. PRECISION FINAL AND MISSED APPROACH SEGMENTS

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.

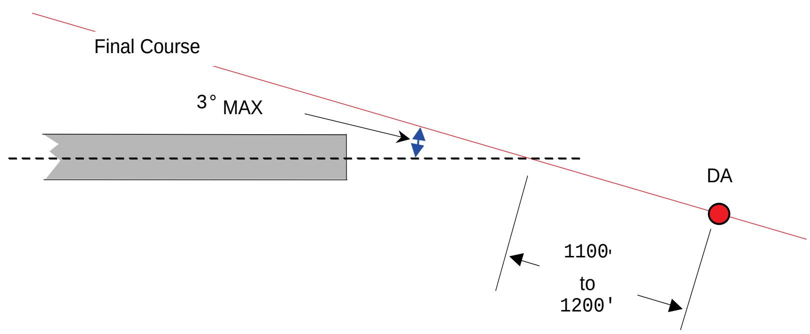
Figure 3-1. Final Segment OEA/OCS



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:

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

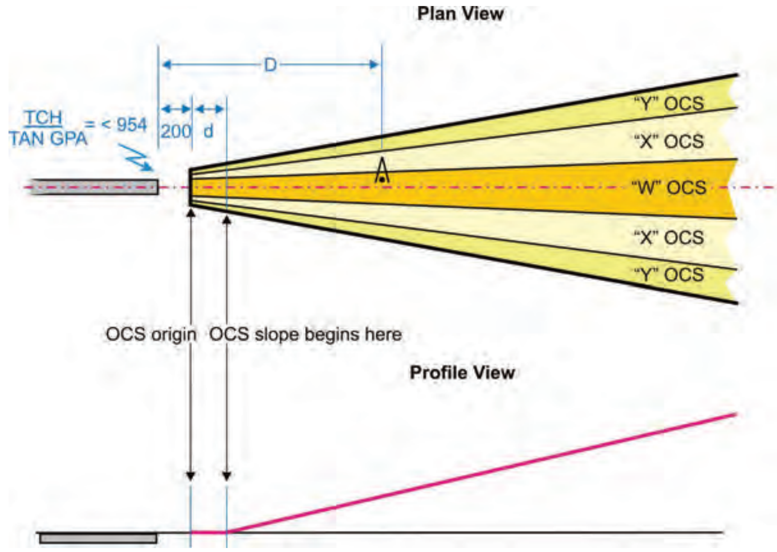
3.2.1 Origin.

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).

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

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

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*.

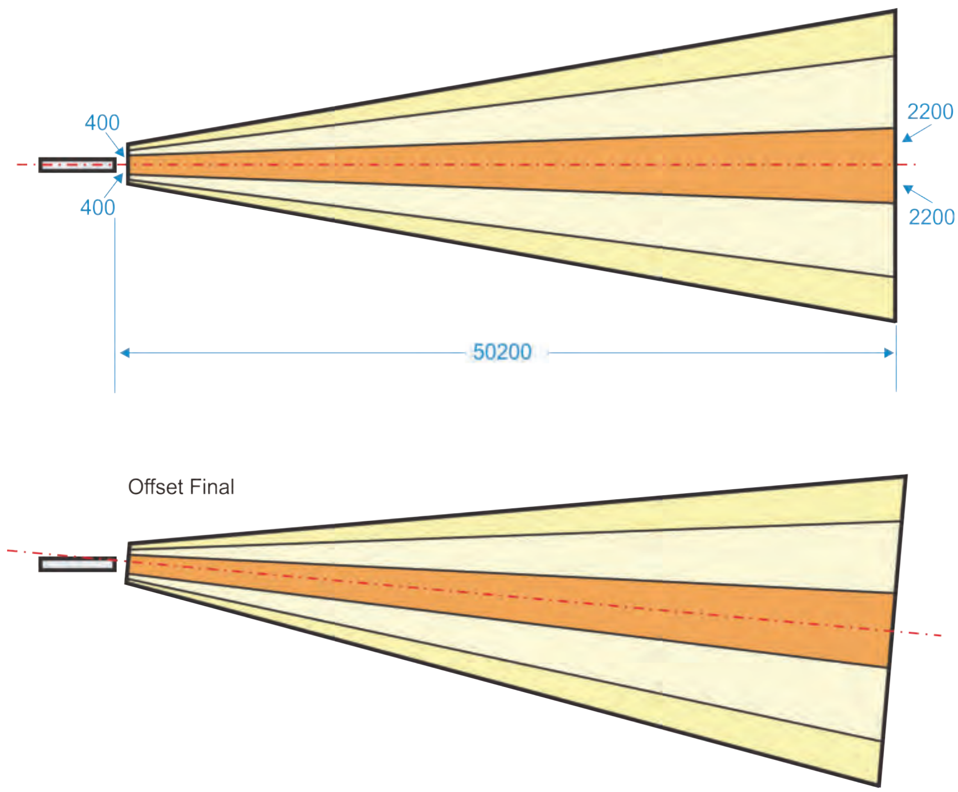
3.3 AIRPORT DESIGN STANDARDS/OBSTACLE FREE ZONES (OFZ).

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:

$$D_W = 0.036(D - 200) + 400$$

Where D = the distance in feet from LTP or FTP.

D_W = Perpendicular distance in feet from course centerline to " W" surface outer boundary.

3.4.2 **Height.** The height (Z_W) of the "W" OCS above ASBL is defined by the formula:

$$Z_W = \frac{D - (200 + d)}{S}$$

Where D = the distance in feet from RWT

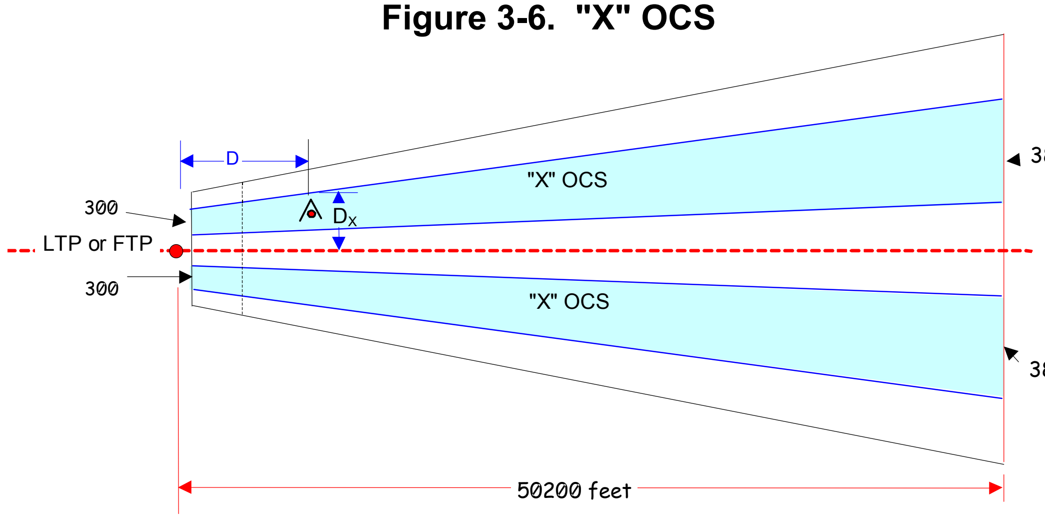
d = d from paragraph 3.2.1 for GPI < 954', 0 for GPI 954' or greater

S =" W" surface slope

3.4.3 **"W" OCS Penetrations.** Lowest minimums are achieved when the "W" surface is clear. If the surface is penetrated by an existing obstacle, adjust obstruction height, raise the GPA (see paragraph 3.2.2), or displace the RWT to eliminate the penetration. If the penetration cannot be eliminated, adjust the DA (see paragraph 3.8).

3.5 **"X" OCS.** See figure 3-6.

Figure 3-6. "X" OCS



3.5.1 **Width.** The perpendicular distance (D_X) from the course to the outer boundary of the "X" OCS is defined by the formula:

$$D_X = 0.10752(D - 200) + 700$$

Where D=distance (ft) from LTP or FTP

3.5.2 **Height.** The "X" OCS begins at the height of the "W" surface at distance "D" from LTP or FTP, and rises at a slope of 1:4 in a direction perpendicular to the final approach course. Determine the height (Z_X) above ASBL for a specific location of the "X" OCS using the following formula:

Height of "W" Sfc   Rise of "X" Sfc

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

Where D = the distance in feet from LTP or FTP,

$d = d$ from paragraph 3.2.1 for GPI $< 954'$, 0 for GPI 954' or greater

D_O = the perpendicular distance in feet between course centerline and a specific point in the "X" surface

D_W = the perpendicular distance between course centerline and the "W" surface boundary.

S = Slope associated with GPA $\left[\frac{102}{GPA}\right]$

3.5.3 **"X" OCS Penetrations.** Lowest minimums can be achieved when the "X" OCS is clear. To eliminate, avoid, or mitigate a penetration, take one of the following actions listed in the order of preference.

3.5.3 a. **Remove or adjust** the obstruction location and/or height.

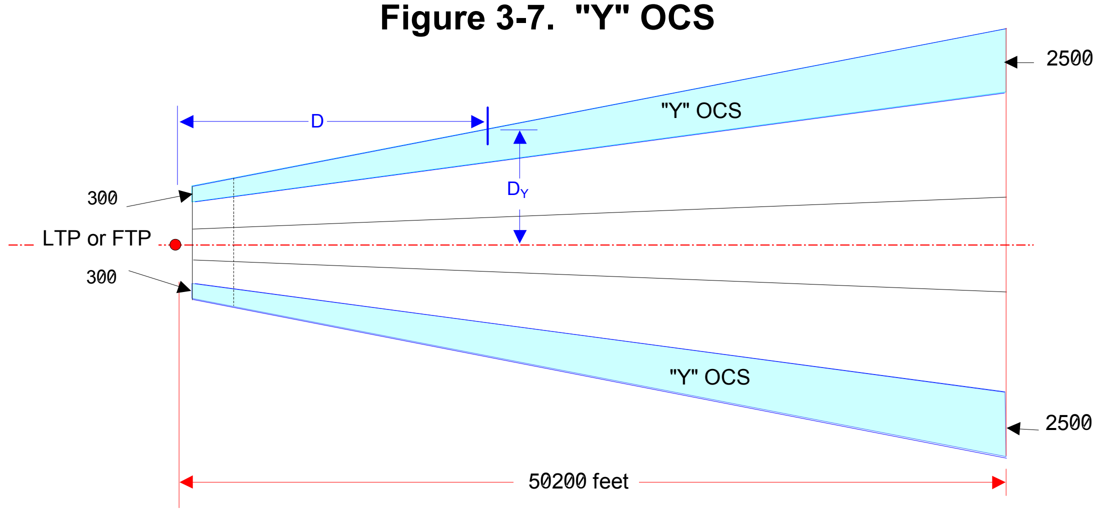
3.5.3 b. **Displace the RWT**.

3.5.3 c **Raise the GPA** (see paragraph 3.2.2) within the limits of table 2-2A.

3.5.3 d. **Adjust DA** (for existing obstacles only). (See paragraph 3.8).

3.6 **"Y" OCS.** See figure 3-7.

Figure 3-7. "Y" OCS



3.6.1 **Width.** The perpendicular distance (D_Y) from the runway centerline extended to the outer boundary of the "Y" OCS is defined by the formula:

$$D_Y = 0.15152(D-200)+1000$$

Where D=distance (ft) from LTP or FTP

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:

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

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:

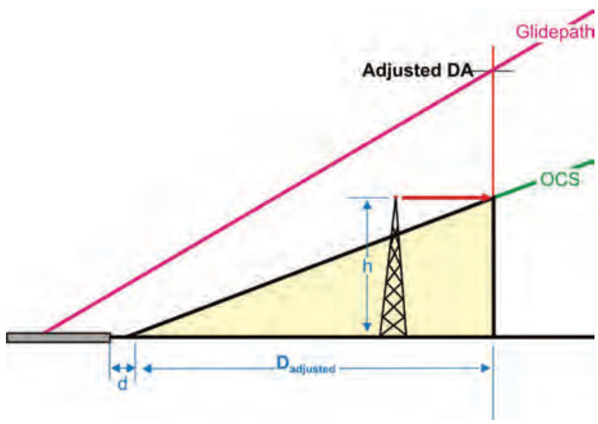
$$D_{adjusted} = \frac{102h}{GPA} + (200+d)$$

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:

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

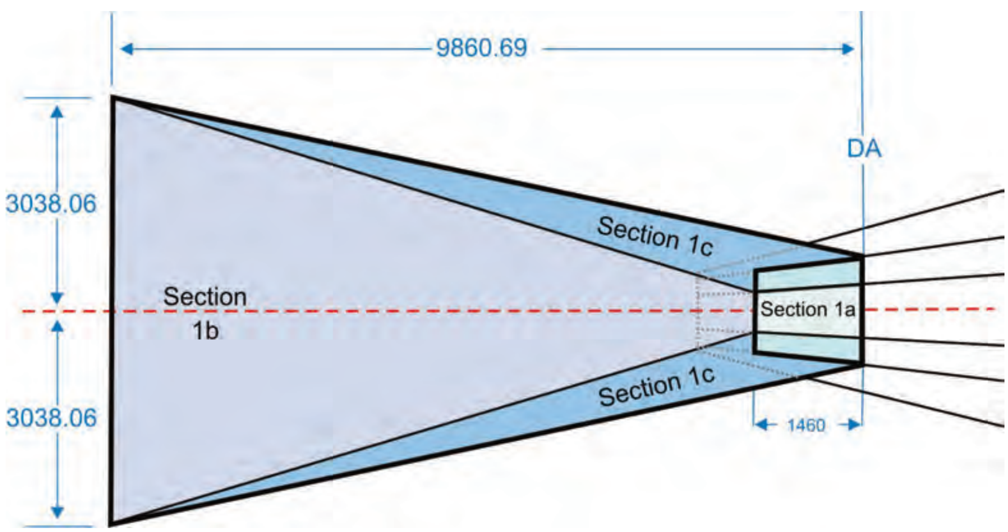
3.8.4 **Compare HAT based on adjusted DA and Minimum HAT.** Publish the DA associated with the higher of the two.

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).

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

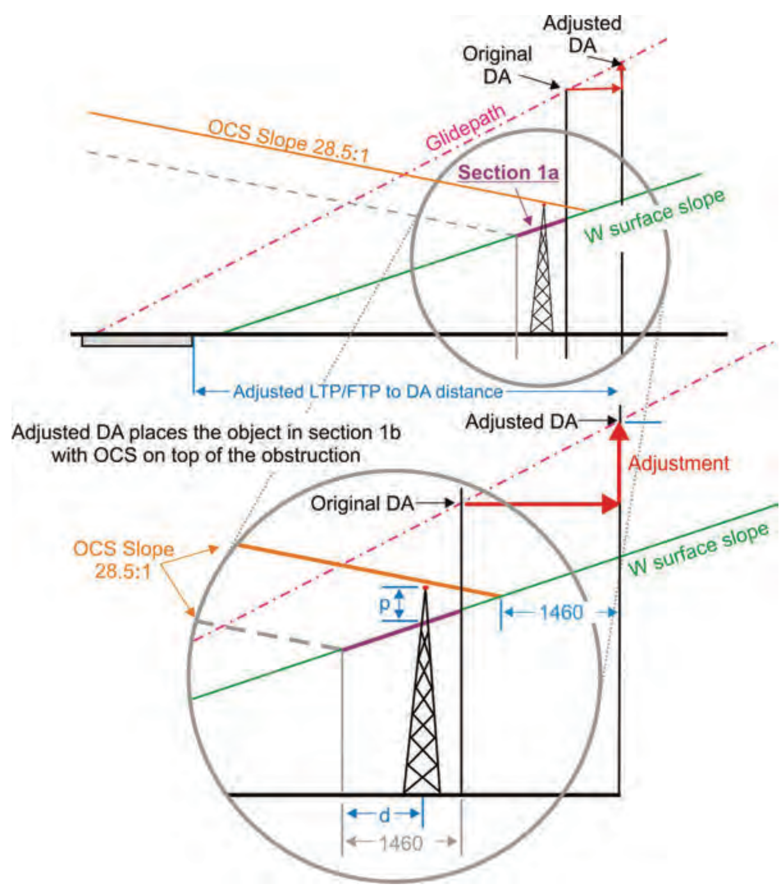
where

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

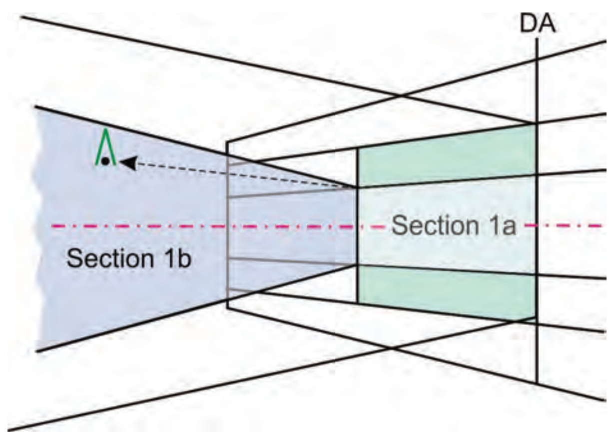


3.9.1 **b. Section 1b** (LEGACY)**.**

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



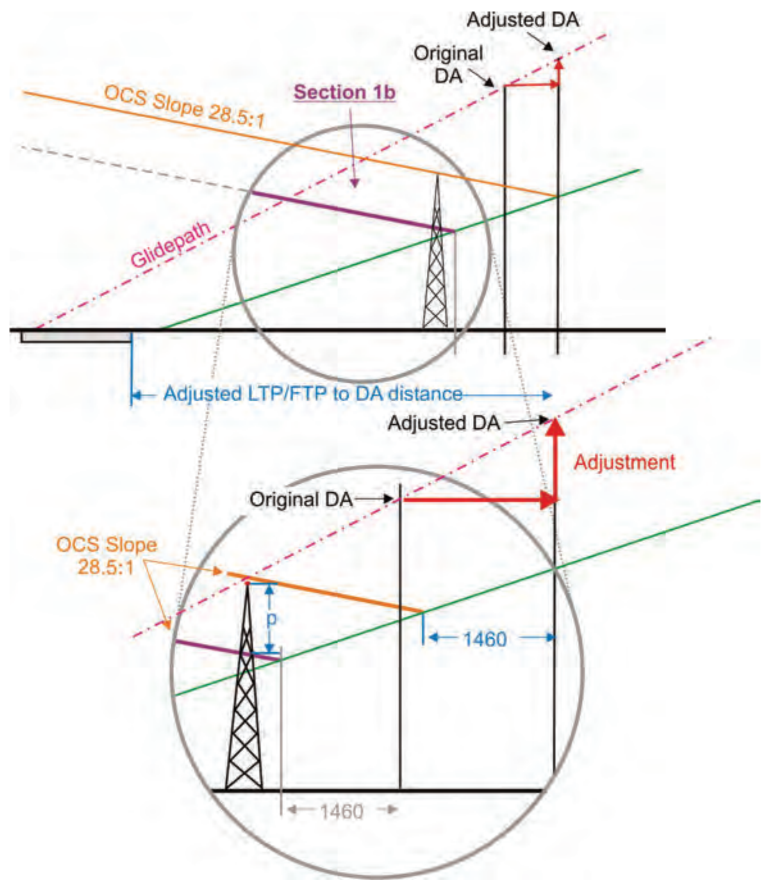
If this section is penetrated, increase the DA using the formula (see figure 3-9D);

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

where

p = *penetration (ft)*

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

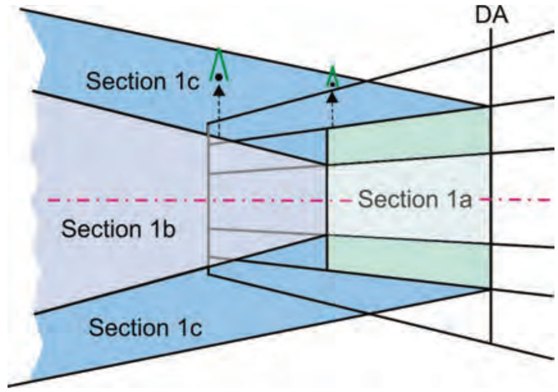


3.9.1 c. Section 1c (LEGACY)**.**

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

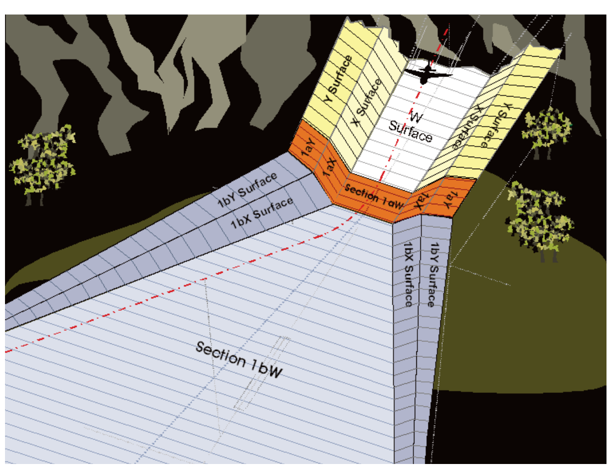
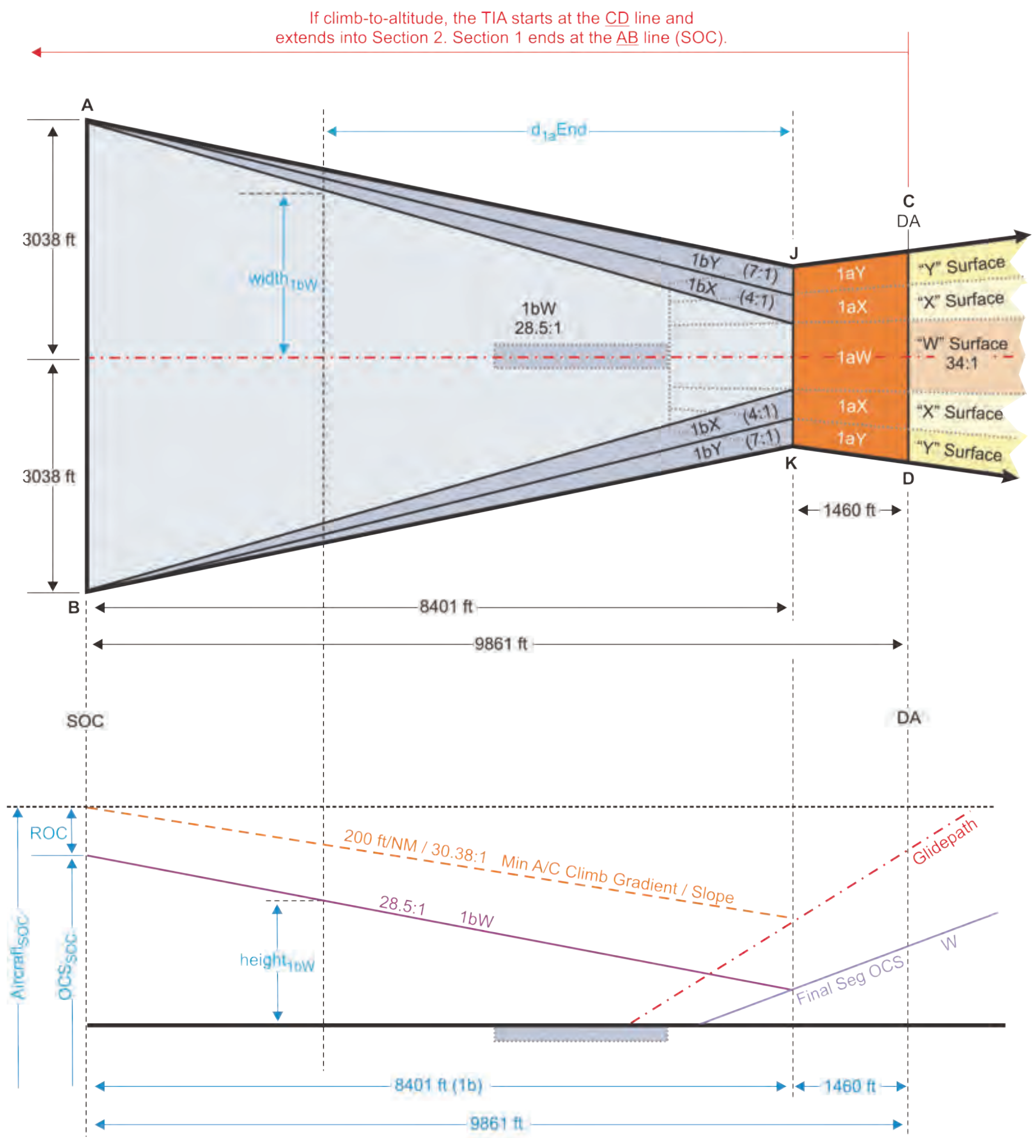


Figure 3-9G. Section 1, 2-D Perspective



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:

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

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:

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

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

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

where

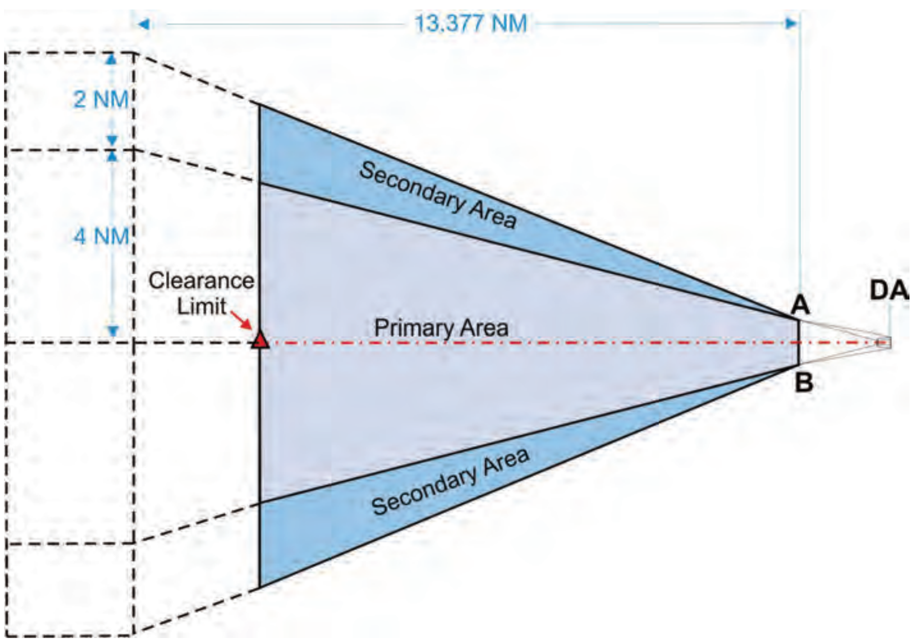
r = 20890537
DA = Published decision altitude (MSL)
$elev_{1Aend}$ = value from paragraph 3.9.2b(1)
d = value from para. 3.2.1 for GPI $<$ 954, 0 for GPI $\geq$ 954

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).

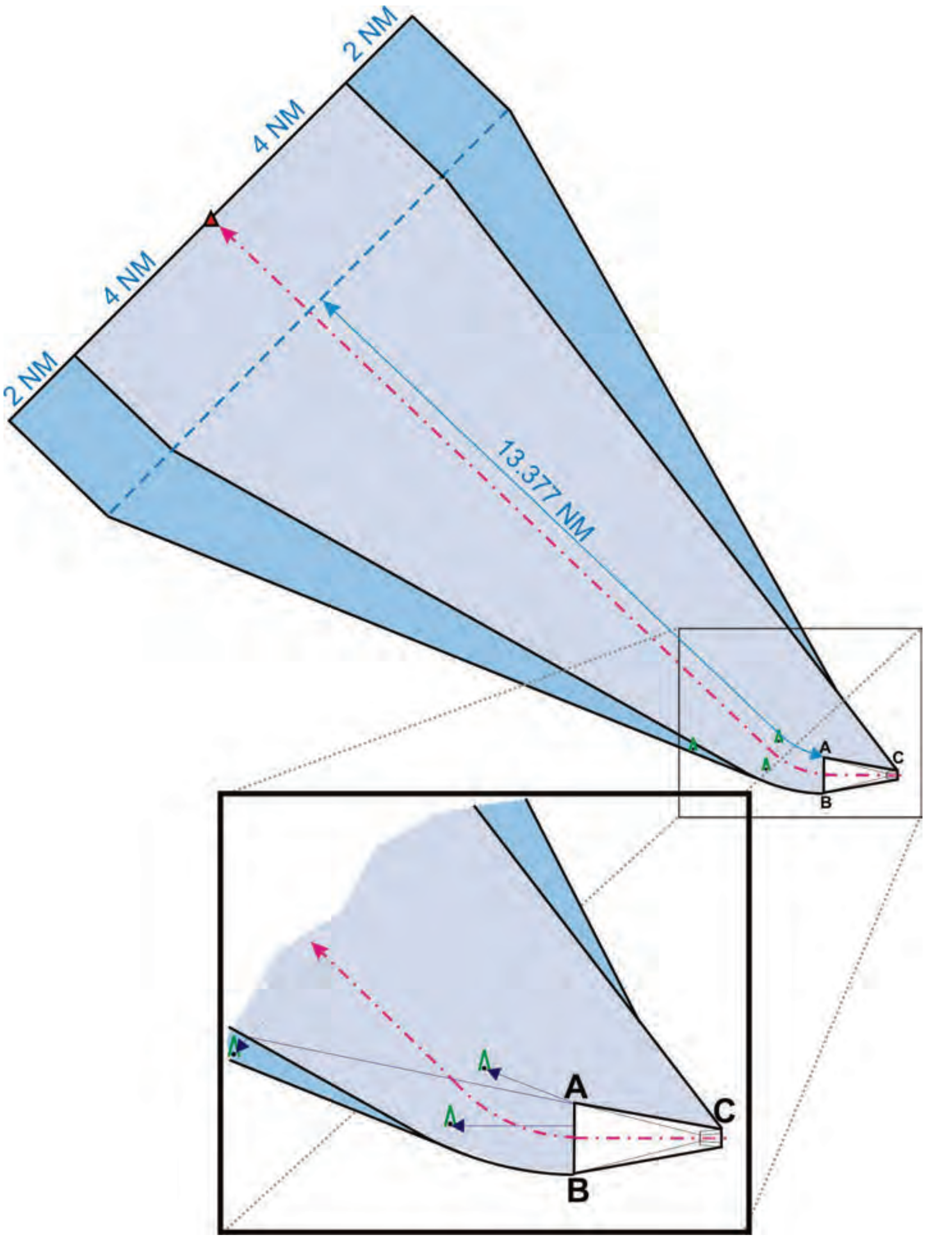
3.9.3 b. (2) Turning Obstacle Clearance. Apply volume 1, paragraph 276 except Zone 1 is not applicable. In Zone 2, obstacles are measured shortest distance to the section 1 outer boundary. In Zone 3, obstacles are measured shortest distance to point C. The OCS start height is the section 1 OCS end elevation. 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:

$$ROC_{OBS} = ROC_{SOC} + 48 \times \mathrm{d}$$

$$Alt_{min} = O_{\mathrm{elev}} + \mathrm{ROC}_{obs}$$

$$CG = \frac{r}{d} \times \ln\left(\frac{r + Alt_{min}}{r + Aircraft_{SOC}}\right)$$

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

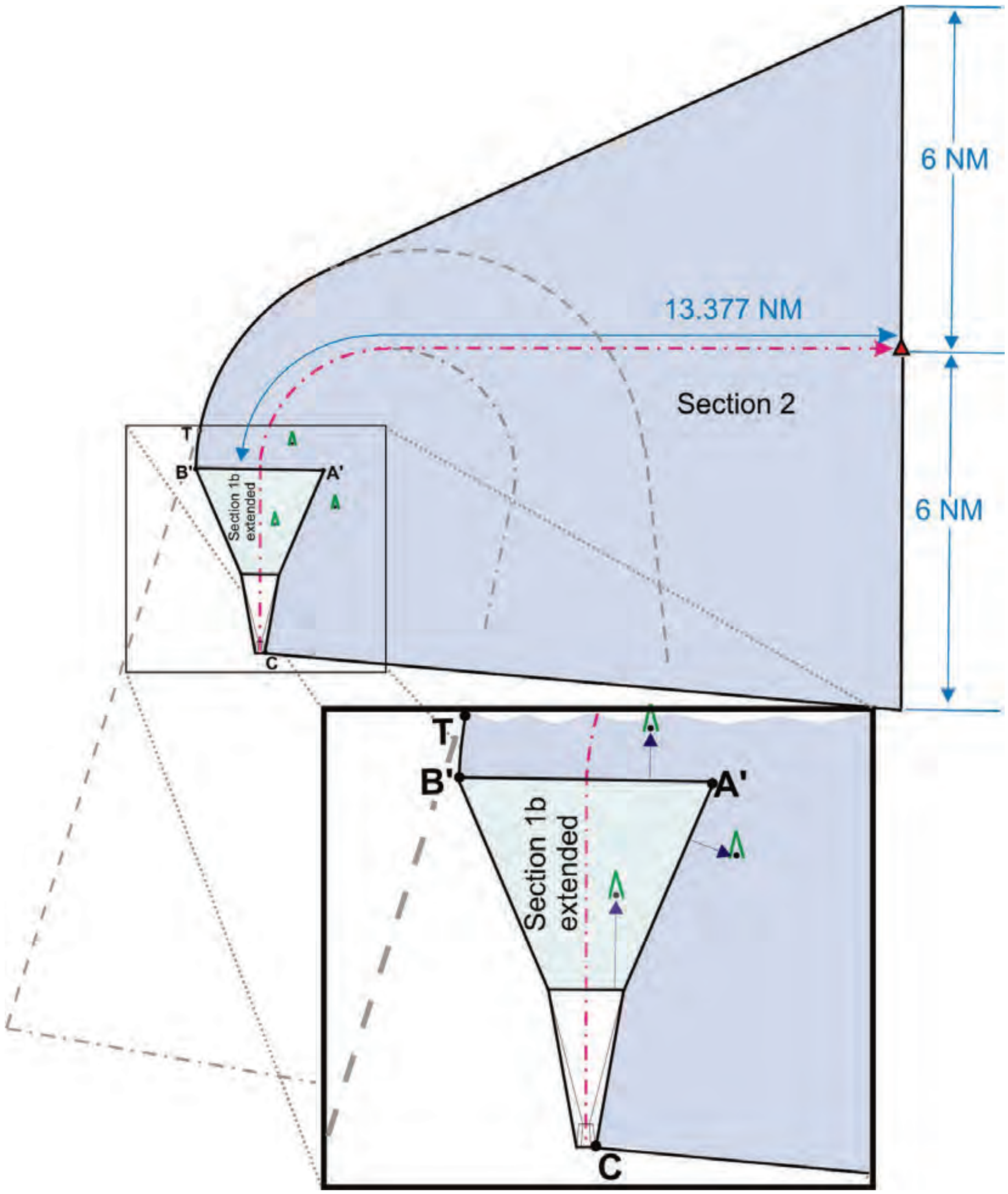
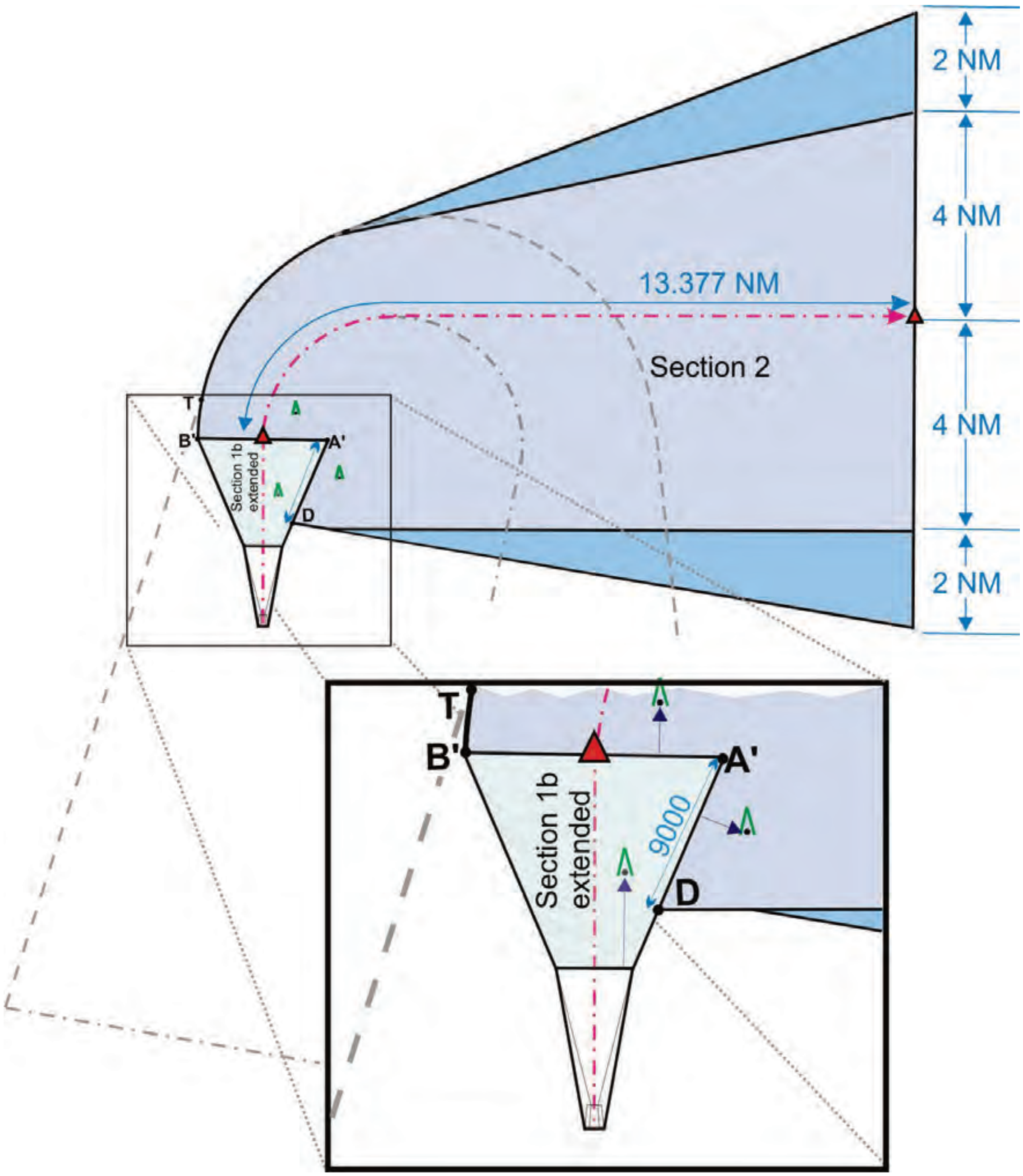


Figure 3-13. Combination Straight and Turning, Fix at end of Section 1b extended and PCG in Section 2



CHAPTER 4.
BAROMETRIC VERTICAL NAVIGATION (BARO VNAV)

4.0 GENERAL.

Design LNAV/VNAV approach procedures under these criteria. Baro VNAV operations are not authorized where remote altimeter is used, or in areas of precipitous terrain. The allowable range of glidepath angles is:

MINIMUM glidepath angle is 2.75°;
OPTIMUM glidepath angle is 3.00°,
MAXIMUM glidepath angle is 3.5°.

4.1 PUBLISHING ON RNAV CHARTS.

When published on an RNAV approach chart that depicts multiple lines of minima (LNAV/VNAV, LNAV, etc.), the TCH, GPA, course alignment, PFAF/FAF, and missed approach route and altitudes shall be identical for all depicted procedures. When minimums are based on remote altimeter and/or temperature settings, or the final segment overlies precipitous terrain, annotate the chart with a note to indicate Baro VNAV is not authorized. Where Baro VNAV is authorized, publish the minimum temperature for which the procedure was designed.

4.2 GROUND INFRASTRUCTURE.

If the airport obstacle free zones or the POFA are penetrated, LOWEST minimums are 300-foot ceiling and 3/4 mile visibility.

4.3 GLIDEPATH QUALIFICATION SURFACE (GQS).

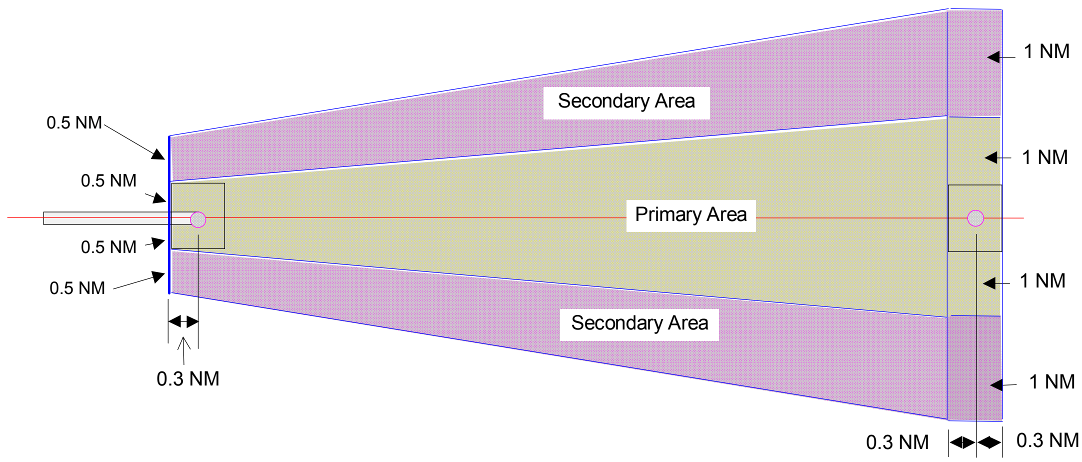
Penetrations of the GQS are not authorized. Apply paragraph 2.12.

4.4 FINAL APPROACH SEGMENT.

LNAV/VNAV procedures are based on the LNAV trapezoid. The Baro VNAV vertical surfaces conform to the LNAV trapezoid.

4.4.1 **Area.** See figure 4-1A.

Figure 4-1A. LNAV-VNAV Primary and Secondary Areas



4.4.2 Alignment.

The default final course aiming point is the LTP/FTP. OPTIMUM alignment is with the runway centerline (RCL) extended. The MAXIMUM offset from RCL is 15°. Approaches serving category A and B aircraft only may be designed with the offset course passing through the LTP/FTP regardless of degree of offset (see figure 4-1B). Where larger aircraft categories (CAT C, D, and E) are accommodated, the offset course must cross the RCL extended at least a MINIMUM distance from the RWT determined by the degree of offset, except as noted below:

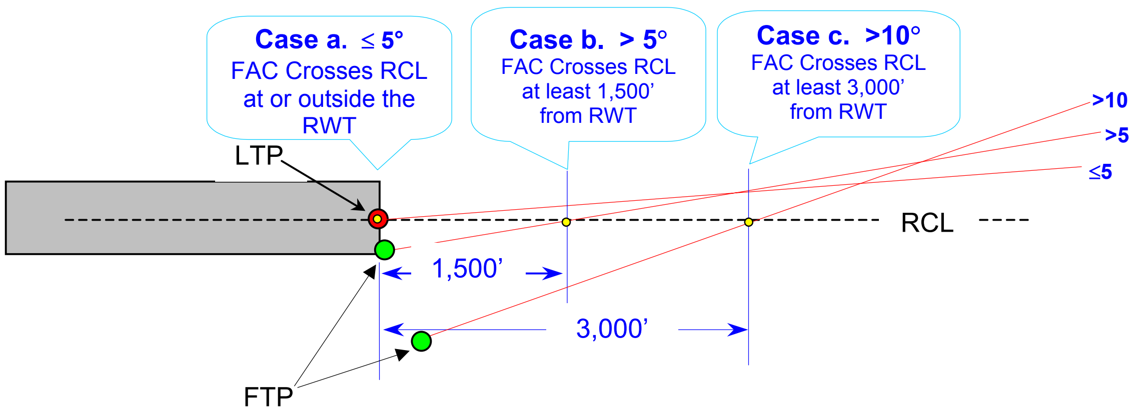
4.4.2 a. **Where the FAC is ≤5°** from the RCL alignment, the FAC shall cross the RCL at or outside the RWT.

4.4.2 b. **When the FAC is >5°** from RCL alignment, the FAC shall cross the RCL at least 1,500 feet from the RWT.

4.4.2 c. **When the FAC is >10°** from RCL alignment, the FAC shall cross the RCL at least 3,000 feet from the RWT.

NOTE: A FAC that intersects the RCL inside RWT, does not intersect the RCL extended or intersects at a distance greater than 3,000 feet from RWT may be established provided that the course lies laterally within 500 feet of the extended RCL at a point 3,000 feet outward from the RWT.

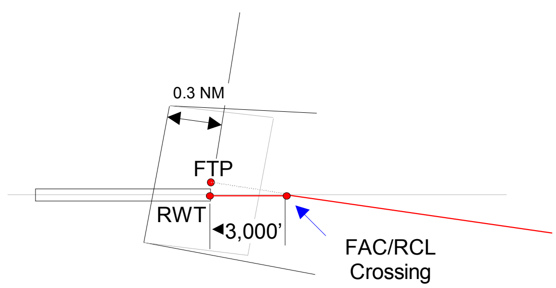
Figure 4-1B. Offset Final Course and RCL Extended Crossing Points



4.4.3 Length.

The primary OCS begins at the earliest point the FAF can be received and extends 0.3 NM past the RWT or FTP (see figures 4-1A, 4-1B, and 4-2).

Figure 4-2. End of Final Trapezoid, 15° Offset



4.4.4 Width.

4.4.4 a. Primary Area.

Calculate the perpendicular distance (D_Y) from the course extended to the outer boundary of the primary area for any distance (D) from RWT or FTP using the following formula:

$$D_Y = \frac{0.5\,NM}{L} \times (D + 1822.83) + 3038.06$$

Where D = the distance in feet from RWT or FTP along course centerline

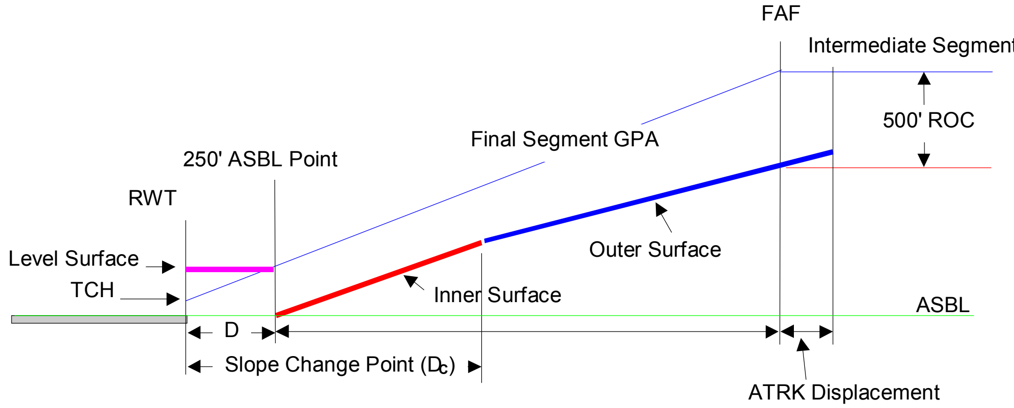
L = the final length in NM from plotted position of FAF to plotted position of RWT or FTP

4.4.4 b. Secondary Area.

The width of the secondary area is equal to the ½ width of the primary at any distance "D" from RWT or FTP (see paragraph 4.4.4a).

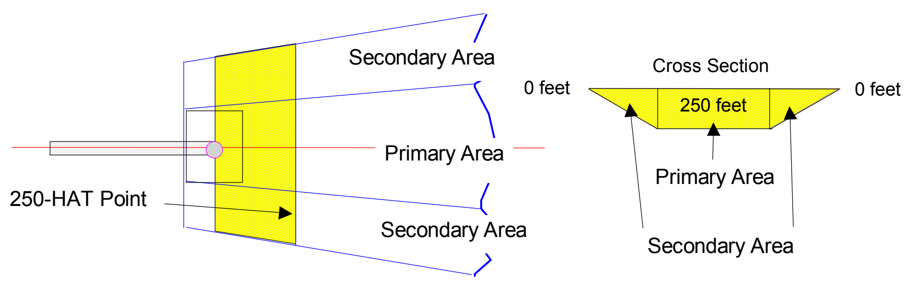
4.4.5 Obstacle Clearance Between RWT and 250' ASBL Point (see figure 4-3).

Figure 4-3. Baro VNAV OCS's



The area between the RWT or FTP and the 250 feet above ASBL point consists of primary and secondary ROC areas. Apply ROC in the appropriate shaded area below to arrive at a preliminary DA (pDA) (see figure 4-4).

Figure 4-4. Obstacle Clearance Inside the 250 Feet Above ASBL Point



In the primary area, apply 250 feet ROC to the highest obstruction (see figure 4-4). Calculate secondary area ROC using the following formulae:

$$D_P = \frac{3{,}038.06}{L} \times (D_X + 1{,}822.83) + 3038.06$$

Example: $\frac{3{,}038.06}{28{,}557.74} \times (3{,}000 + 1{,}822.83) + 3{,}038.06 = 3{,}551.13$

$D_S = D_P$

$$ROC_S = \frac{250}{D_S} \times ([2 \times D_s] - D_y)$$

Example: $\frac{250}{3{,}551.15} \times ([2 \times 3{,}551.13] - 4{,}200) = 204.32$

Where
L = final length in feet (plotted position of FAF to plotted position of RWT or FTP).
DP=the distance in feet from course centerline to the primary area outer boundary.
D_S =the width of the secondary area at distance D_X.
D_X = the distance in feet from RWT or FTP to the obstacle measured along course centerline.
D_Y=the perpendicular distance in feet from course centerline to the obstacle.

Determine the pDA by adding the appropriate ROC value to the controlling obstruction height and round up to the next higher 20-foot increment.

4.4.6 Inner Surface.

The inner surface originates at the point on the ASBL corresponding distance from RWT that the glidepath reaches 250 feet above ASBL (see figure 4-3). Calculate the distance (D_{250}) from RWT or FTP to the OCS origin using the following formula:

$$D250 = \frac{250 - TCH}{\tan(\theta)} \qquad \text{Example: } \frac{250-53}{\tan(3)} = 3758.98$$

Where θ = glidepath angle

Determine the slope of the inner surface (S_V) as follows:

STEP 1: Obtain the mean low temperature of the coldest month of the year for the last five years of data. If the data is given in Fahrenheit (°f), convert the temperature to Celsius (°c) and enter table 4-1. Use the following formulae to convert between Celsius and Fahrenheit temperatures:

$$°c = \frac{°f - 32}{1.8} \qquad \text{Example}: \frac{76 - 32}{1.8} = 24.44°c$$

$$°f = (1.8 \times °c) + 32 \qquad \text{Example}: (1.8 \times 24.44) + 32 = 75.99°f$$

STEP 2: Convert the mean temperature into a deviation from ISA using the following formula:

$$\text{deviation} = °c - \left[15°c - \left(\frac{\text{Airport Elevation}}{500}\right)\right] \qquad \text{Example}: -28 - \left[15°c - \left(\frac{1{,}528}{500}\right)\right] = -39.9°$$

Round deviation to the next lower 5°c increment. Use this rounded deviation or -15°c, whichever is lower, and the GPA to find the surface slope from table 4-1.

Table 4-1. S_V Considering GPA and International Standard Atmosphere (ISA) Temperature Deviation

ISA (C) DEV	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8
-10	23.2	22.4	21.7	21.0	20.4	19.8	19.3	18.8	18.3	17.8	17.4	17.0
-15	23.8	23.0	22.2	21.6	20.9	20.3	19.8	19.3	18.8	18.3	17.9	17.5
-20	24.4	23.6	22.9	22.2	21.5	20.9	20.3	19.8	19.3	18.8	18.4	18.0
-25	25.1	24.3	23.5	22.8	22.1	21.5	20.9	20.4	19.9	19.4	18.9	18.5
-30	25.8	25.0	24.2	23.4	22.8	22.1	21.5	21.0	20.5	20.0	19.5	19.1
-35	26.6	25.7	24.9	24.1	23.4	22.8	22.2	21.6	21.1	20.6	20.1	19.6
-40	27.4	26.5	25.7	24.9	24.2	23.5	22.9	22.3	21.7	21.2	20.7	20.3
-45	28.2	27.3	26.5	25.7	24.9	24.2	23.6	23.0	22.4	21.9	21.4	20.9
-50	29.1	28.2	27.3	26.5	25.8	25.0	24.4	23.8	23.2	22.6	22.1	21.6

NOTE: IF the glidepath angle falls between table values, use the higher value.

4.4.7 Outer Surface.

Calculate the slope of the outer surface (S_W) appropriate for the glidepath angle (θ) using the following formula: $S_W = \frac{102}{\theta}$ The outer surface begins at point "c" and ends at the earliest point the FAF can be received (see figure 4-3). Calculate the distance (D_C) from RWT or FTP to point C using the following formula

$$D_C = \frac{(a \times S_W) - (200 \times S_V)}{(S_W - S_V)}$$

Where a=distance from RWT or FTP to OCS origin (D_{250})

4.4.8 Height of the OCS.

4.4.8 **a. Calculate the height** (I_Z) above ASBL of the inner surface using the following formula:

$$I_Z = \frac{D_O - D_{250}}{S_V}$$

Where D_O = the distance in feet from the RWT or FTP to the obstacle

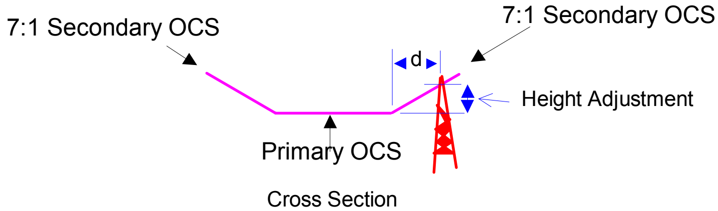
D_{250} = the distance from the RWT or FTP origin to the inner surface origin

4.4.8 **b. Calculate the height** (O_Z) above ASBL of the outer OCS using the following formula:

$$O_Z = \frac{(D_O - 200) \times GPA}{102}$$

4.4.8 **c. The secondary OCS** has a slope of 7:1 measured perpendicular to the segment centerline. To evaluate the height of a secondary OCS obstruction, reduce the obstruction height by the amount of secondary surface rise from the edge of the primary OCS (see figure 4-5). Then evaluate the revised height of the obstruction against the height of the primary OCS abeam the obstruction.

Figure 4-5. Secondary OCS Evaluation



Height Adjustment $= \frac{d}{7}$

Where d = distance in feet from edge of primary OCS measured perpendicular to the segment centerline.

4.4.9 **OCS Penetrations.**

Obstructions should not penetrate the OCS. If the OCS is clear, publish the pDA value. If the OCS is penetrated, take one of the following actions. These actions are listed in order of preference.

ACTION 1: Remove or adjust the obstruction location and/or height.

ACTION 2: Raise glidepath angle.

ACTION 3: Adjust DA.

4.4.9 **a. Adjustment of DA for Penetration of INNER SURFACE**.

CASE 1: If elevation (revised elevation if paragraph 4.4.8c applied) of the obstacle is less than the elevation of point C ($C_{elevation}$):

$$C_{elevation} = E + \frac{D_C - D_{250}}{S_V}$$

$$DA_{adjusted} = E + \tan(\theta)\left(\left(D_O + \frac{TCH}{\tan(\theta)}\right) + (p \times S_V)\right)$$

Where θ = glidepath angle
D_O = distance (ft) to obstacle from LTP measured parallel to FAC
p = amount of penetration (ft)
S_V = slope of inner surface
E = LTP elevation (ft)

CASE 2: If the elevation (revised elevation if paragraph 4.4.8c applied) of the obstacle is equal to or greater than the elevation of point C:

$$DA_{adjusted} = E + \tan(\theta)\left[\left([h-c]S_W\right) + D_C + \frac{TCH}{\tan(\theta)}\right]$$

Where h = obstacle MSL elevation (revised elevation if para 4.4.8c applied)
c = elevation (MSL) of point C

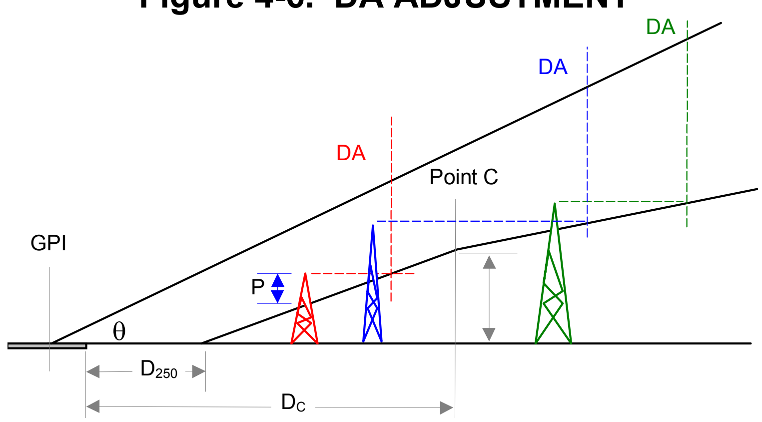
4.4.9 **b. Adjustment of DA for penetration of OUTER SURFACE** (see figure 4-6):

$$DA_{adjusted} = E + \tan(\theta)\left[(pS_W) + D_O + \frac{TCH}{\tan(\theta)}\right]$$

$$\text{Distance LTP to } DA_{adjusted} = \frac{DA_{adjusted} - E}{\tan(\theta)} - \frac{TCH}{\tan(\theta)}$$

Where $DA_{adjusted}$=Adjusted DA (MSL)

Figure 4-6. DA ADJUSTMENT



4.5 **VISIBILITY MINIMUMS.**

To determine visibility minimums, refer to TERPS Volume 1, chapter 3 for localizer procedures.

4.6 MISSED APPROACH SEGMENT.

Height loss is assumed after DA. The missed approach area begins at the cd line prior to the DA point. Apply RNAV departure criteria (Order 8260.44) from the segment origin to the missed approach holding fix. Locate the first fix encountered after DA at least 9,114 feet from the ab line and a maximum of 5 NM. If a turn is associated with a fly-by fix, the minimum distance is 9,114+DTA (see figures 4-7 and 4-8A and 4-8B).

Figure 4-7. Straight Missed Approach Surfaces

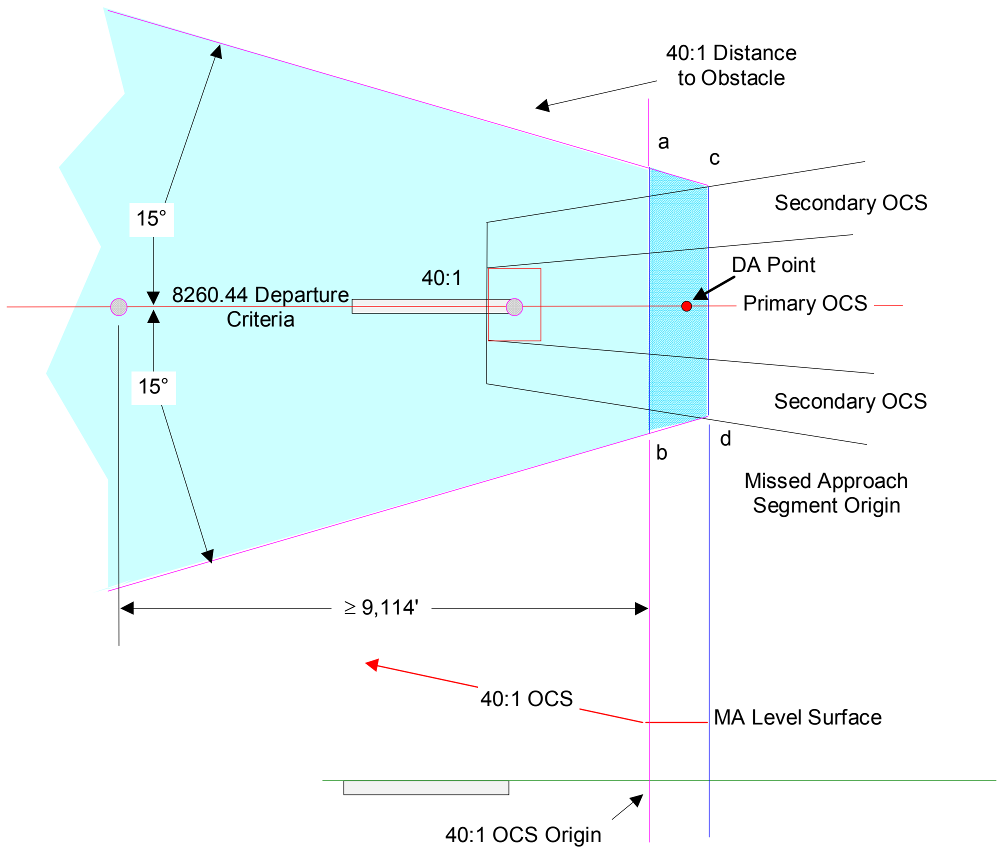


Figure 4-8A. Turning Approach Surfaces Minimum Distance from DA to Turn Fix

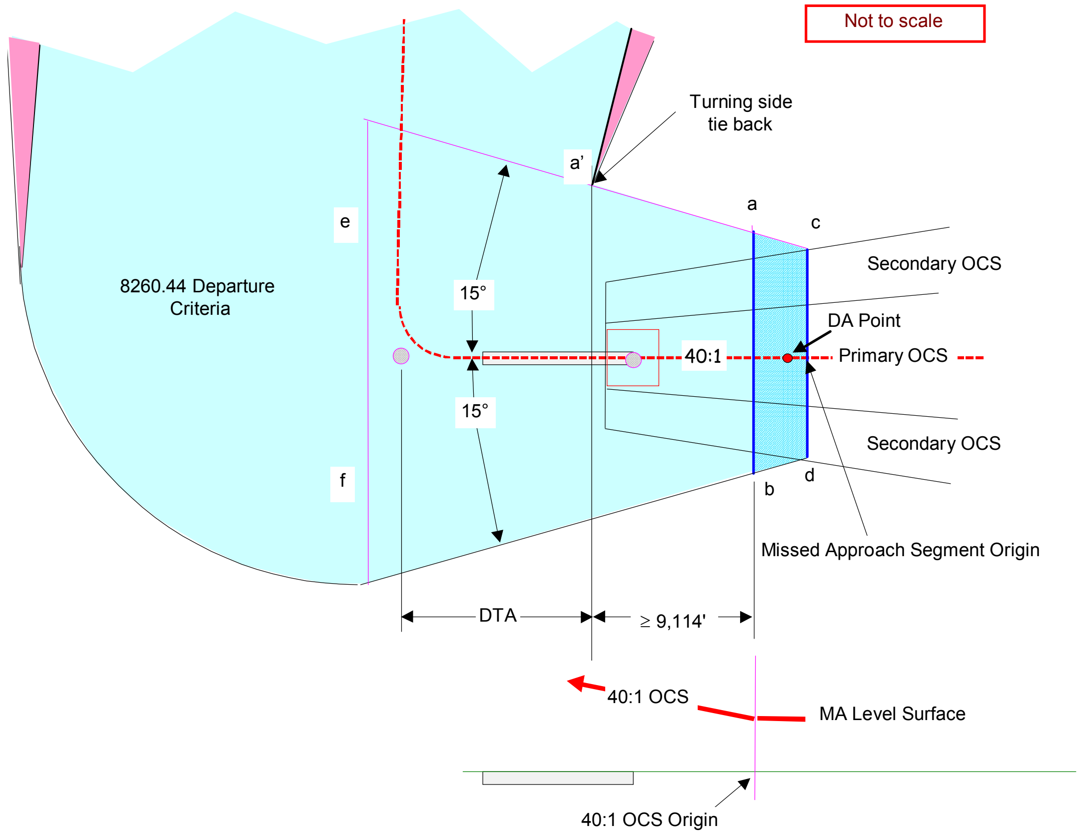
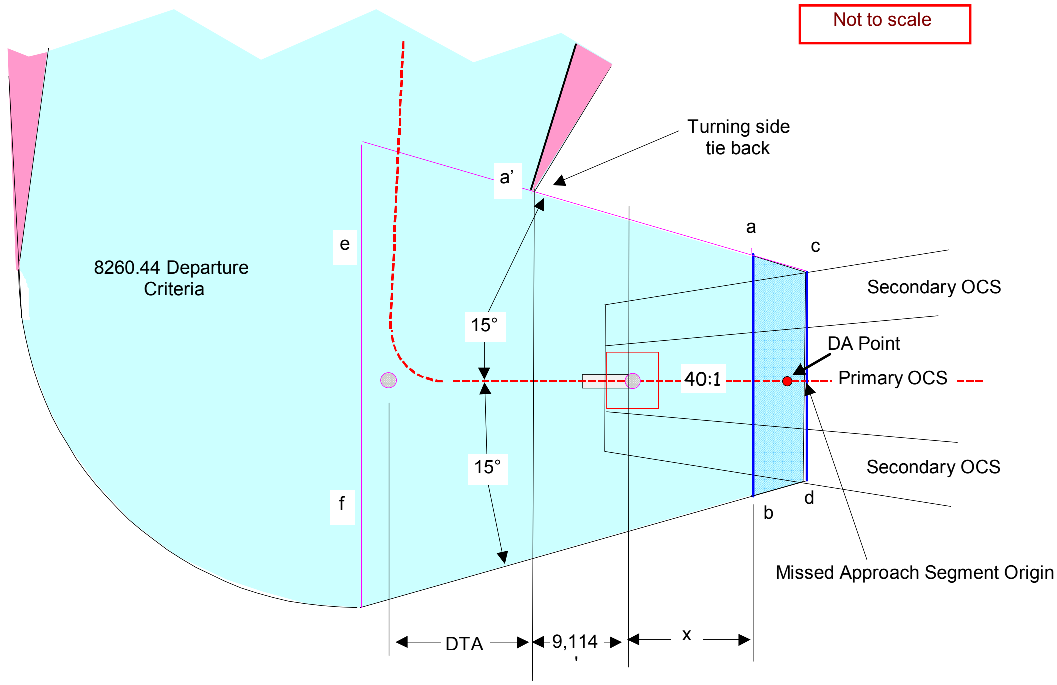


Figure 4-8B. Turning Approach Surfaces Greater than Minimum Distance from DA to Turn Fix



4.6.1 Area.

4.6.1 a. Level Surface. See figure 4-9.

The level surface accounts for possible along track errors inherent with barometric altimetry and allows an aircraft to lose (dip down) 50 feet prior to commencing climb.

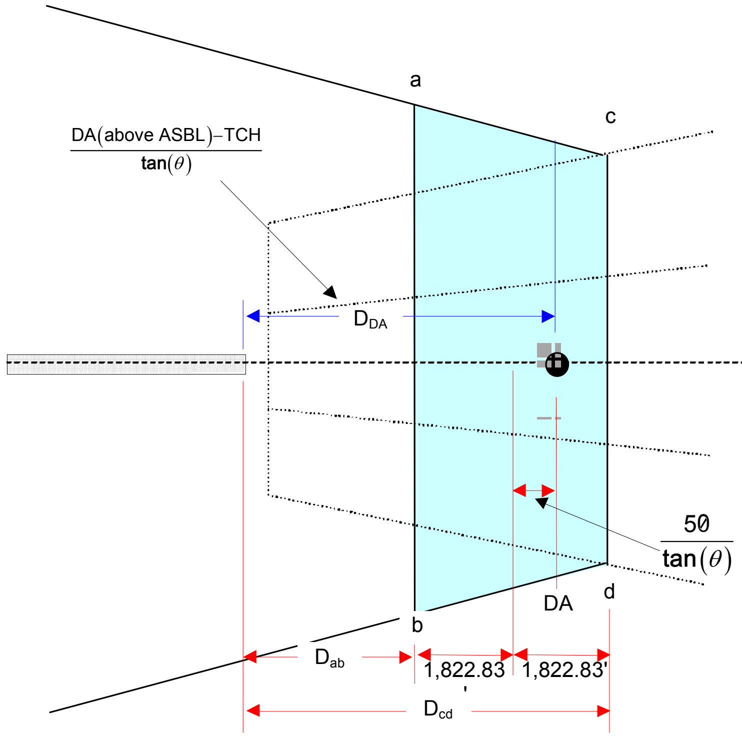
4.6.1 **a. (1) Length.** Calculate the distance (D_{cd}) from RWT to the **origin** of the MA segment (cd line), and the distance (D_{ab}) from RWT to the end of the level surface (ab line), using the following formulae:

$$D_{cd} = \frac{DA - (E + TCH)}{\tan(\theta)} - \frac{50}{\tan(\theta)} + 1822.83$$

$$D_{ab} = D_{cd} - 3645.66$$

Where E = RWT elevation
θ = GPA

Figure 4-9. Level Surface



4.6.1 **a. (2) Width.** The area splays at 15° relative to the MA course beginning at the secondary outer boundary at the cd line (see figure 4-9).

4.6.1 **a. (3) OCS.** A level surface overlies the primary area. Where obstructions penetrate the OCS, increase the DA by the value of the penetration. The height of the MA LEVEL OCS (MSL) is determined by the formula:

$$hmas = DA - ROC$$

4.6.1 **b. 40:1 Surface.** Apply Order 8260.44 criteria.

4.6.1 **b. (1) Length.** The 40:1 surface begins at the ab and extends along the MA course until the clearance limit.

4.6.1 **b. (2) Width.** The primary area splays as specified in Order 8260.44 relative to the MA course beginning at the final primary outer boundary at the cd line (see figure 4-9).

4.6.1 **b. (3) OCS.** Where obstructions penetrate the OCS, increase the DA by the value ($DA_{adjustment}$) calculated by the following formula:

$$DA_{adjustment} = \frac{\theta(40p)}{102}$$

Where p = amount of penetration in feet

4.6.1 c. Missed Approach Altitude.

4.6.1 **c. (1) Straight Missed Approach Procedures.** Use TERPS paragraphs 274b and d to establish the charted missed approach altitude. Use TERPS paragraph 274c to determine if a climb-in-holding evaluation is required.

4.6.1 **c. (2) Combination Straight Turning Missed Approach Procedures.** Use TERPS paragraphs 277d and f to establish the charted missed approach altitude. Use TERPS paragraph 277e to determine if a climb-in-holding evaluation is required.

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Policy Memo
Dec 21 2007

APPENDIX 1. CATEGORY (CAT) II AND III PRECISION MINIMUMS REQUIREMENTS

RESERVED

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)

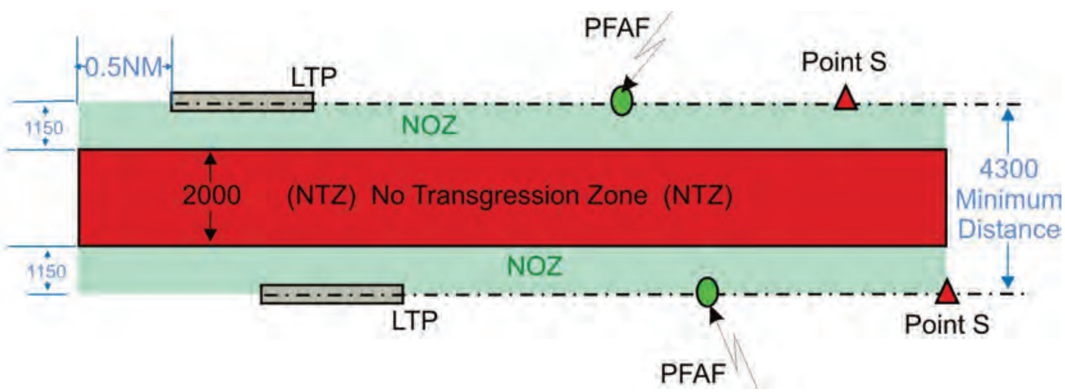
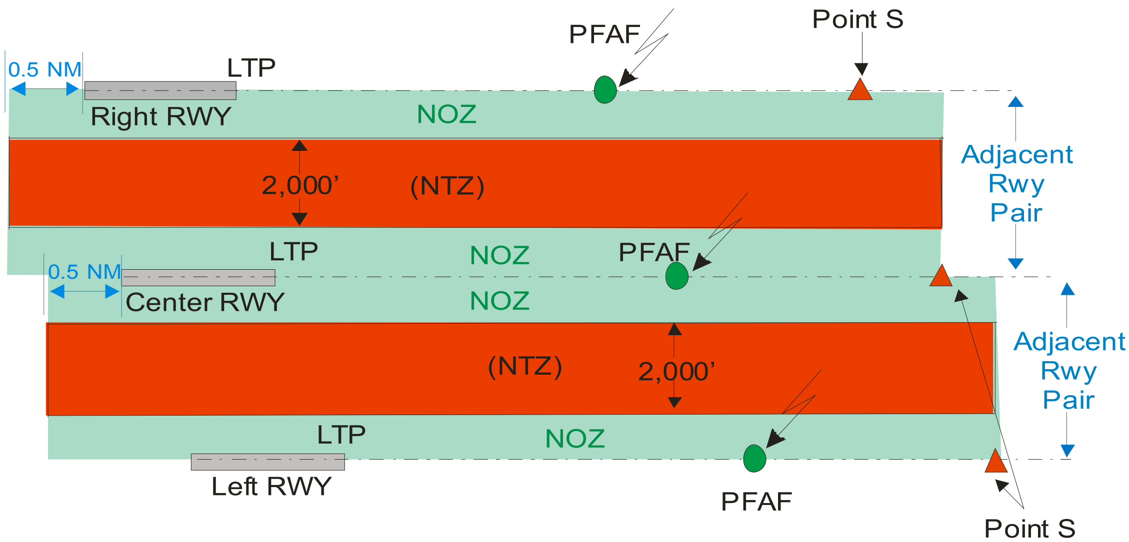


Figure A2-2. No Transgression and
Normal Operating Zones (Triple Approach).



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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

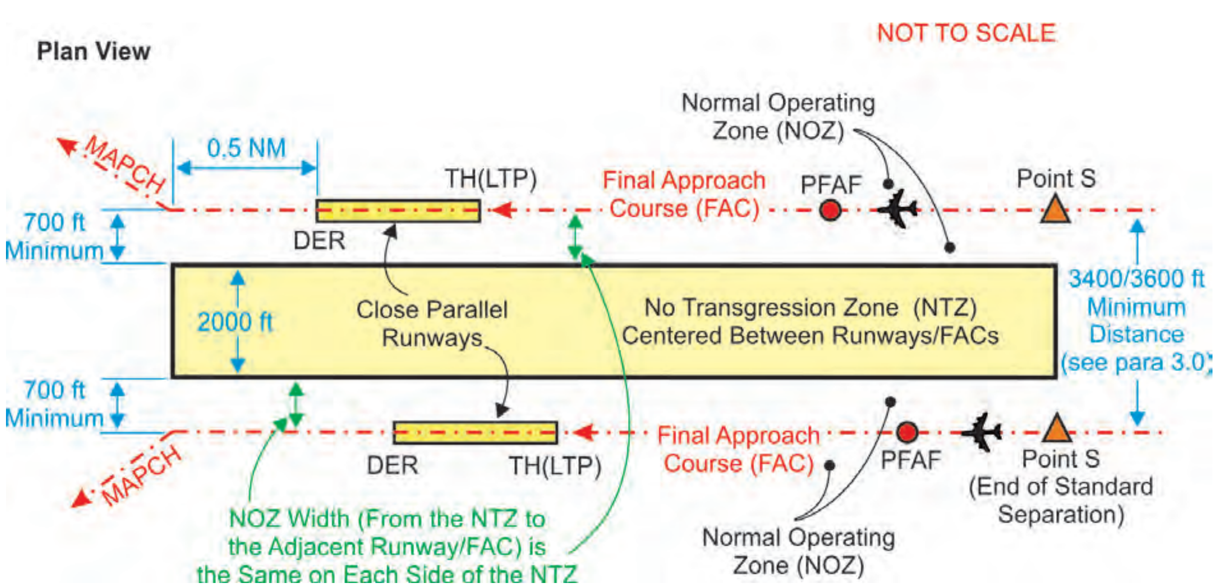
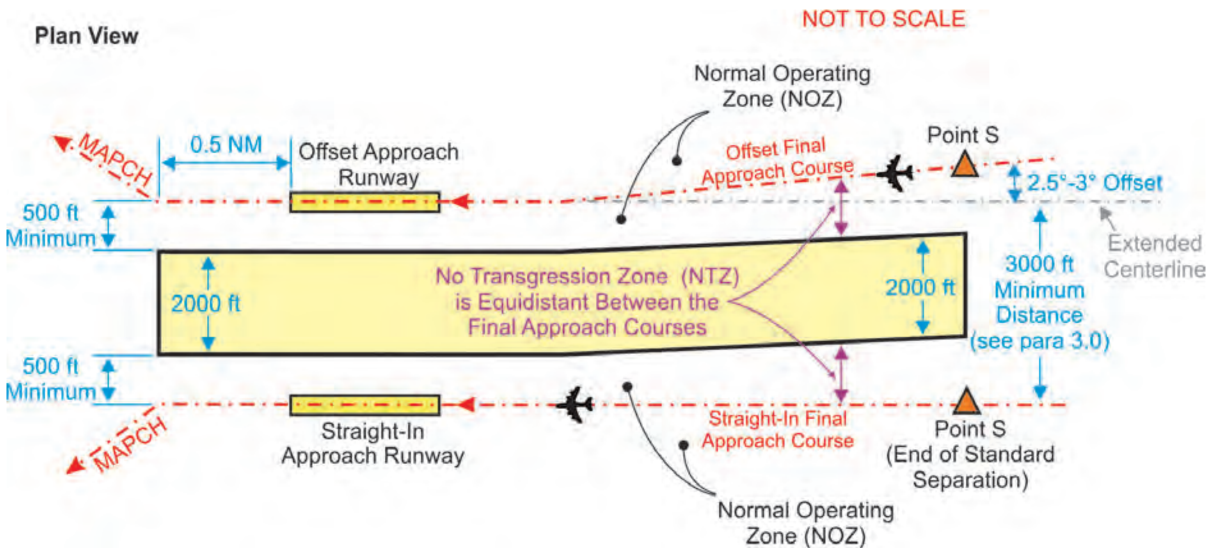


Figure A3-2. NTZ, NOZ, and FAC With an Offset Approach, Less Than 3400-foot Spacing



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

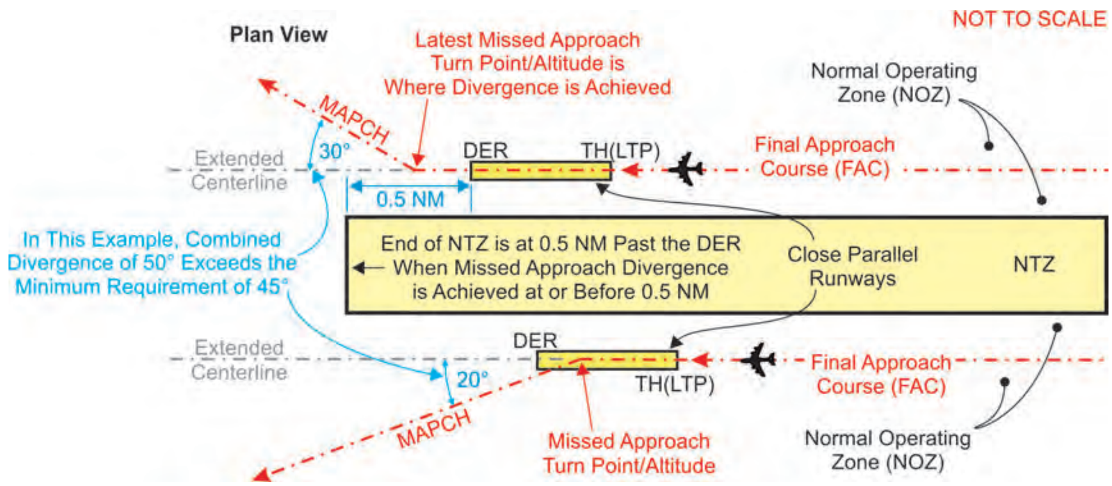
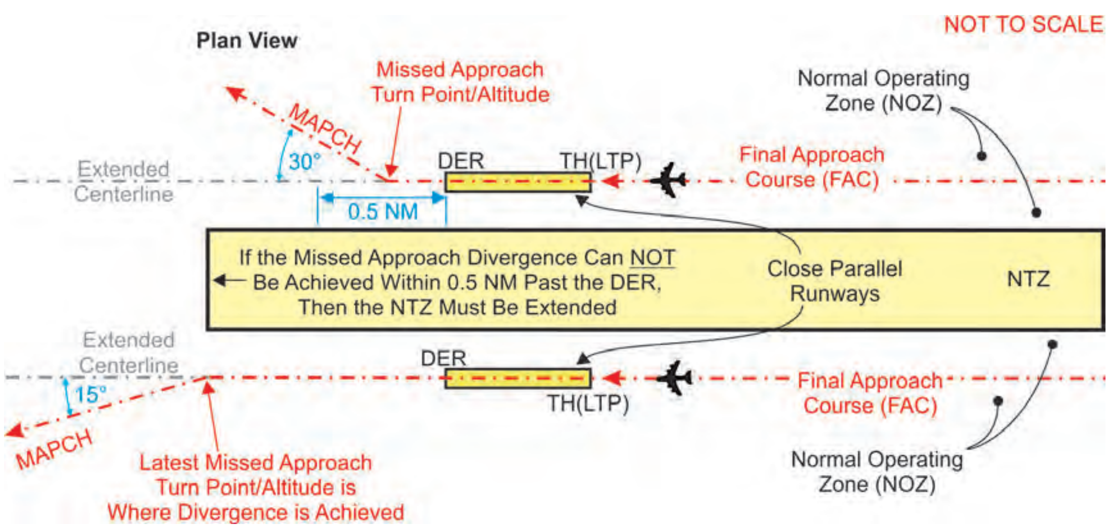


Figure A3-4. Missed Approach Divergence Delayed Beyond 0.5 NM



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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BACK

APPENDIX 4. OBSTACLE ASSESSMENT SURFACE EVALUATION FOR SIMULTANEOUS PARALLEL PRECISION OPERATIONS

1.0 BACKGROUND.

One of the major aviation issues is the steady increase in the number and duration of flight delays. Airports have not been able to expand to keep pace with traffic growth. The Federal Aviation Administration (FAA) has taken a variety of measures to increase airport capacity. These include revisions to air traffic control procedures; addition of landing systems, taxiways and runways; and application of new technology. The precision radar monitor (PRM) program is one of these new initiatives. PRM is an advanced radar monitoring system intended to increase the use of multiple, closely-spaced parallel runways in instrument meteorological conditions (IMC) weather by use of high resolution displays with alert algorithms and higher aircraft position update rate. Monitor controllers are required for both standard and closely-spaced runway separations. The primary purpose of radar monitoring during simultaneous, independent approach operations is to ensure safe separation of aircraft on the parallel approach courses. This separation may be compromised if an aircraft blunders off course toward an aircraft on the adjacent approach. For close parallel operations (3,400 feet but less than 4,300 feet) and for standard parallel operations (4,300 feet and above), the radar monitoring allows controllers to direct either aircraft off the approach course to avoid a possible collision. Resolution of a blunder is a sequence of events: the monitor alerts and displays the blunder, the controllers intervene, and the pilots comply with controller instructions; thus, increasing the operational safety, flyability, and airport capacity.

2.0 DEFINITIONS.

2.1 COURSE WIDTH (CW).

The angular course deviation required to produce a full scale (±) course deviation indication of the airborne navigation instrument. This width is normally tailored to a parameter of not greater than ±3°. For precision runways longer than 4,000 feet, a linear sector width parameter of ±350 feet each side of centerline at RWT applies. Few Category I localizers operate with a course sector width less than 3° (±1½°). Tailored width may be determined by the formula:

$$W = \text{ArcTan}\left(\frac{350}{D}\right) \quad \text{Total Course Width at RWT} = 2 \times W$$

Where: W = Half Width (in degrees) at RWT
D = Distance from localizer antenna to RWT (in feet)

2.2 PARALLEL APPROACH OBSTRUCTION ASSESSMENT (PAOA).

An examination of obstruction identification surfaces, in addition to the ILS TERPS surfaces, in the direction away from the NTZ and adjacent parallel ILS runway, into which an aircraft on an early ILS breakout could fly.

2.3 PARALLEL APPROACH OBSTRUCTION ASSESSMENT SURFACES (PAOAS).

PAOA assessment surfaces for identifying obstacles that may impact simultaneous precision operations.

2.4 PARALLEL APPROACH OBSTRUCTION ASSESSMENT SURFACE PENETRATION.

One or more obstructions that penetrate the PAOAS.

2.5 PARALLEL APPROACH OBSTRUCTION ASSESSMENT CONTROLLING OBSTRUCTION (PAOACO).

The obstruction within the boundaries of the PAOAS which constitutes the maximum penetration of that surface.

2.6 NO TRANSGRESSION ZONE (NTZ).

See Volume 3, appendix 3, paragraph 4.3.

2.7 NORMAL OPERATIONAL ZONE (NOZ).

See Volume 3, appendix 3, paragraph 4.4.

3.0 GENERAL.

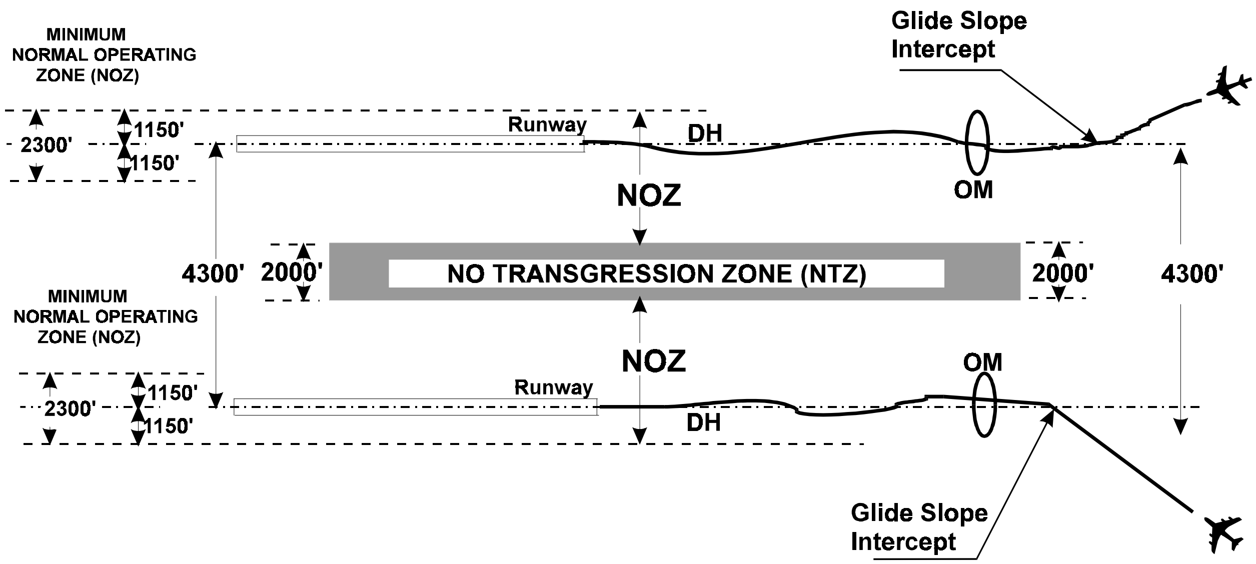
This order characterizes criteria used during the interim test phase of evaluating close parallel operations where early turnout obstacle assessments were accomplished by contractual means using terrestrial photometric techniques combined with survey methods of surface evaluation. This assessment technique is recommended for future evaluations of all independent simultaneous parallel approach operations. Facility information (glidepath angle (GPA), threshold crossing heights (TCH), touchdown zone elevation (TDZE), threshold elevations, etc.) may be obtained from air traffic planning and automation, flight procedures offices, and/or the systems management organizations for the regions in which independent simultaneous parallel operations are planned.

3.1 PARALLEL RUNWAY SIMULTANEOUS ILS APPROACHES.

The procedures for airports with multiple parallel runways must ensure that an aircraft approach on one runway is safely separated from those approaching the adjacent parallel runway. An example of such procedures is depicted in figure A4-1. Aircraft are directed to the two intermediate segments at altitudes which differ by at least 1,000 feet. Vertical separation is required when lateral separation becomes less than 3 nautical miles (NM), as aircraft fly to intercept and stabilize on their respective localizers (LOC). This 1,000-foot vertical separation is maintained until aircraft begin descent on the glidepath.

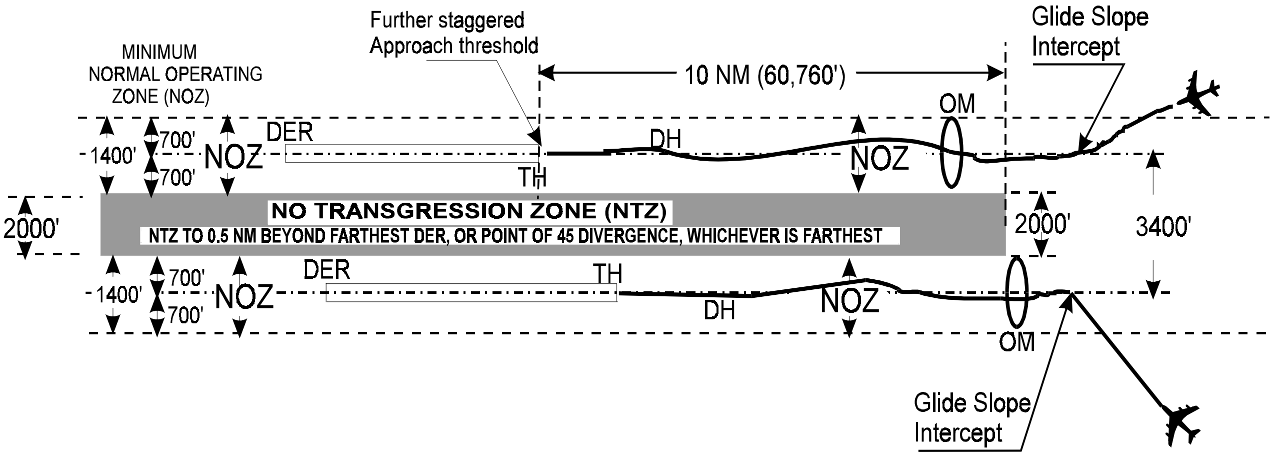
3.1.1 **When lateral radar separation is less than the 3 NM** and the 1,000-foot altitude buffer is lost, the aircraft must be monitored on radar. The controllers, on separate and discrete frequencies, will observe the parallel approaches, and if an aircraft blunders from the NOZ into a 2,000-foot NTZ, the monitor controller can intervene so that threatened aircraft on the adjacent approach are turned away in time to prevent a possible encounter. This maneuver, on the part of the threatened aircraft, is termed a "breakout" because the aircraft is directed out of the approach stream to avoid the transgressor aircraft. A controller for each runway is necessary so that one can turn the transgressing aircraft back to its course centerline while the other directs the breakout (see figure A4-1).

Figure A4-1. Simultaneous precision parallel Runway Approach Zones



3.1.2 **The 2,000-foot NTZ**, flanked by two equal NOZ's, provides strong guidance to the monitor controller and maneuvering room for the aircraft to recover before entering the adjoining NOZ. Aircraft are required to operate on or near the approach course within the limits of the NOZ. If an aircraft strays into the NTZ or turns to a heading that will take it into the NTZ, it is deemed a threat to an aircraft on the adjacent course and appropriate corrective action or breakout instructions are issued (see figure A4-2).

Figure A4-2. Simultaneous ILS No Transgression Zone and Normal Operating Zone



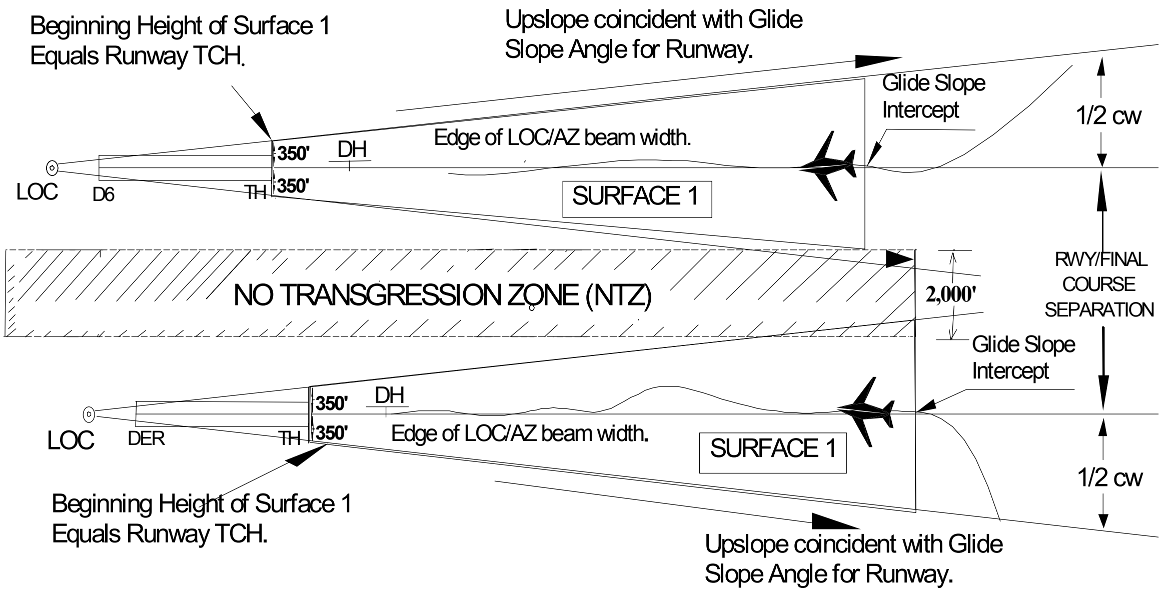
4.0 PAOA EVALUATION.

The PAOA evaluation shall be conducted to identify penetrating obstacles as part of a coordinated assessment for all independent simultaneous approach operations to parallel ILS/MLS runways. In these criteria, ILS glidepath/localizer terms are synonymous to and may be used interchangeably with MLS elevation glidepath/azimuth (GP/AZ) terms. The surface dimensions for the obstacle assessment evaluation are defined as follows:

4.1 SURFACE 1.

A final approach course descent surface which is coincident with the glide slope/glidepath (GS/GP) beginning at runway threshold with the width point abeam the threshold 350 feet from runway centerline opposite the NTZ, with lateral boundaries at the outer edge of the LOC/AZ CW, and ending at the farthest GS/GP intercept (see figure A4-3).

Figure A4-3. Final Approach Descent Surface 1



1/2 CW = Perpendicular distance from runway/extended C_L to edge of course beam width.

1/2 CW = Distance from Threshold in feet along C_L X TAN (1/2 Course Beam Angle) + 350'.

OR

1/2 CW = Distance from LOC/AZ Antenna in feet along C_L X TAN $\frac{\text{(LOC/AZ Beam Angle)}}{2}$.

Suface 1 Height – Distance from TH in feet along C_L X TAN of the GS/GP angle + TCH.

4.1.1 **Length.** Surface 1 begins over the runway threshold at a height equal to the TCH for the runway, and continues outward and upward at a slope that is coincident with the GS/GP, to its ending at the GS/GP intercept point.

4.1.2 **Width.** Surface 1 has a width equal to the lateral dimensions of the LOC/AZ course width. The Surface 1 half-width (see figure A4-2) is calculated using the following formula:

$$\frac{1}{2}W = A \times Tan\left(\frac{B}{2}\right) + 350$$

Where W = Width of Surface 1

A = Distance from RWT measured parallel to course

B = Course Width Beam Angle

OR

$$\frac{1}{2}W = L \times Tan\left(\frac{B}{2}\right)$$

Where W = Width of Surface 1

L = Distance from Azimuth antenna (in feet)

B = Course Width Beam Angle

4.1.3 **Surface 1 Height.** Surface height at any given centerline distance (d), may be determined in respect to threshold elevation, by adding the TCH to the product of centerline distance in feet from threshold times the tangent of the GS/GP angle.

$$h1 = \left[d \times Tan(GPA)\right] + TCH$$

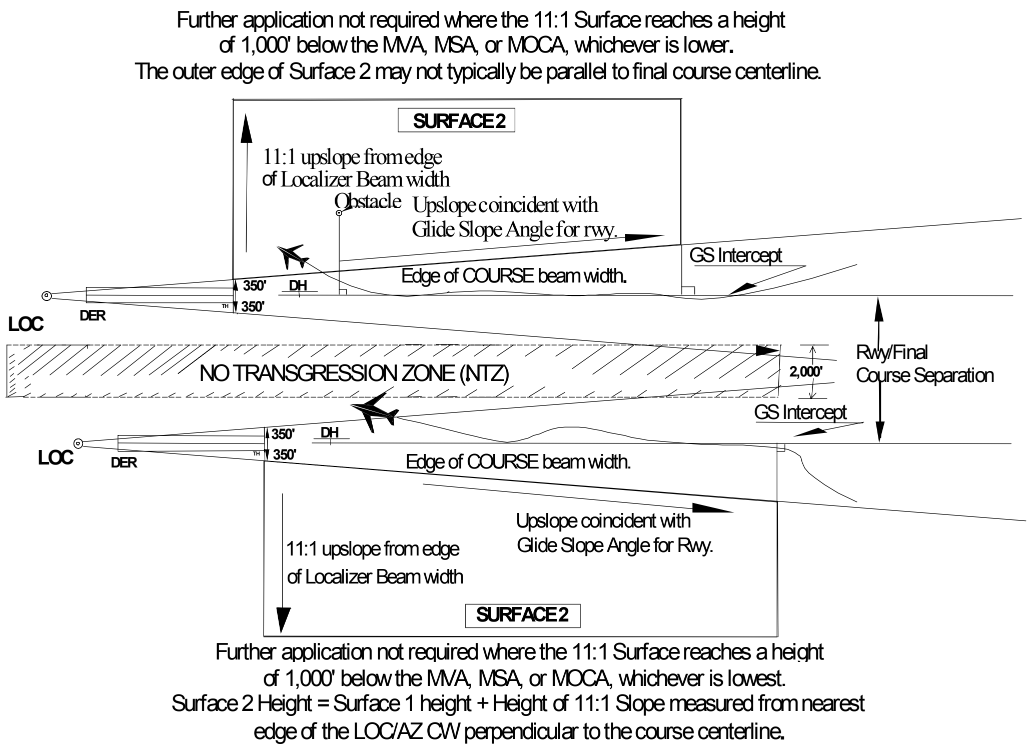
Where: h1 = surface 1 height above ASBL

4.2 **SURFACE 2.**

4.2.1 **Length.** Same as paragraph 4.1.1.

4.2.2 **Width and Height.** Surface 2 shares a common boundary with the outer edge of surface 1 on the side opposite the NTZ, and slopes upward and outward from the edge of the descent surface 1 at a slope of 11:1, measured perpendicular to the LOC/AZ extended course centerline. Further application is not required when the 11:1 surface reaches a height of 1,000 feet below the MVA, MSA, or MOCA, whichever is lowest (see figure A4-4).

Figure A4-4. Parallel Approach Obstacle Assessment Surface 2



4.3 **SURFACE 3 (CATEGORY I).**

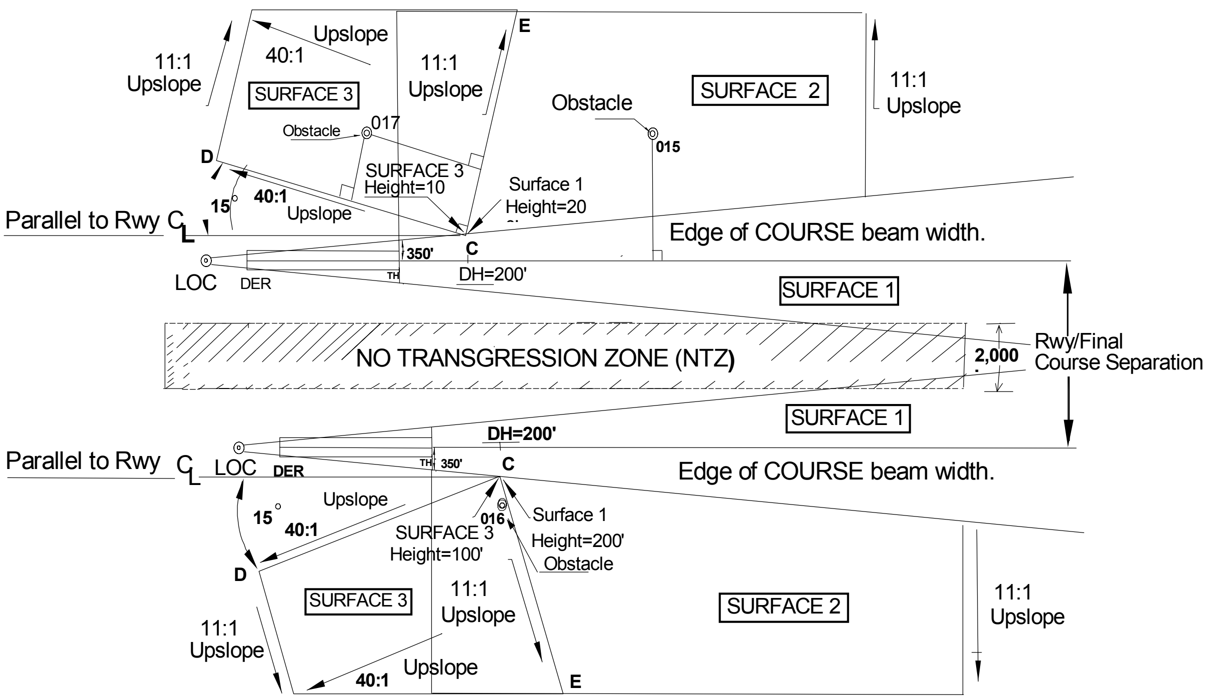
4.3.1 **Length.** For category I operations, surface 3 begins at the point where surface 1 reaches a height of 200 feet above the TDZE and extends to the point the 40:1 and 11:1 slopes reach a height of 1,000 feet below the MVA, MSA, or MOCA, whichever is lowest.

4.3.2 **Width.** From the beginning point, the edge of surface 3 area splays at a 15° angle from a line parallel to the runway centerline.

4.3.3 **Surface Height.** Surface 3 begins at a height of 100 feet above TDZE (100 feet lower than surface 1). The surface rises longitudinally at a 40:1 slope along the 15° splay line CD while continuing laterally outward and upward at an 11:1 slope (line CE is perpendicular to the 15° splay line CD). Further application is not required when the 40:1 and 11:1 slopes reach a height of 1,000 feet below the MVA, MSA, or MOCA, whichever is lowest (see figure A4-5).

Figure A4-5. CAT I Missed Approach Early Breakout Parallel Approach Obstacle Assessment Surface 3.

The outer edges of Surfaces 2 or 3 may not typically be parallel to each other or runway C_L.
Further application not required when the 40:1 and 11:1 surfaces reach a height of 1,000' below MVA, MSA or MOCA, whichever is lower.



Further application not required when the 40:1 and 11:1 surfaces reach a height of 1,000' below MVA, MSA, or MOCA, whichever is lower. Surface 3 Height = Height of 11:1 Slope measured (fr. 0bs.) perpendicular to Line CD + Height of 40:1 Slope measured (fr. 0bs.) perpendicular to Line CE + 100 feet.

4.4 SURFACE 4 (CATEGORY II).

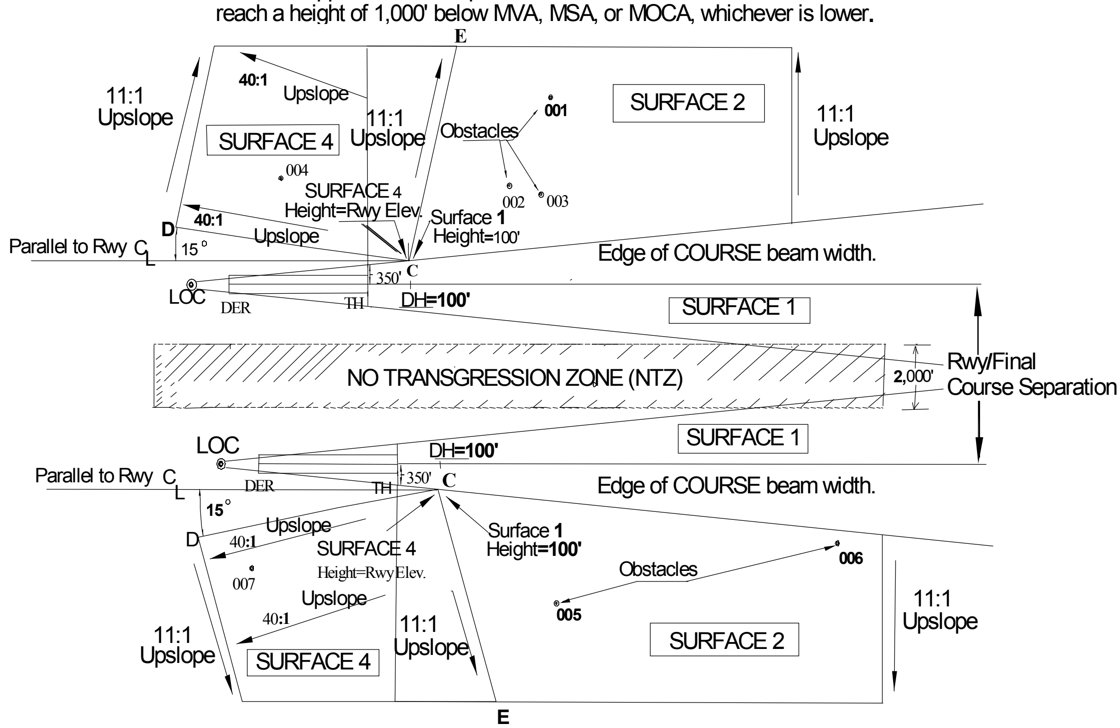
4.4.1 Length. Surface 4 begins at the point where surface 1 reaches a height of 100 feet above the runway TDZE and extends to the point 40:1 and 11:1 slopes reach a height of 1,000 feet below the MVA, MSA, or MOCA, whichever is lowest.

4.4.2 **Width.** From the point of beginning, the edge of surface 4 area splays at a 15° angle from a line parallel to the runway centerline.

4.4.3 **Surface Height.** Surface 4 begins at the point where surface 1 reaches a height of 100 feet above the runway TDZE and rises longitudinally at a 40:1 slope along the 15° splay line CD, while continuing laterally outward and upward at an 11:1 slope (line CE is perpendicular to the 15° splay line CD). Further application is not required when the 40:1 and 11:1 slopes reach a height of 1,000 feet below the MVA, MSA, or MOCA, whichever is lowest (see figure A4-6).

Figure A4-6. CAT II Missed Approach Early Breakout Parallel Approach Obstacle Assessment Surface 4

The outer edges of Surface 2 or 4 may not typically be parallel to each other or runway C_L. Further application not required when the 40:1 and 11:1 surfaces reach a height of 1,000' below MVA, MSA, or MOCA, whichever is lower.



Further application not required when the 40:1 and 11:1 surfaces reach a height of 1,000' below MVA, MSA, or MOCA, whichever is lower. Surface 4 Height = Height of 11:1 Slope measured (fr. Obs.) perpendicular to Line CD + Height of 40:1 Slope measured (fr. Obs.) perpendicular to Line CE.

4.5 **ESTABLISH A LATITUDE-LONGITUDE LIST** for all obstacles penetrating PAOA surfaces 2, 3, and 4. Identify locations of surface penetration within the surface areas (see figures A4-3, A4-4, and A4-5).

4.6 **PARALLEL OPERATIONS APPLICATION REQUIREMENTS.**

PAOA obstacle penetrations shall be identified and, through coordinated actions of those affected, considered for electronic mapping on controller radar displays. If possible, penetrations should be removed by facilities considering independent simultaneous approach operations to parallel precision runways. Where obstacle removal is not feasible, air traffic operational rules shall be established to avoid obstacles. If a significant number of penetrations occur, a risk assessment study shall be required to provide guidance as to whether independent simultaneous ILS/MLS operations to parallel runways should be approved or denied.

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APPENDIX 5.

THRESHOLD CROSSING HEIGHT

GROUND POINT OF INTERCEPT

RUNWAY POINT OF INTERCEPT

TCH/GPI/RPI CALCULATION

The following spreadsheets are a part of this appendix and can be found on the internet "http:\\terps.faa.gov"

Figure A5-1. Non-Radar Precision TCH/GPI/RPI

Figure A5-2. Precision Approach Radar (PAR) (Scanning Radar)

Figure A5-3. Precision Radar TCH/GPI/RPI

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Version 1.0

Figure A5-1. Non-Radar Precision TCH/GPI/RPI

1,016.00	A=Distance (ft) from GS antenna to RWT
100.00	a=RWT elevation (MSL)
98.00	c=Elevation (MSL) of runway crown at RPI/TDP
90.00	h=ILS antenna base elevation (MSL)
107.20	p=Phase center (MSL) of elevation antenna
3.00	e=Glidepath angle

STEP 1: CALCULATE OR SPECIFIY TCH

51.25	**ILS** (smooth terrain)	$\tan(e) \times A - (a - c)$
43.25	**ILS** (rapidly dropping terrain)	$\tan(e) \times A - (a - h)$
60.45	**MLS**	$\tan(e) \times A + (p - a)$
50.00	**LAAS/WAAS**	Specify TCH

STEP 2: CALCULATE GPI

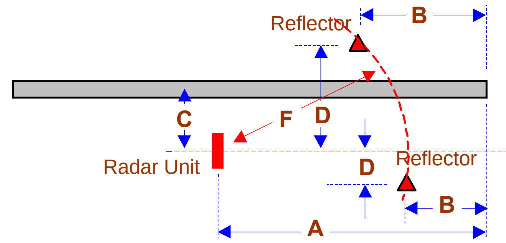
977.84	**ILS** (smooth terrain)	
825.19	**ILS** (rapidly dropping terrain)	$\frac{TCH}{\tan(e)}$
1,153.38	**MLS**	
954.06	**LAAS/WAAS**	

STEP 3: CALCULATE RPI

1,016.00	**ILS** (smooth terrain)	
863.35	**ILS** (rapidly dropping terrain)	$\frac{TCH + (a - c)}{\tan(e)}$
1,191.55	**MLS**	
992.22	**LAAS/WAAS**	

Figure A5-2.
Precision Approach Radar (PAR)
(Scanning Radar)

Version 1.0

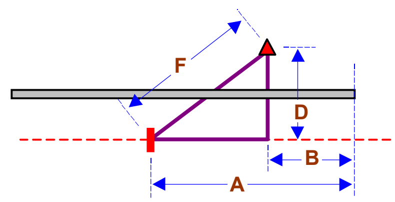


ELEVATIONS (MSL):		DISTANCES (FT):	
Threshold [a]:	100	AZ antenna to threshold [A]:	4500
Touchdown Reflector [b]:	105	TD reflector to threshold [B]:	750
RWY Crown in TDZE [c]:	100.7	AZ antenna to centerline [C]:	450
RPI (if known) [d]:	100.5	TD reflector to CLA line [D]:	475
Glidepath Angle [e]:	3	RWY gradient (if required) [E]:	0.00023333

STEP 1: Determine distance from AZ antenna to TD reflector [F].

3,779.96

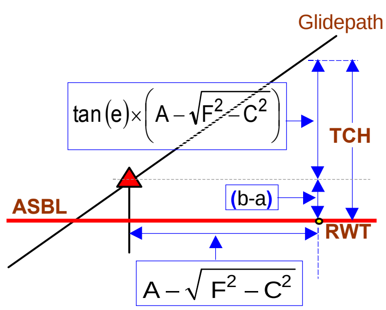
$$F = \sqrt{(A-B)^2 + D^2}$$

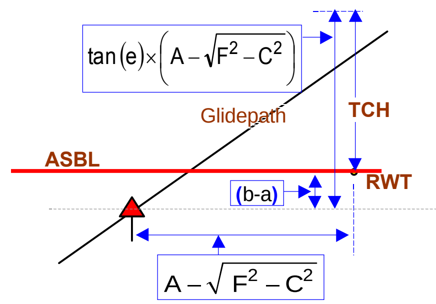


STEP 2: Determine threshold crossing height [TCH].

44.14

$$TCH = \tan(e) \times \left(A - \sqrt{F^2 - C^2} \right) + (b - a)$$





STEP 3: Determine ground point of intercept [GPI].

842.32

$$GPI = \frac{TCH}{\tan(e)}$$

STEP 4: Determine runway point of intercept [RPI].

[d] known

832.78

$$RPI = \frac{TCH - (d - a)}{\tan(e)}$$

[d] unknown

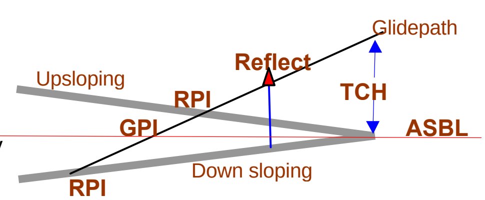
838.59

$$RPI = \frac{TCH}{\tan(e) + E} \quad \text{for up sloping runway}$$

[d] unknown

846.09

$$RPI = \frac{TCH}{\tan(e) - E} \quad \text{for down sloping runway}$$



Version 1.0

Figure A5-3. Precision Radar TCH/GPI/RPI

(Tracking Radar)

100.00	a=RWT elevation (MSL)
98.00	c=Elevation (MSL) of runway crown at RPI/TDP
3.00	e=Glidepath angle

STEP 1: **SPECIFIY TCH**

50.00 **<== TCH**

STEP 2: **CALCULATE GPI**

954.06 **<== GPI**

$$\frac{TCH}{\tan(e)}$$

STEP 3: **CALCULATE RPI**

992.22 **<== RPI**

$$\frac{TCH + (a - c)}{\tan(e)}$$

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BACK

FAA ORDER **8260.3B**

Army TM 95-226
Navy OPNAV Inst. 3722.16C
Coast Guard CG 318
Air Force AFMAN 11-226(I)

UNITED STATES STANDARD
FOR
TERMINAL
INSTRUMENT
PROCEDURES
(TERPS)

Policy Memo
Dec 28 2007

VOLUME 4

DEPARTURE PROCEDURE CONSTRUCTION

U. S. DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

CHAPTER 1. GENERAL CRITERIA

1.0 GENERAL.

IFR departure procedures may be designed and published for all runways authorized by the approving authority. For civil procedures, runway/taxiway separations, and airport obstacle free zones (OFZ) must meet the standards in Advisory Circular (AC) 150/5300-13, Airport Design, or appropriate military directives for military procedures for specified departure visibility minimums. Criteria for RNAV-equipped aircraft are provided in Orders 8260.44, Civil Utilization of Area Navigation (RNAV) Departure Procedures, and 8260.40, Flight Management System (FMS) Instrument Procedures Development.

1.1 TERMINOLOGY, ABBREVIATIONS, AND DEFINITIONS.

1.1.1 Climb Gradient (CG).

A climb requirement expressed in ft/NM (gradient greater than 200 ft/NM).

1.1.2 Course.

A specified track measured in degrees from magnetic north.

1.1.3 Dead Reckoning (DR).

The navigation of an airplane solely by means of computations based on airspeed, course, heading, wind direction, speed, ground speed, and elapsed time.

1.1.4 Departure End of Runway (DER).

The end of the runway opposite the landing threshold. It is sometimes referred to as the stop end of runway (SER).

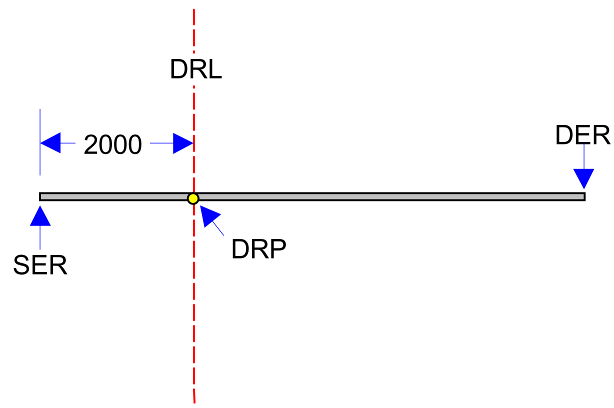
1.1.5 Departure Reference Line (DRL).

An imaginary line of indefinite length perpendicular to runway centerline at the DRP.

1.1.6 Departure Reference Point (DRP).

A point on the runway centerline 2,000 feet from the SER (see figure 1-1).

Figure 1-1. Runway Terms



1.1.7 Departure Route.

A specified course and altitude along a track defined by positive course guidance (PCG) to a clearance limit, fix, or altitude.

1.1.8 Departure Sector.

Airspace defined by a heading or a range of headings for aircraft departure operations**.**

1.1.9 Diverse Vector Area (DVA).

An area in which a prescribed departure route is not required. Radar vectors may be issued below the minimum vectoring or minimum IFR altitude. It can be established for diverse departure, departure sectors, and/or video map radar areas portraying obstacles and terrain.

1.1.10 Diverse Departure.

A departure without restrictions to the route of flight.

1.1.11 Diverse Departure Evaluation to Establish Sector(s) for Prescribed Departure Routes.

An evaluation of a diverse area to establish an unrestricted area or sector for purposes of publishing departure routes, including multi-turns and legs.

1.1.12 Initial Climb Area (ICA).

An area beginning at the DER to provide unrestricted climb to at least 400 feet above DER elevation.

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.

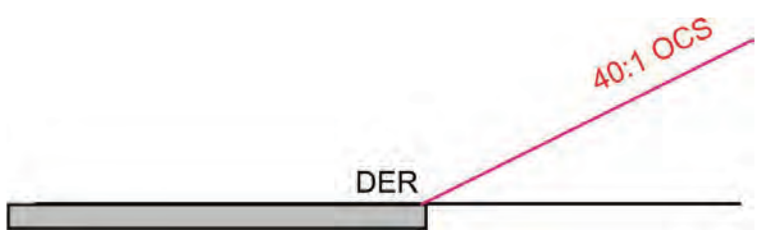
1.2.3 **Develop a VCOA procedure** where obstacles more than 3 SM from DER require climb gradients greater than 200 ft/NM (see chapter 4).

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).

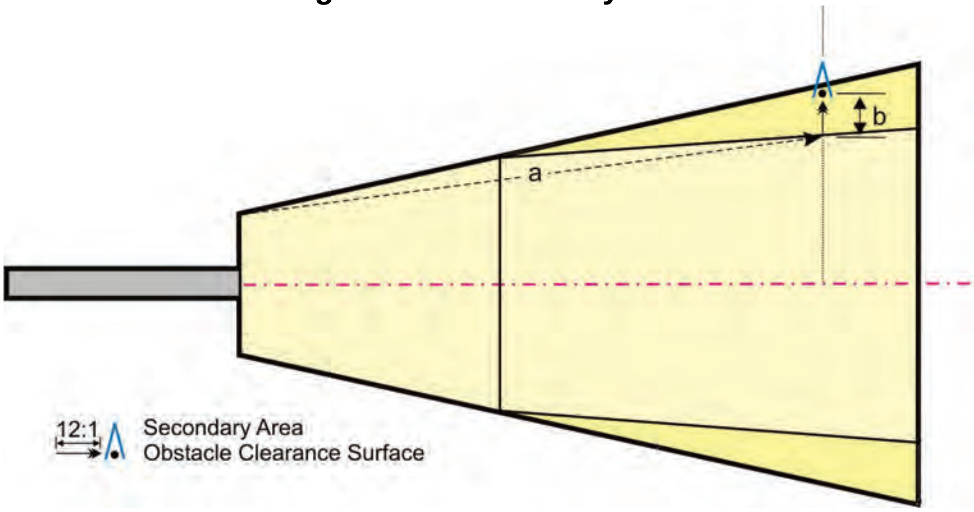
$$h_{SECONDARY} = h_{OCS} + \frac{b}{12}$$

where

h_{OCS} *= primary OCS height*

b = perpendicular distance (ft) from edge of primary

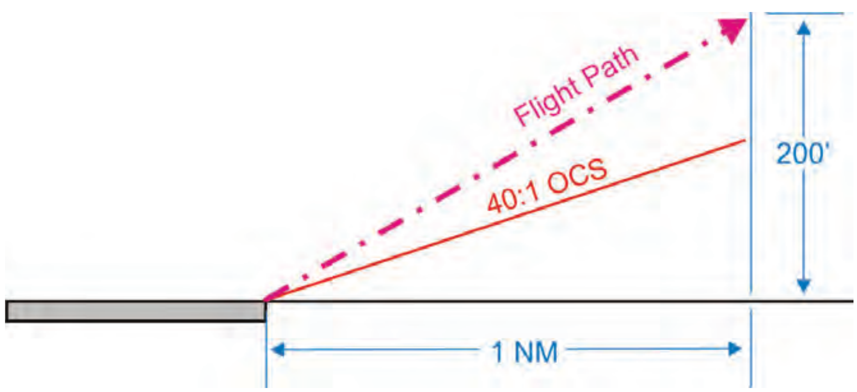
Figure 1-3. Secondary OCS



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

1.4.6 **b. (2) Develop** a VCOA procedure to an altitude that will provide obstacle clearance without a CG, and/or

1.4.6 **b. (3) Develop** a specific textual or graphic departure route to avoid the obstacle(s).

1.5 CEILING AND VISIBILITY.

1.5.1 Ceiling.

Specify a ceiling value equal to the height of the obstruction above the airport elevation rounded to the next higher 100-foot increment.

1.5.2 Visibility.

Specify a visibility value equal to the distance measured directly from the DER to the obstruction rounded to the next higher reportable value. Limit the visibility to a distance of 3 statute miles.

1.6 INITIAL CLIMB AREA (ICA).

The ICA is an area centered on the runway centerline extended used to evaluate obstacle clearance during the climb to 400 feet above DER (minimum climb gradient 200 ft/NM).

1.6.1 ICA Terms.

1.6.1 **a. ICA baseline (ICAB).** The ICAB is a line extending perpendicular to the runway centerline ± 500 at DER. It is the origin of the ICA (see figure 1-5).

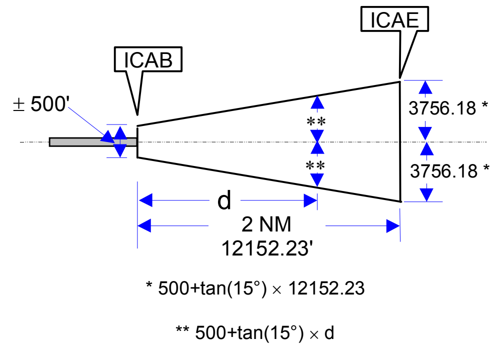
1.6.1 **b. ICA end-line (ICAE).** The ICAE is a line at the end of the ICA perpendicular to the runway centerline extended. The splay of 15° and length of the ICA determine its width (see figure 1-5).

1.6.2 Area.

1.6.2 **a. Length.** The ICA length is normally 2 NM, measured from the ICAB to the ICAE along runway centerline extended. It may be less than 2 NM in length for early turns by publishing a climb gradient, or a combination of climb gradient and reduction in TORA. The ICA may be extended beyond 2 NM to maximum length of 10 NM. A specified altitude (typically 400' above DER) or the interception of PCG route must identify the ICAE.

1.6.2 **b. Width.** The ICA origin is 1,000 feet (± 500 perpendicular to runway centerline) wide at the DER. The area splays outward at a rate of 15° relative to the departure course (normally runway centerline).

Figure 1-5. ICA



1.6.2 **c. OCS.** The OCS originates at the ICAB, normally at DER elevation (see paragraph 1.3). Apply the OCS by measuring the shortest distance from the ICAB to the obstacle and evaluate per paragraph 1.3. The MSL elevation of the ICAE is calculated using the following formula:

MSL ICAE elevation=a+b+303.81

where a=DER elevation
b=OCS origin height above DER elevation
(nominally 0)

Example: ICAE elevation=987.24+0+303.81=1291.05

BACK

CHAPTER 2. DIVERSE DEPARTURE

2.0 GENERAL.

Evaluate diverse "A" and "B" areas to a distance of 25 NM for nonmountainous areas (see figure 2-1) and 46 NM for mountainous areas. If obstacles do not penetrate the OCS, unrestricted diverse departure may be authorized; publish standard takeoff minimums.

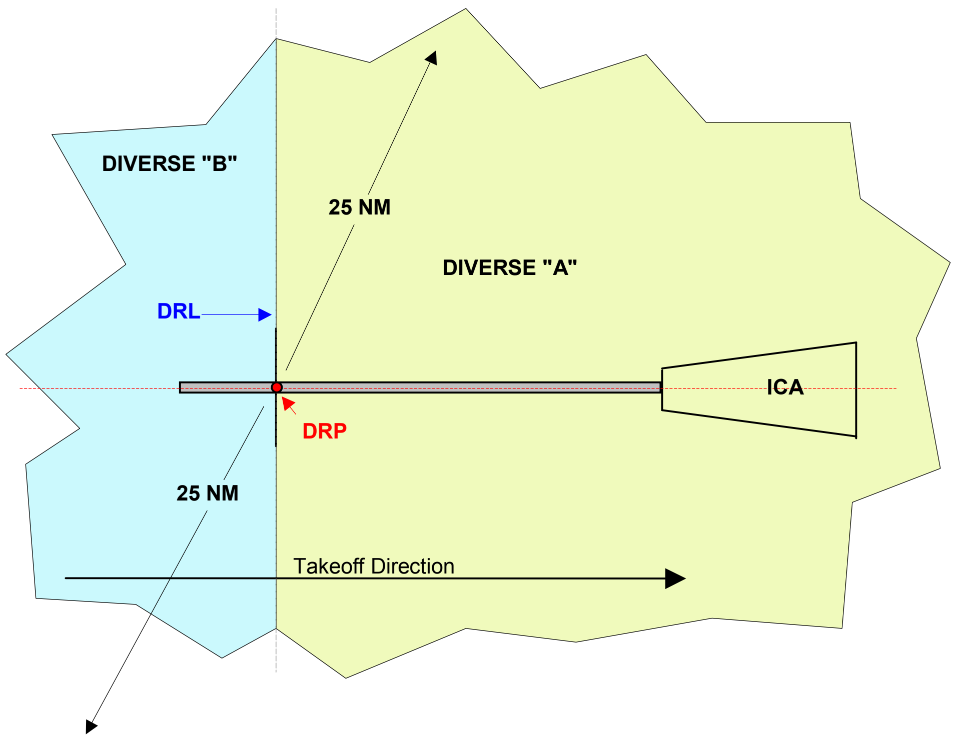
2.1 AREA. The diverse departure evaluation covers three areas:

Initial Climb Area. See chapter 1, paragraph 1.6.

Diverse A. All areas on the DER side of the DRL.

Diverse B. All areas on the SER side of the DRL.

Figure 2-1. Diverse "A" and "B" Areas



2.1.1 Initial Climb Area (ICA).

Evaluate the ICA under paragraph 1.6.

2.1.2 Diverse "A" Area.

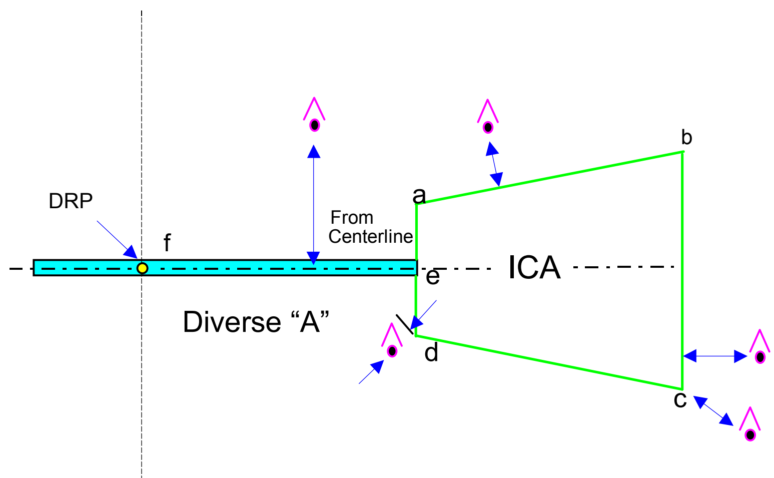
Calculate the height of the OCS at any given location in the diverse "A" area by measuring the distance from the obstacle to the closest point on the centerline of the runway between the DRP and DER, or the closest point on ICA boundary lines as appropriate (see figure 2-2). The beginning OCS elevation is equal to the MSL elevation of the ICAE.

$$h = a + \frac{d}{40}$$

where h=OCS MSL elevation at obstacle
d=distance (ft) from obstacle to closest point
a=ICAE MSL elevation

Example: $h = 1309.77 + \frac{18002.33}{40} = 1759.83$

Figure 2-2. Diverse "A" Area Evaluation



2.1.3 Diverse "B" Area.

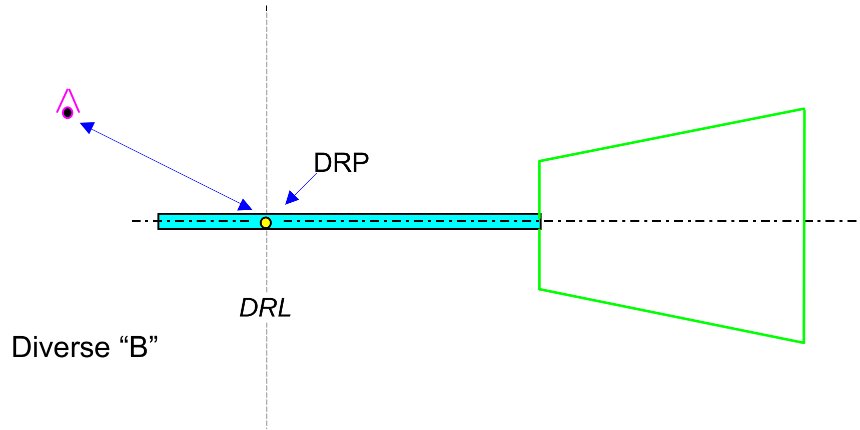
Evaluate obstacles in the Diverse "B" area by measuring the distance in feet from the obstacle to the DRP (see figure 2-3). Calculate the OCS MSL elevation at the obstacle using the following formula:

$$h = \frac{d}{40} + (b + 400)$$

where h=OCS MSL elevation at obstacle
d=distance (ft) from obstacle to DRP
b=Airport MSL elevation

Example: $h = \frac{8500}{40} + (1283.22 + 400) = 1895.72$

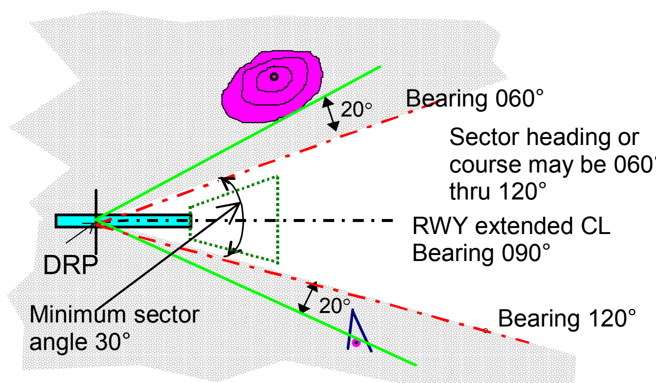
Figure 2-3. Diverse "B" Area



2.2 DEPARTURE SECTORS.

Where OCS penetrations prevent unrestricted diverse departure, consider constructing sectors within the diverse areas where departure flight is prohibited. Departure instructions must assure the aircraft will maneuver clear of the prohibited sector boundaries. Separate sector boundaries from obstacles via a buffer established by the 20° splay from the DRP. The minimum angle between sector boundaries is 30°. The ICA must be protected at all times (see figure 2-4).

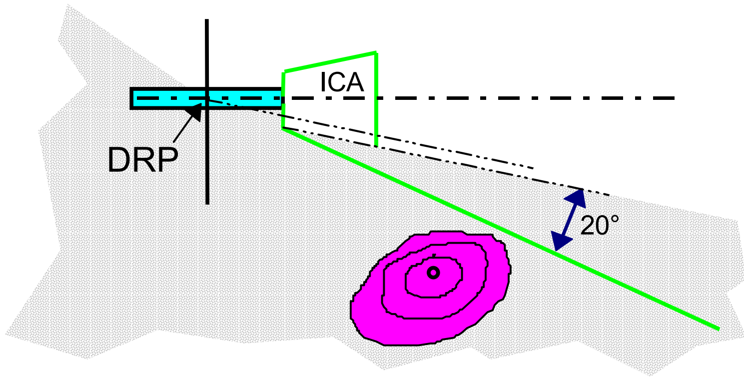
Figure 2-4. Minimum Sector Area



2.2.1 Boundary Based on the ICA.

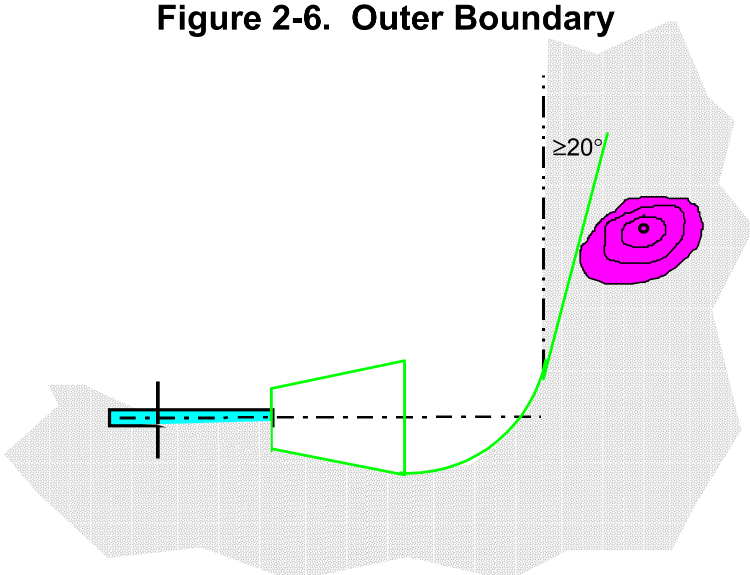
When the 20° splay from the DRP cuts across the ICA, construct a line 20° relative to the side of the ICA. To protect the ICA, no obstacle may lie inside this line (see figure 2-5).

Figure 2-5. Boundary Based on ICA



2.2.1 a. **Outer Boundary involving a Turn.** Locate the turn point on runway centerline (extended) and establish the ICAE. Construct the outer boundary from the ICAE, using table 1-1 for selection of the outer boundary radius. Construct a line from the obstacle tangent to the outer boundary radius. Establish the outer boundary buffer 20° from this line on the maneuvering side. Begin the 20° buffer at the tangent point where the obstacle line intercepts the arc (see figure 2-6).

Figure 2-6. Outer Boundary



2.2.2 **Defining Sector Boundaries.**

Construct boundaries to define each sector. Sector boundaries originate at the DRP, or are defined tangentially from the outer boundary radius (see figure 2-7A). Define and publish sector boundaries by reference to aircraft magnetic headings. Sector "headings" shall be equivalent to the magnetic bearing of the sector boundaries from their origins.

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

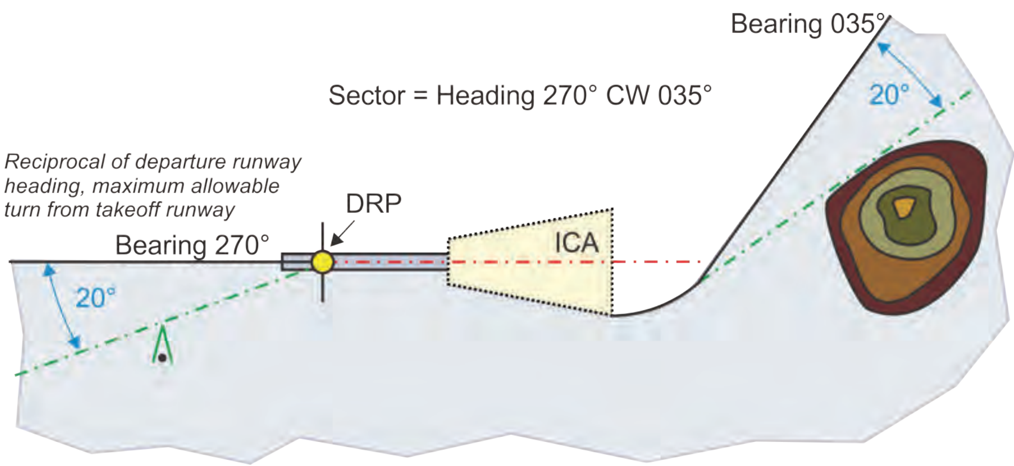
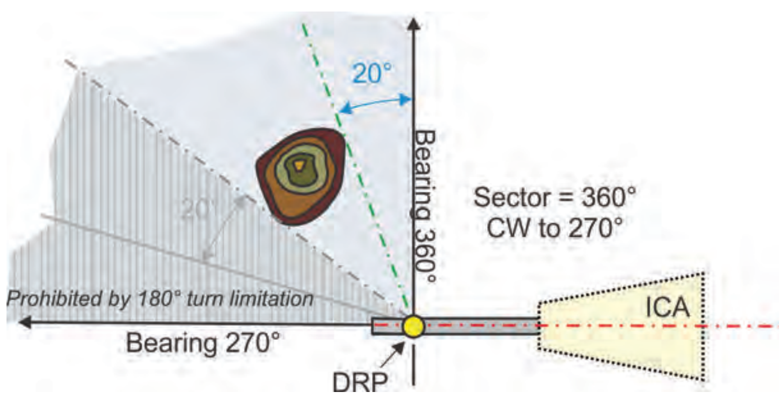


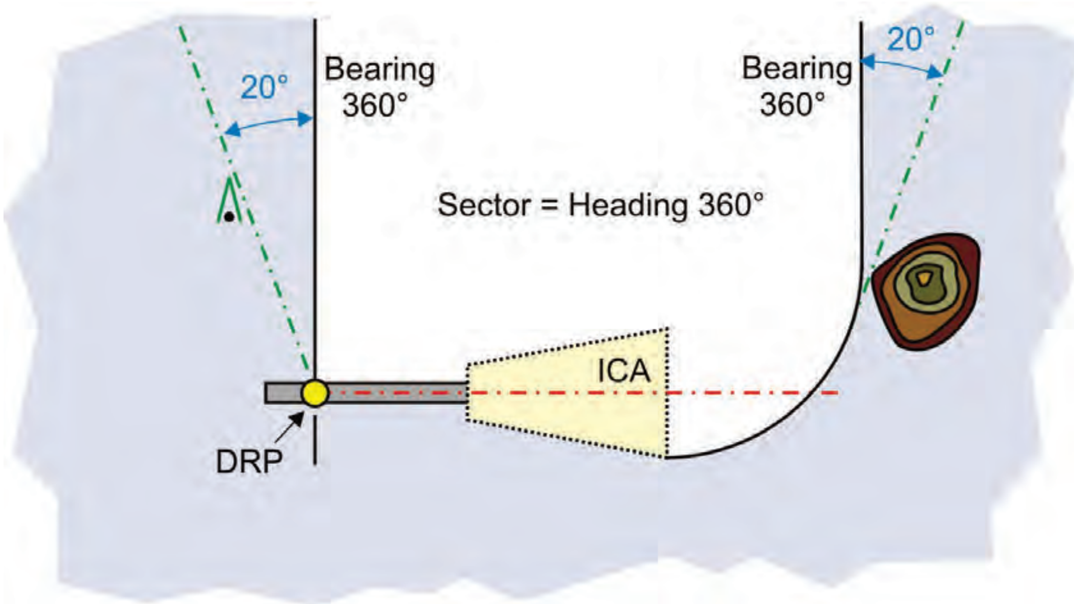
Figure 2-7B shows a sector of 360 degrees clockwise to 270 degrees. Heading 270 degrees could be assigned; however, the maximum turn to the right is a heading not in excess of the reciprocal of the takeoff runway heading.

Figure 2-7B. Maximum Heading Limitation



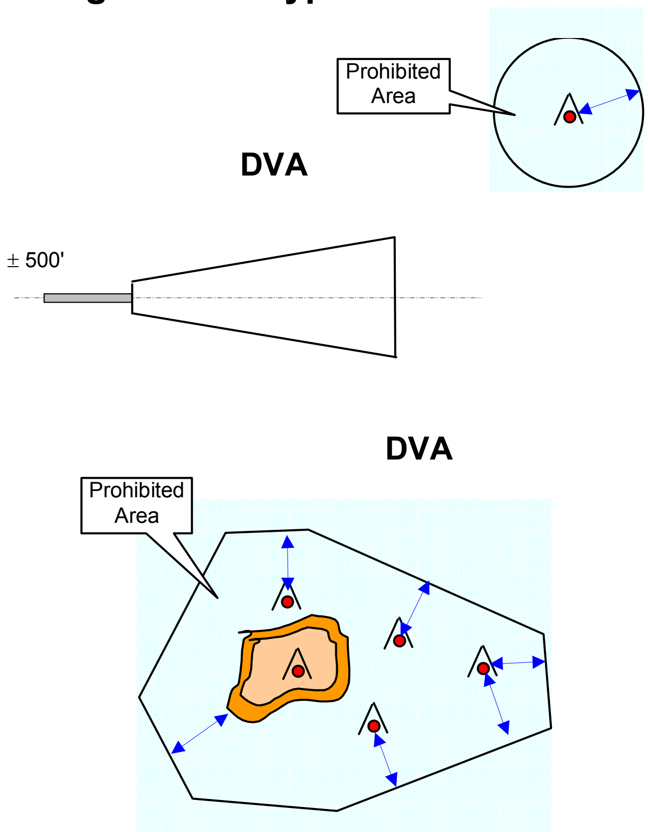
2.2.3 **b. Assign a single heading for a sector** which has parallel boundaries. The heading must parallel the boundaries. Figure 2-8 shows heading 360 degrees as the only heading allowable.

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.

Figure 2-9. Typical DVA Areas



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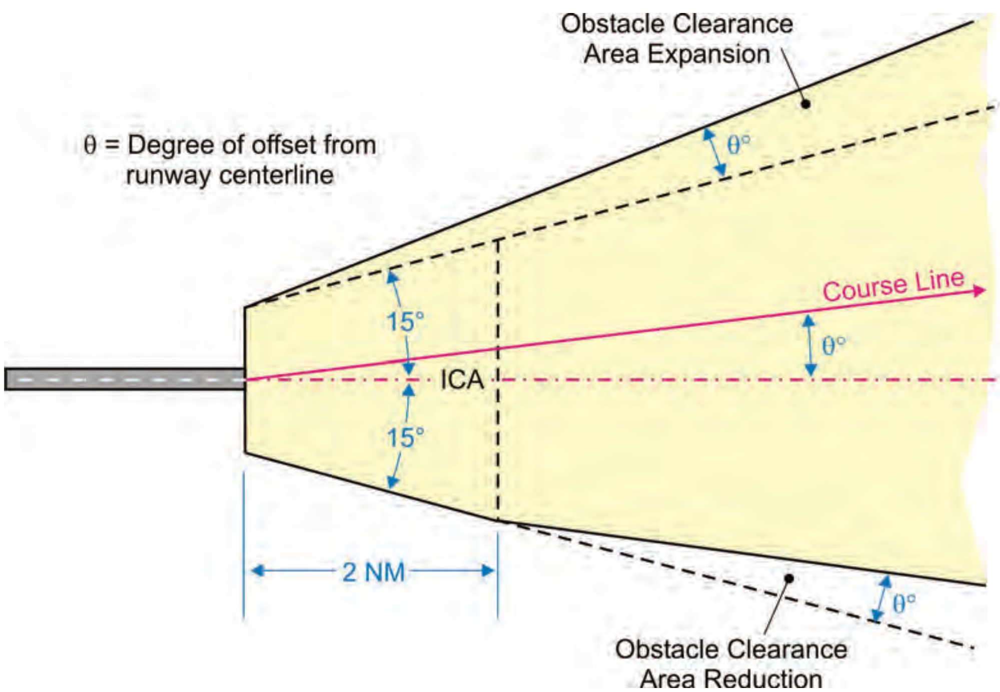
CHAPTER 3. DEPARTURE ROUTES

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.

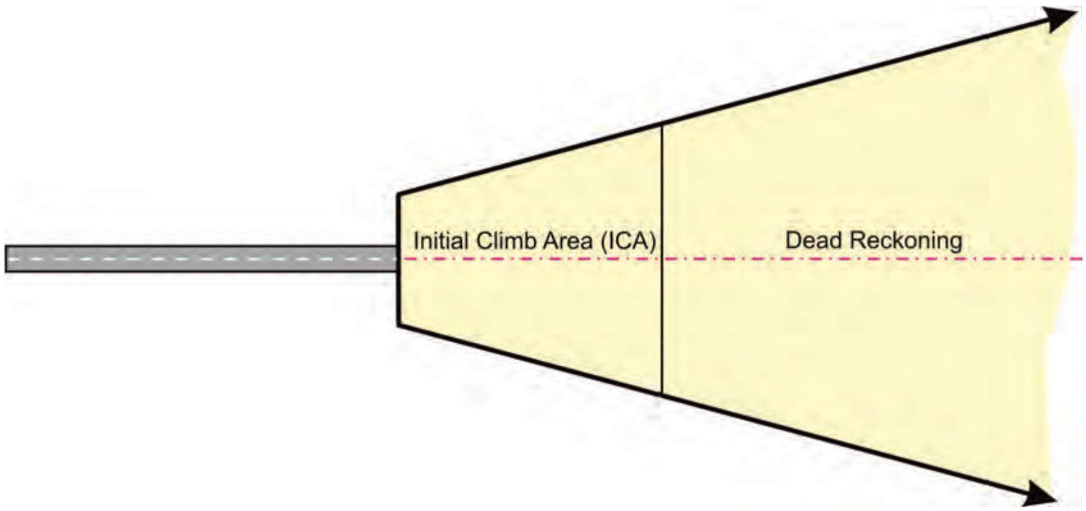
Figure 3-1. Turn ≤15 degrees at DER



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 ($\frac{1}{2}W_P$), and the width of the secondary area (W_S).

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

$$W_S = k_S \times D$$

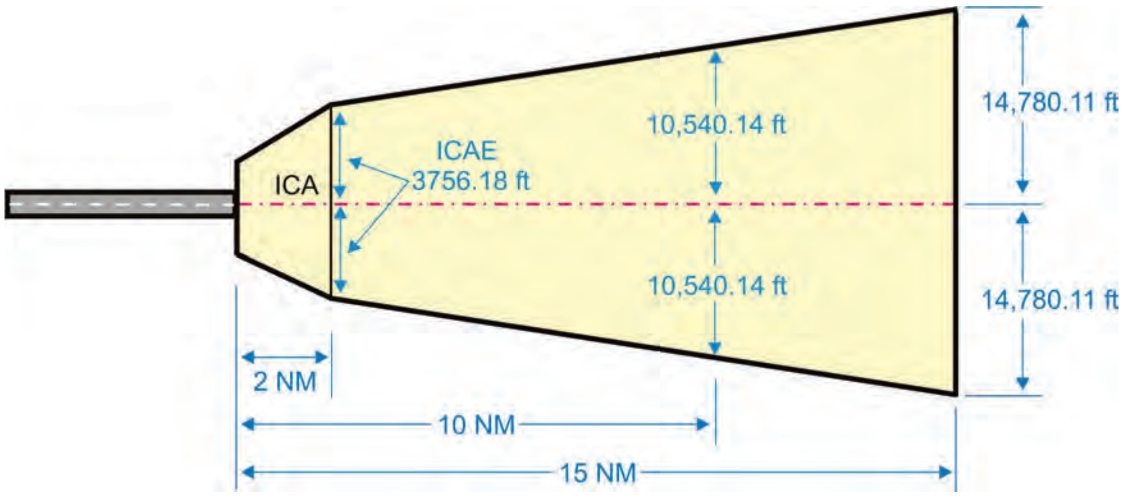
Table 3-1.

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

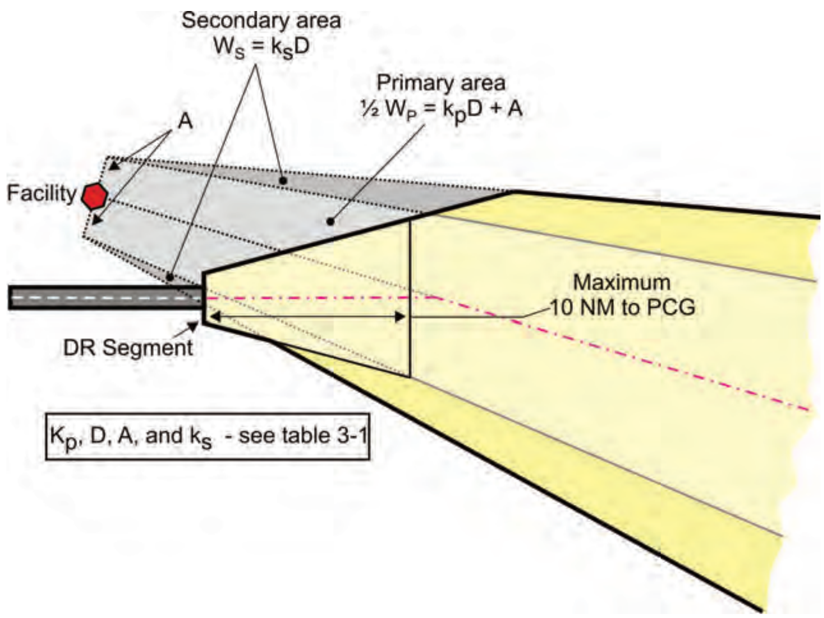
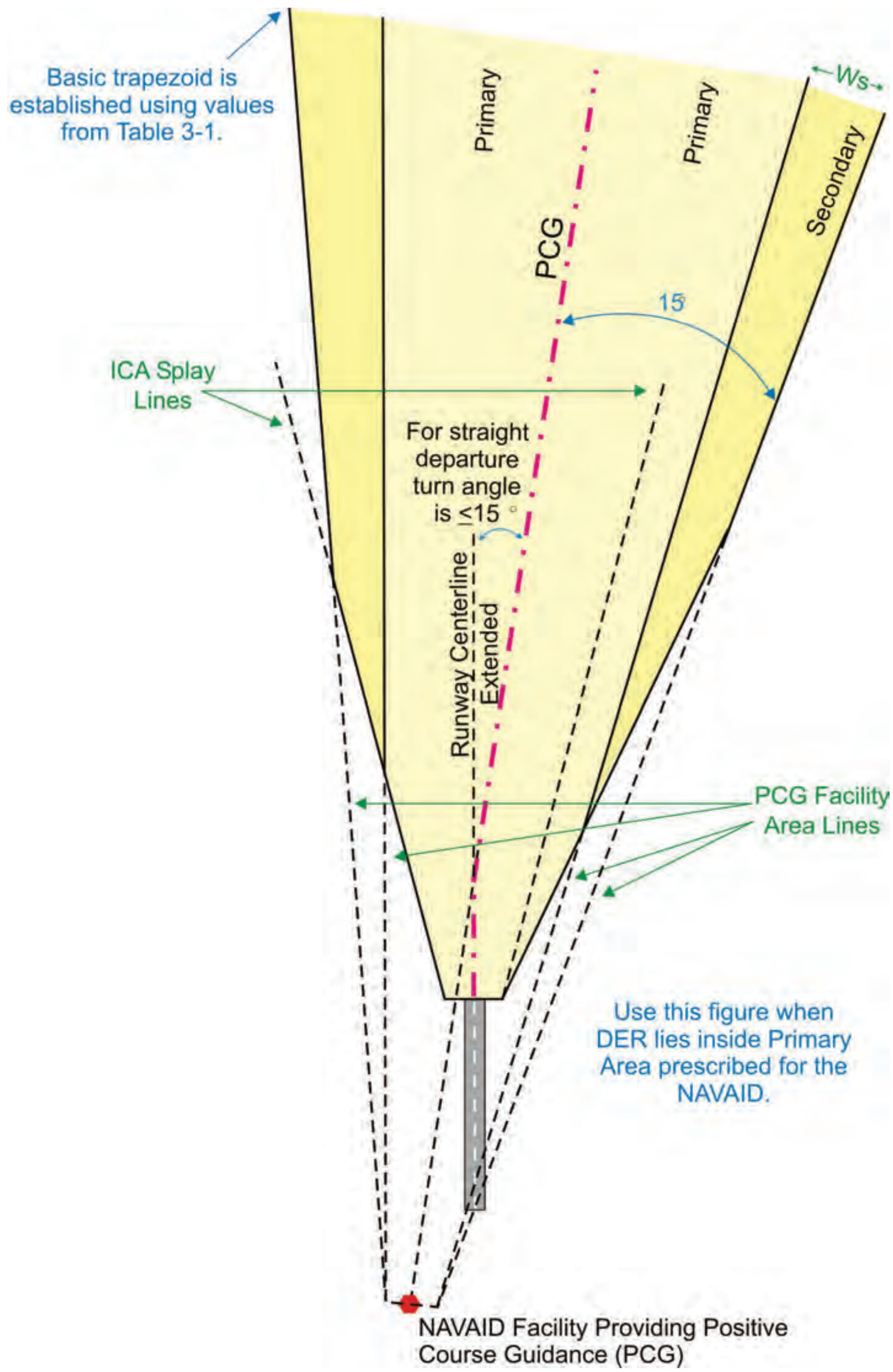


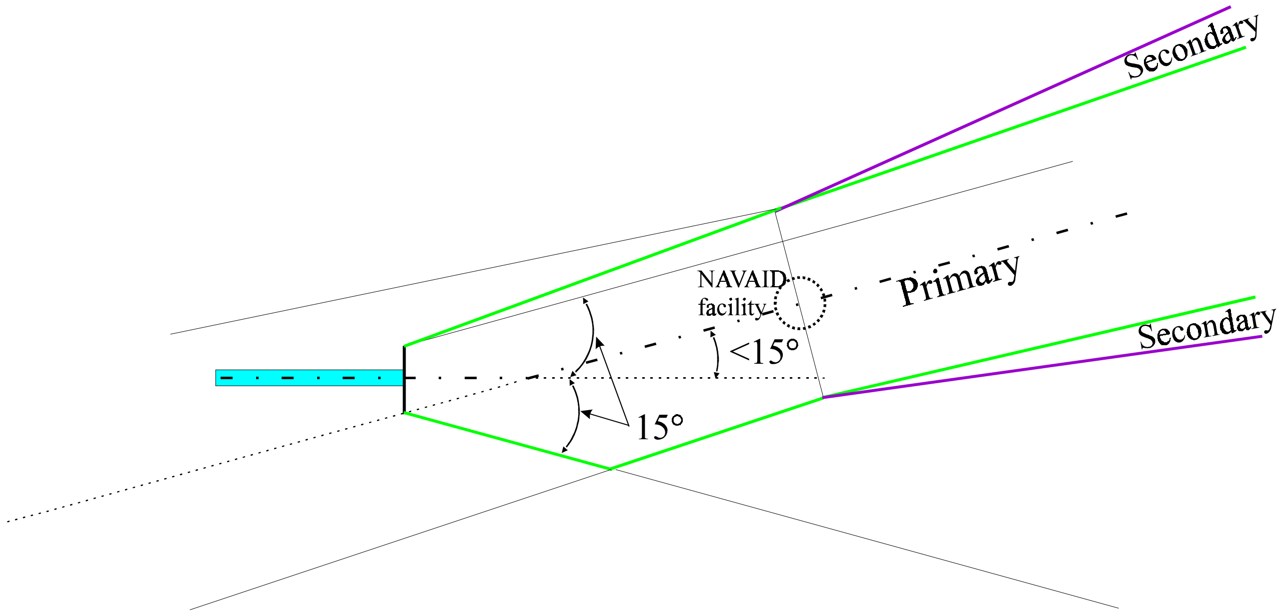
Figure 3-5. DER within Primary Area Facility



3.3.3 **Secondary Area Obstructions.** Secondary areas may be constructed and employed where PCG is provided.

3.4 **RESERVED.**

Figure 3-6. Facility Area Relationship



3.5 TURNING SEGMENT CONSTRUCTION.

3.5.1 **General.** Construct turning segments when the course change is more than 15°. Establish an ICA. For outer boundary radius use table 3-2 and apply paragraphs 3.5.1a through 3.5.1d, as appropriate. Use next higher airspeed in table 3-2 if specific speed is not given.

3.5.1 **a. For turns below 10,000 feet** mean sea level (MSL), use 250 KIAS unless a speed restriction other than 250 KIAS is noted on the procedure for that turn. Use 200 KIAS for a minimum speed for Category C and 230 KIAS for Category D aircraft.

3.5.1 **b. For turns at 10,000 feet and above,** use 310 KIAS unless a speed restriction not less than 250 KIAS above 10,000 through 15,000 feet is noted on the procedure for that turn. Above 15,000 feet, speed reduction below 310 KIAS is not permitted.

3.5.1 **c. When speeds greater than** 250 KIAS are authorized below 10,000 feet MSL, and speeds greater than 310 KIAS are authorized at or above 10,000 feet MSL, use the appropriate speed in table 3-2.

3.5.1 **d. Use the following standard** Note to publish a speed restriction: "Do NOT exceed (speed) until CHUCK (fix)."

Table 3-2

Primary Area Outer Boundary radius (R1)				
Aircraft Speeds	**90**	**120**	**150**	**175**
Turn radii:				
Below 10,000′ MSL	0.9	1.4	1.9	2.4
10,000′ MSL and above	1.4	2.0	2.7	3.3
Aircraft Speeds	**180**	**210**	**240**	**250**
Turn radii:				
Below 10,000′ MSL	2.5	3.2	3.9	4.2
10,000′ MSL and above	3.4	4.3	5.2	5.5
Aircraft speeds	**270**	**300**	**310**	**350**
Turn radii:				
Below 10,000′ MSL	4.7	5.6	6.0	7.3
10,000′ MSL and above	6.2	7.3	7.7	9.3

(Speeds include 60-knot omni winds below 10,000′ MSL; 90-knot omni winds at 10,000′ and above; bank angle 23°.)

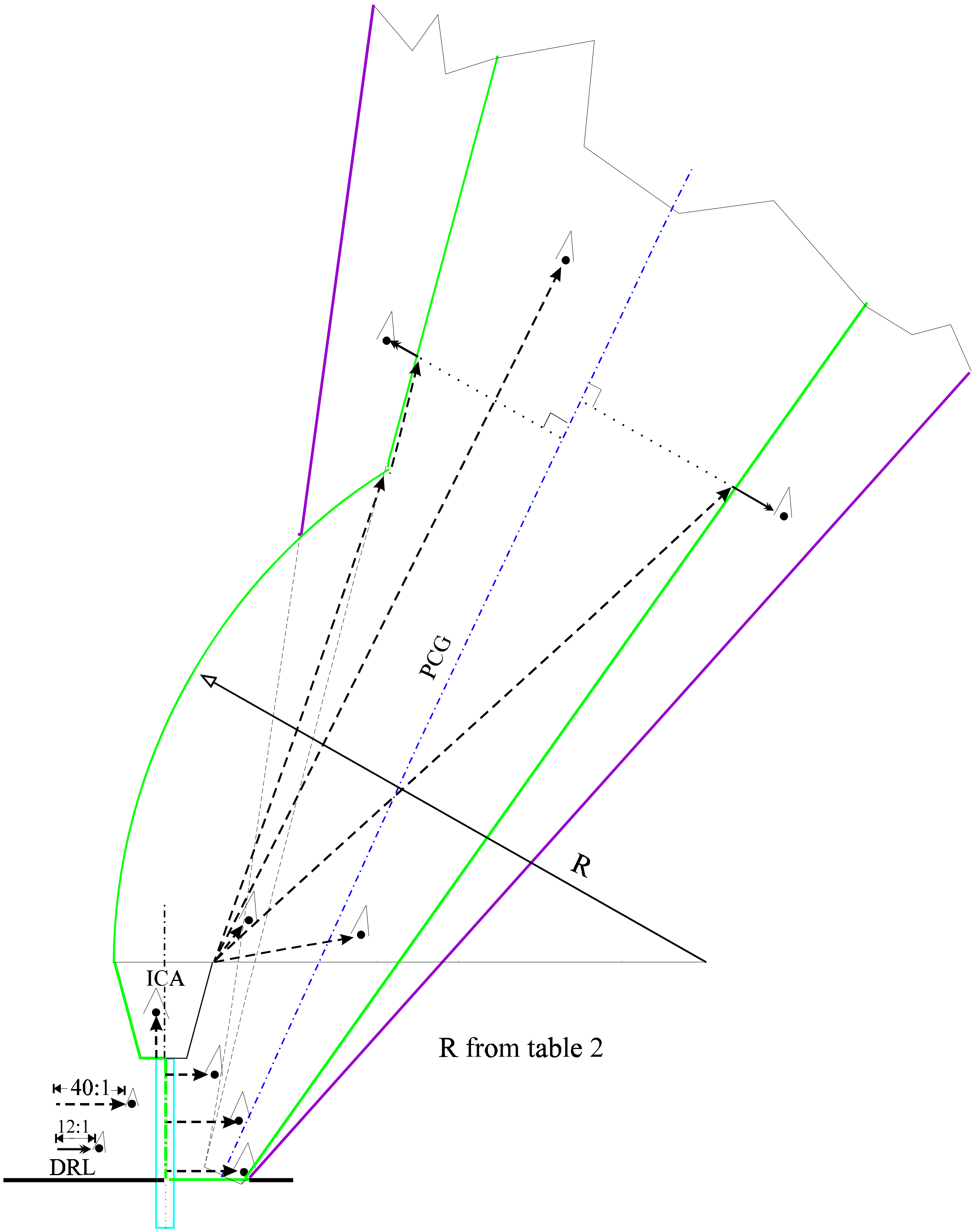
3.6 RESERVED.

3.7 TURN TO PCG.

3.7.1 **Extend the ICA boundaries** as necessary to intersect the boundaries appropriate to the PCG provided. Where the ICA outer boundary will not intersect the PCG boundary, construct an outer boundary radius from the outer edge of the ICA to intersect the PCG boundary. For the radius length, use table 3-2 or the width of the end of ICA, whichever is longer (see figure 3-7).

3.7.2 **Specify a course, not aligned with the runway centerline,** to intersect a PCG course. The amount of turn is not restricted.

Figure 3-7. ICA Joining PCG Area



3.8 MULTIPLE TURNS.

Use table 3-1 to establish dimensions of basic trapezoids.

3.8.1 **Climb to Altitude and Turn; Turns less than 90°.** See figure 3-8. Construct a line from departure reference point (DRP) to edge of obstacle area at the fix denoting the second turn point. Extend splay of ICA to line A,B, (perpendicular to runway centerline extended), where altitude is reached for the turn. Measure out runway centerline extended using SCG.

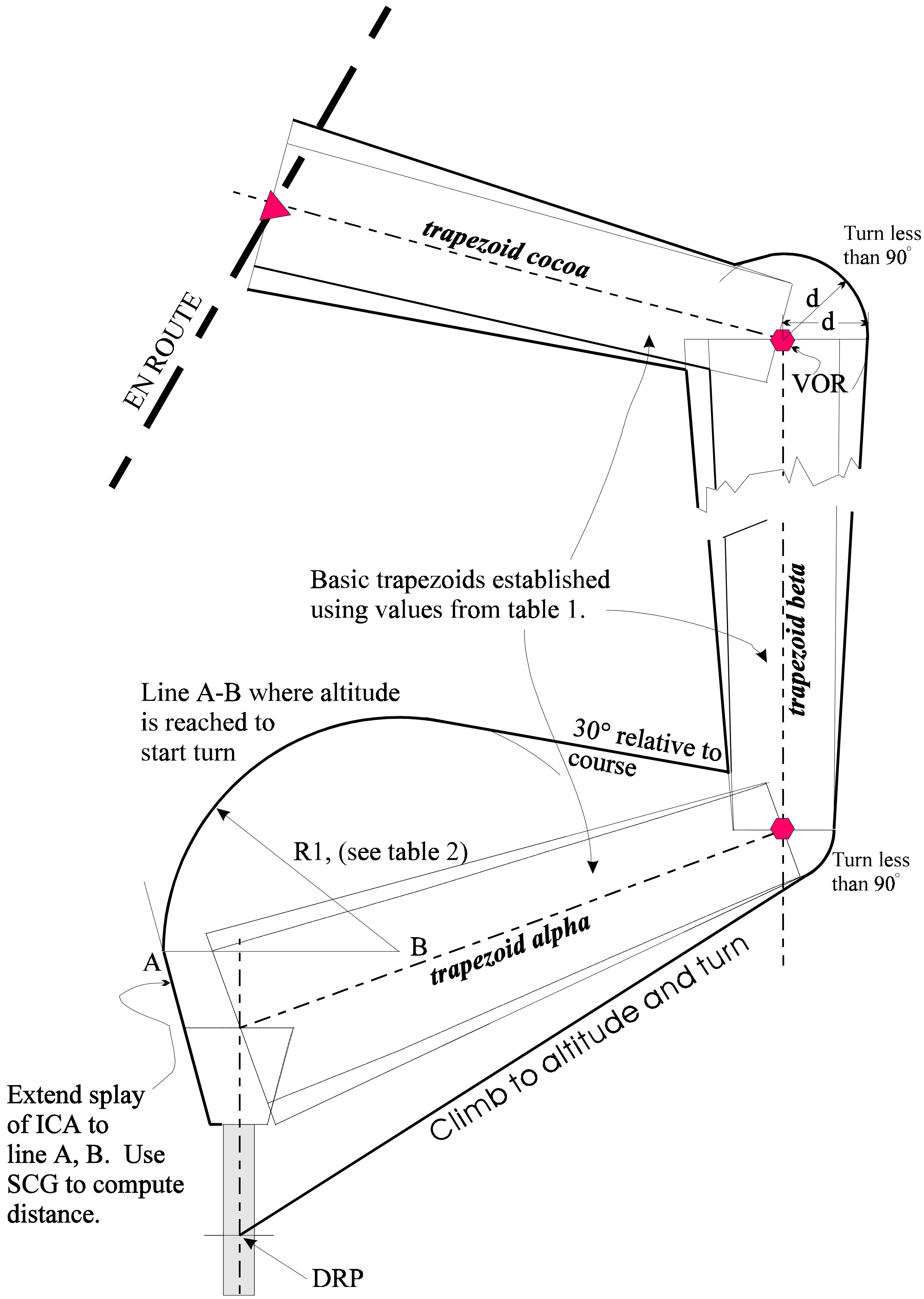
3.8.1 **a. Align the centerline** of trapezoid alpha, through point C (end of ICA on runway centerline extended).

3.8.1 **b. Construct an arc from point A** using radius R1 (table 3-2) centered on point B. Construct a tangent from the arc to the boundary of the secondary area of the next segment, (trapezoid beta), 30° relative to trapezoid alpha centerline.

3.8.1 **c. Construct trapezoid beta.** Extend the outer boundary area, radius “d”, to join trapezoid cocoa. Inside boundaries join at the primary and secondary intersections.

3.8.1 **d. Construct trapezoid cocoa** and its associated segment, if necessary, to join en route structure.

Figure 3-8. Climb to an Altitude and Turn Direct to Fix with Multiple Turns.



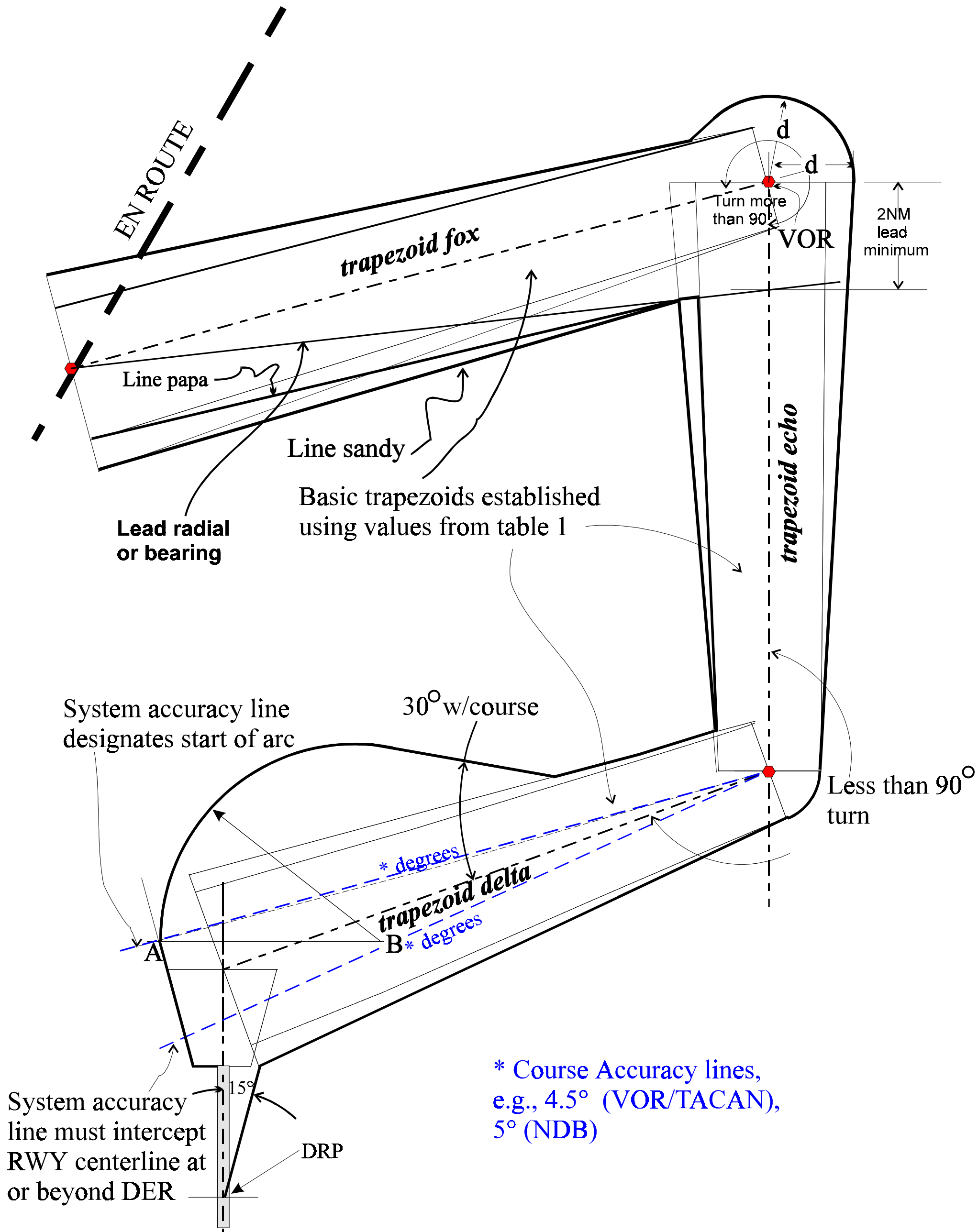
3.8.2 **Climb to Intercept a Course.** See figure 3-9. Construct a 15° splay relative to runway centerline from the departure reference point (DRP) to the secondary boundary of trapezoid delta (inside of turn) area. System accuracy line of delta must intercept runway centerline at or beyond DER.

3.8.2 **a. Extend the splay of ICA to line A, B.** System accuracy line of trapezoid delta (outside of turn) intercepts the ICA splay at point A.

3.8.2 **b. Construct an arc from point A** using radius R1 (table 3-2) centered on point B. Construct a tangent from the arc to the boundary of next segment (trapezoid echo) 30° relative to trapezoid delta centerline.

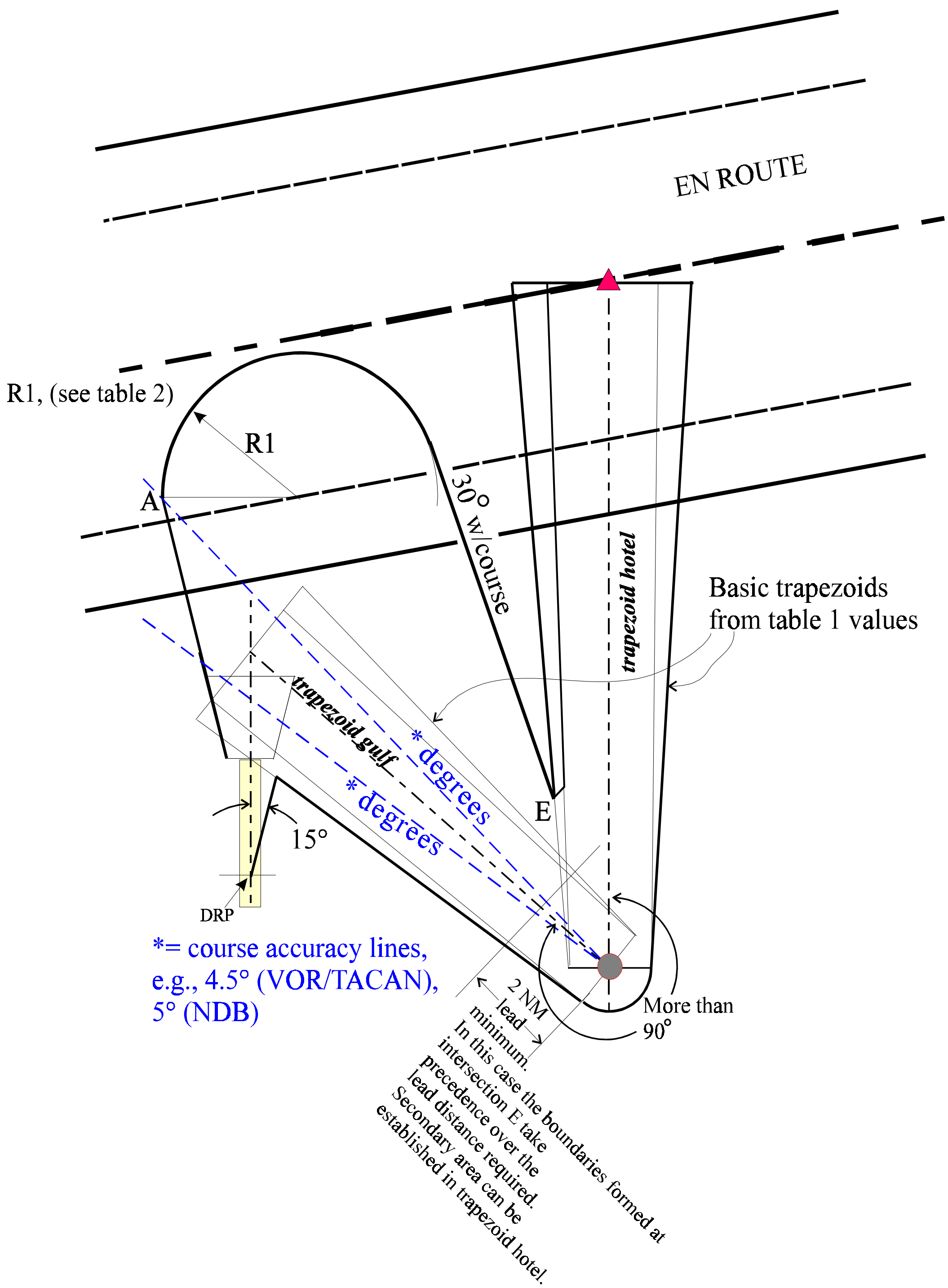
3.8.2 **c. Construct trapezoids echo and fox** as necessary. Provide a 2-NM lead area when turns are more than 90°, prior to the "VOR" turning into trapezoid fox. Specify a 2-mile lead when possible with a radial, bearing, or DME. When unable to identify the lead point, construct and provide a 2-mile lead area for evaluation of obstacles. Outside protection arc must be as large as the end of the trapezoid, i.e., "d" at fix jiffy. In the segment containing trapezoid fox, note primary "line papa" and secondary "line sandy" originate from the 2-mile lead of trapezoid echo.

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



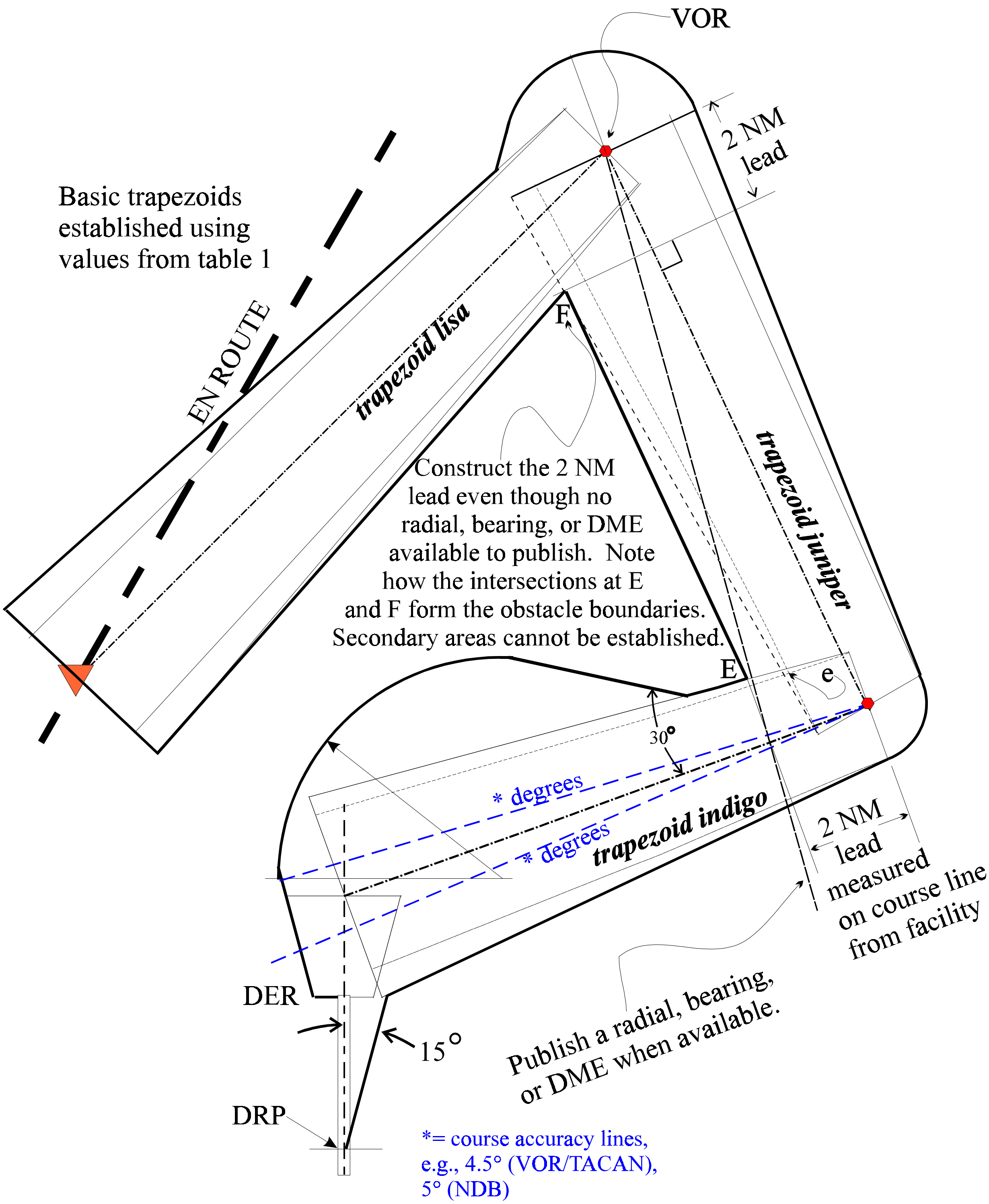
3.8.3 **Figure 3-10 illustrates multiple turns more than 90°.** Initial course intercepts positive course of trapezoid gulf after takeoff from DER. The obstacle area radius is constructed from point A with a tangent 30° relative to the course in trapezoid gulf. The area formed around the intersection of E with trapezoid hotel takes precedence over the 2-NM lead requirement. Primary and secondary areas can be established on the inside of the turn in trapezoid hotel because the 2-mile lead does not cut off any of the primary area.

Figure 3-10. Climb to Intercept Course.



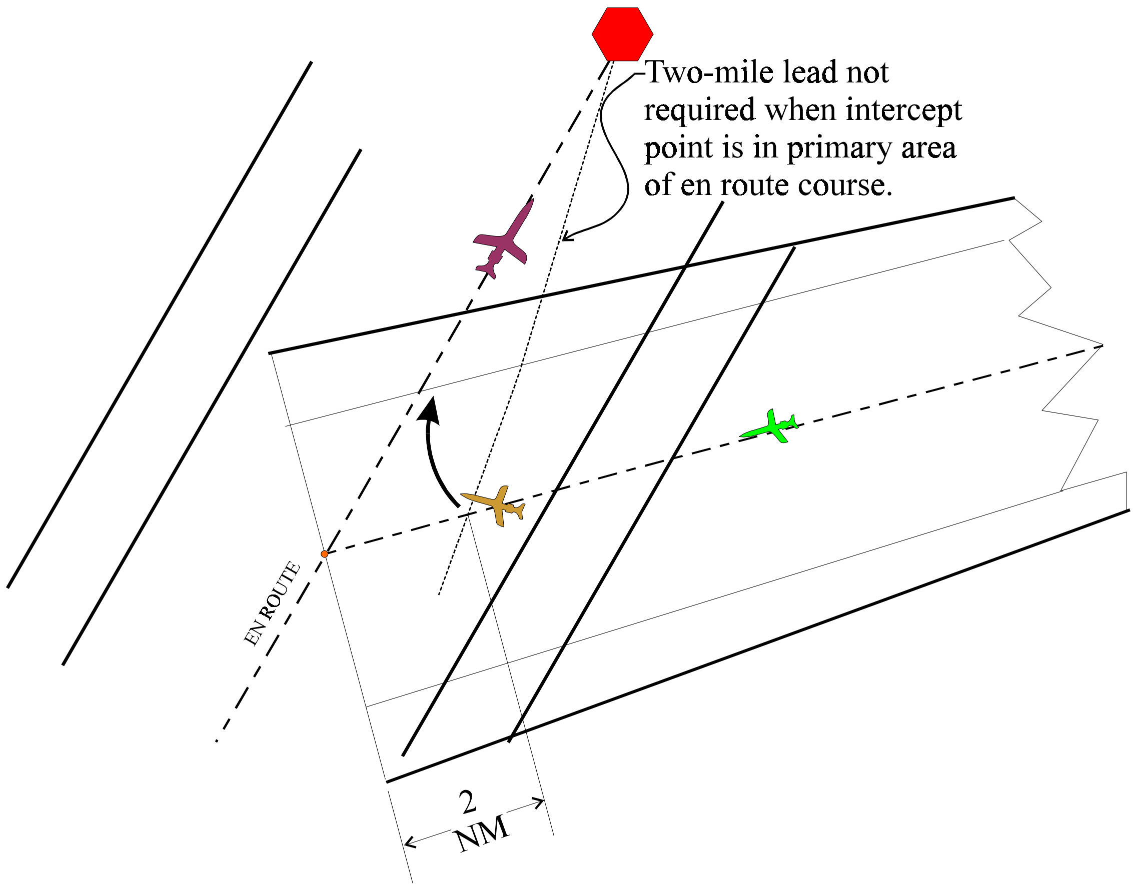
3.8.4 **Figure 3-11 illustrates multiple turns more than 90°.** Publish either a radial, bearing, or a DME when available. Construct a 2-NM lead even though no radial, bearing, nor DME is available. This provides a lead area for the pilot's early turn. Note how the intersections at E and F form the boundaries of obstacle clearance areas. Point E is established abeam the 2-mile lead. The dark lines around point E form a primary area boundary. A secondary area cannot be established on the inside area of trapezoid juniper because the 2-mile lead forms the area that takes precedence over the normal primary and secondary areas at "e".

Figure 3-11. Multiple turns.



3.8.5 **Figure 3-12 illustrates the 2-mile lead** not required when lead point is within primary area of en route course.

Figure 3-12. Turn on to En Route Course.



3.8.6 **Evaluation of Multiple Turn Areas.** See figures 3-13 and 3-14.

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

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

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

3.8.6 **d. Climbing in a Holding Pattern.** When a climb in a holding pattern is used, no obstacle shall penetrate the holding pattern obstacle clearance surface. This surface begins at the end of the segment, F-G, figure 3-14, leading to the holding fix. Its elevation is that of the departure OEA at the holding fix. It rises 40:1 from the nearest point of the F-G line to the obstacle in the primary area. It also rises 40:1 to the edge of the primary area of the holding pattern abeam an obstacle in the secondary area of the holding pattern. In the secondary area, the surface rises 12:1 to the obstacle measuring the shortest distance between the obstacle and the edge of the primary area (see figure 3-14). The holding pattern altitude must have a level surface evaluation of 1,000 feet.

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

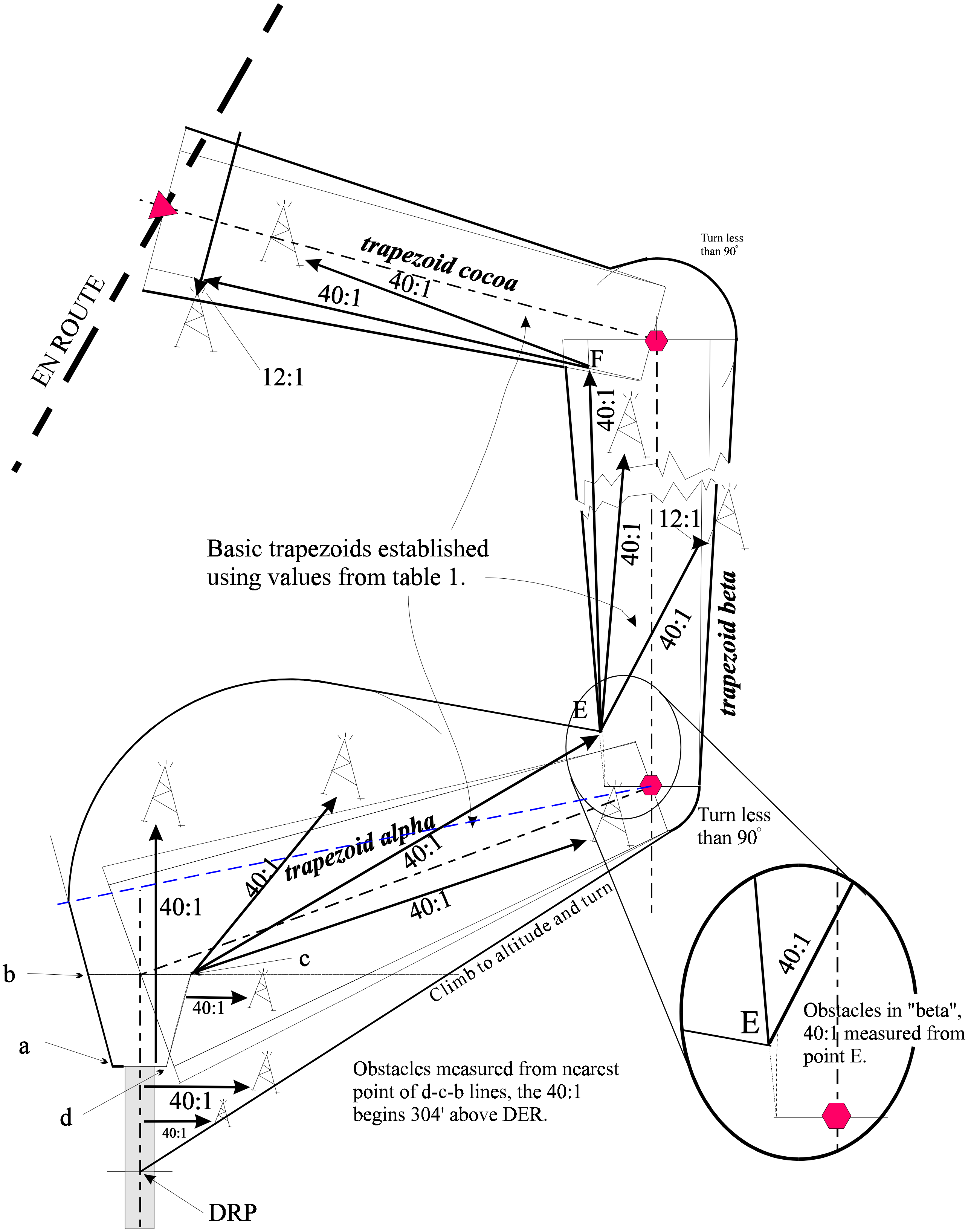
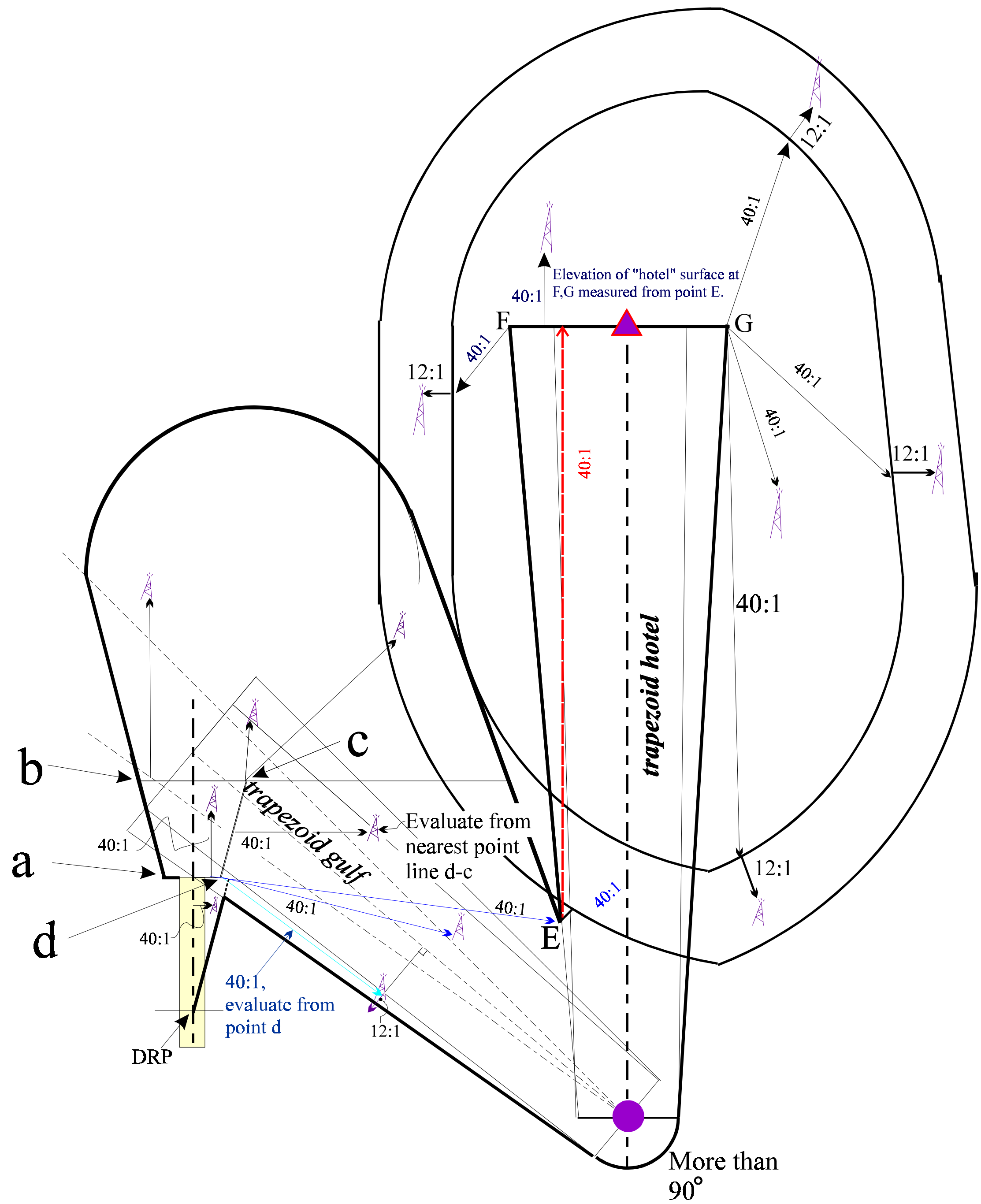


Figure 3-14. Climb in a Holding Pattern, Turns More Than 90 Degrees Evaluation.



CHAPTER 4. VISUAL CLIMB OVER AIRPORT (VCOA)

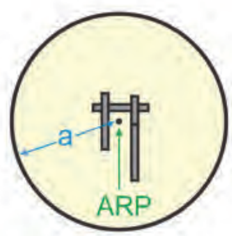
4.0 GENERAL.

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.

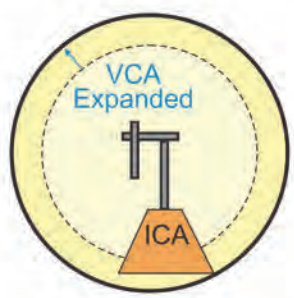
Figure 4-1. VCA



a=R1 (Table 1-3) plus the Distance from ARP to most Distant DER

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.



The VCA Must Completely Encompass the ICA.

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.

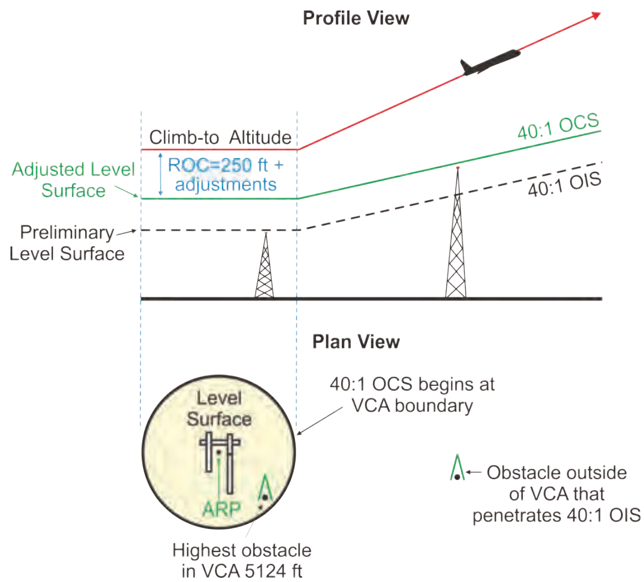
Identify the highest obstruction within the visual climb area (VCA). This is the preliminary height of the VCA level surface. Evaluate a 40:1 surface from the edge of the level surface. If the 40:1 surface is penetrated, raise the VCA level surface height by the amount of the greatest penetration (see 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

$$\text{Example: } CG = \frac{3379 - 2100}{0.76 \times 5.34} = 315.15 \text{ ft/NM}$$

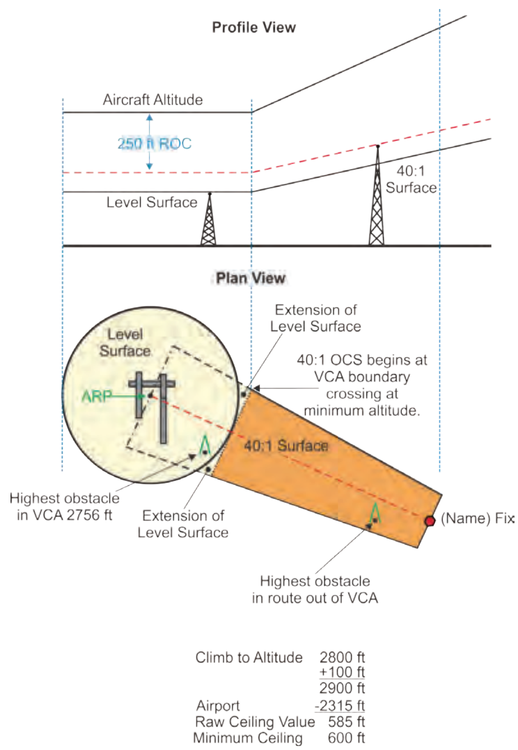
Calculate altitude (alt) that the CG may be discontinued:

$$alt = b + (d \times CG)$$

Example:

$$alt = 2100 + (5.34 \times 316) = 3787.44 \text{ round up to } 3800'$$

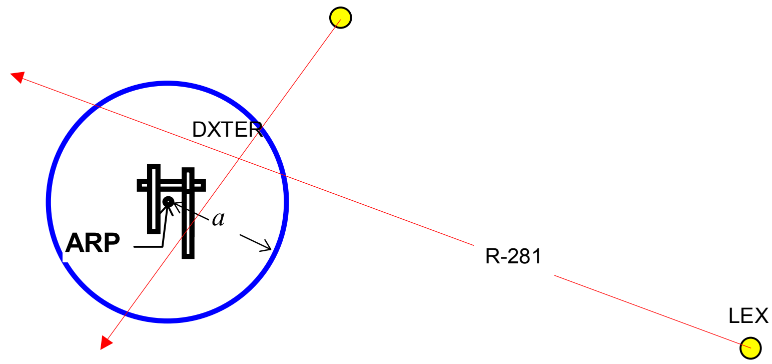
Figure 4-4. Route Out of VCA



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 westbound at or above 6,000′, then climb to FL180 via AMA R-098 to AMA VORTAC", "Climb in visual conditions to cross DXTER eastbound at 5,000′, then via LEX R-281 to LEX." (see figure 4-5).

Figure 4-5. VCOA Departure Route



4.3 CEILING AND VISIBILITY.

Publish a ceiling that is the 100-foot increment above the "climb-to" altitude over the VCA. Obstacles inside the VCA are subject to see and avoid maneuvers. Obstacles outside the VCA may be avoided by publishing a ceiling above an altitude that must be attained inside the VCA over a specified fix or identifiable point. From this altitude, a 40:1 OCS from the VCA boundary clears all obstacles outside the VCA omni-directionally, or along a route of flight (see figures 4-3, 4-4). Determine the published visibility from table 4-2.

Table 4-2. Visibility

Altitudes MSL	2,000'	5,000'	10,000'
Speed KIAS			
90	1	1	1
120	1	1	1 1/4
180	1 1/2	2	2 1/2
210	2	2 1/2	2 3/4
250	2 1/2	3	3
310	3	3	3
350	3	3	3

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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.

DoD Only: 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.

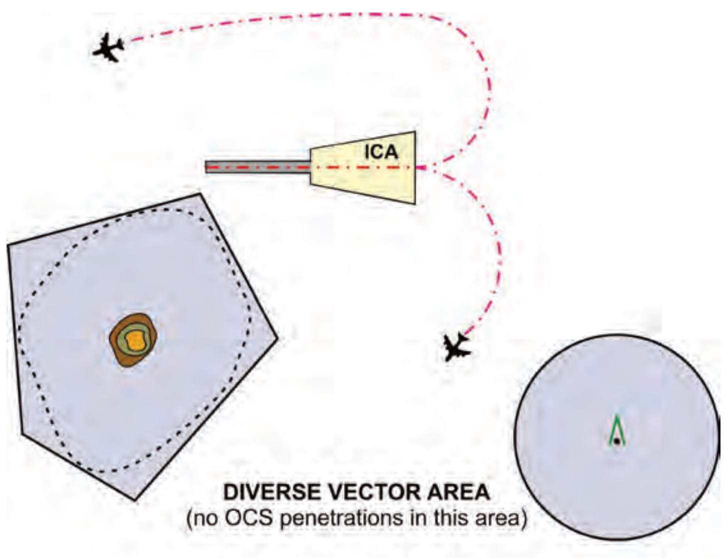
a. Isolate Penetrating Obstacles. This method is generally suitable for isolating single obstacles, or a group of obstacles in proximity to each other. Boundaries surrounding obstacles that penetrate a departure runway's OCS are established that define an area where vectors below the MVA/MIA are prohibited. 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.

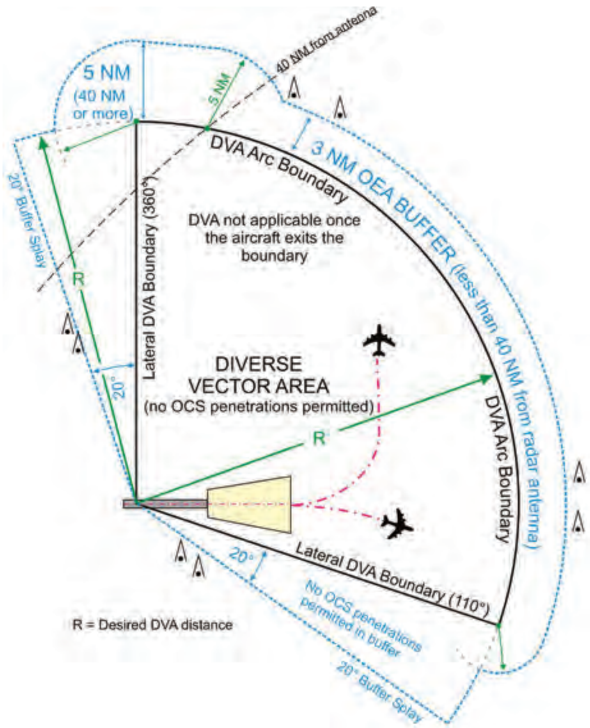
(3) Isolation areas must be located so that sufficient room to vector departing aircraft is provided which would allow ATC to issue vectors as necessary to avoid the areas. This determination must be made in collaboration with the air traffic facility.

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.

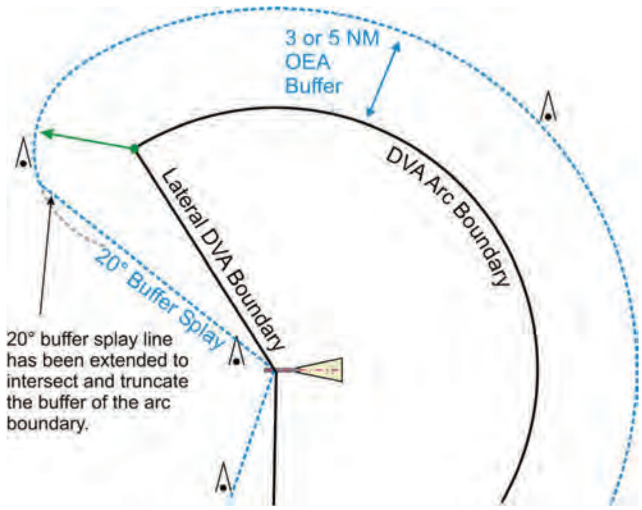
(3) An OEA buffer expands outward from the DVA boundaries. The buffer of the DVA arc boundary must meet the distance requirements of volume 1, chapter 10, paragraph 10.2.4a, except a 5 NM buffer always applies to a DVA that will be used by an ARTCC. The lateral buffers begin at DRP and splay outward 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

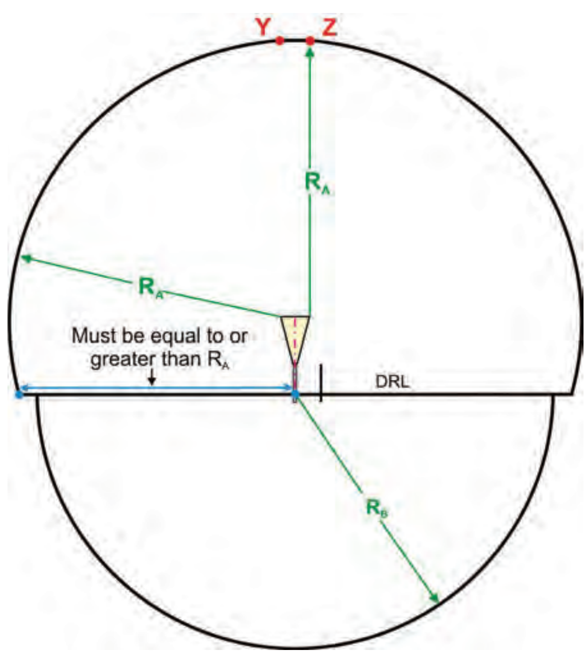


Figure 5-5. Construction with Points W and X

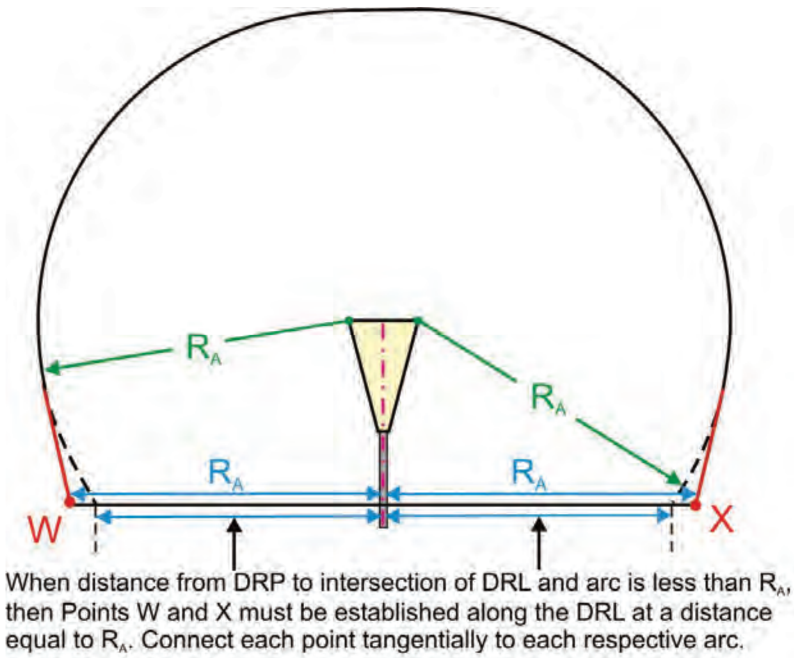


Figure 5-6. MVA Chart With Applicable Buffer Areas

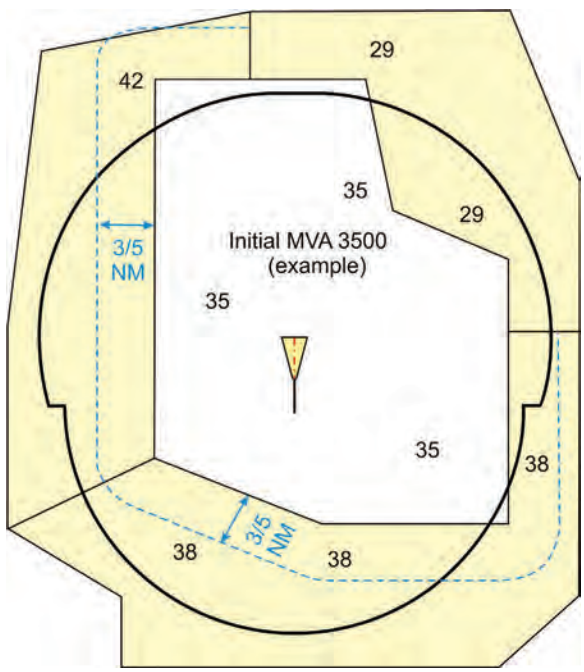


Figure 5-7. Obstacle Search Area

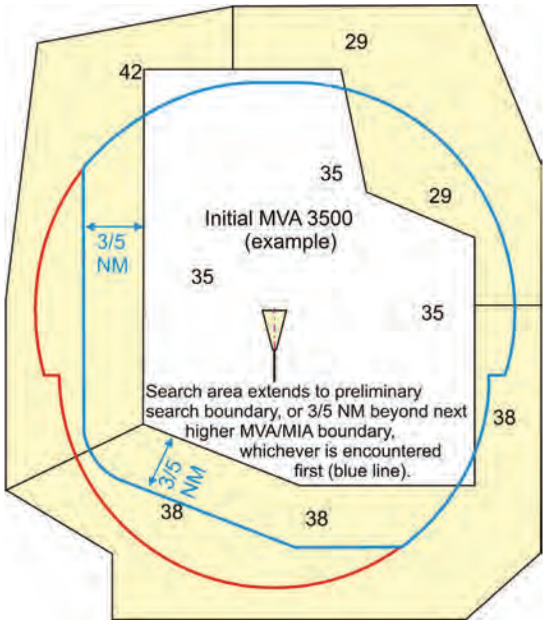
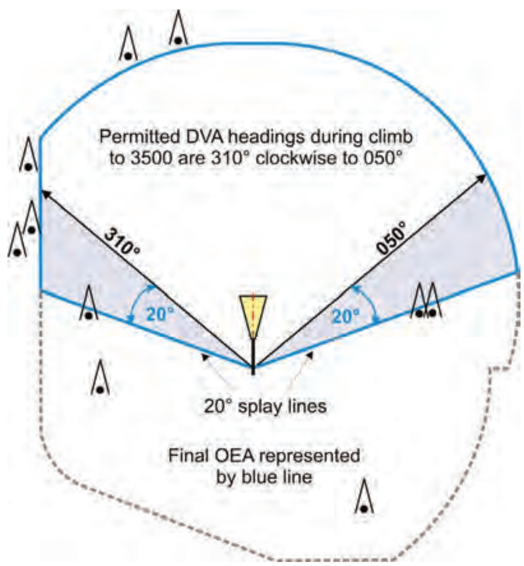


Figure 5-8. Permitted DVA Headings Based on Obstacles

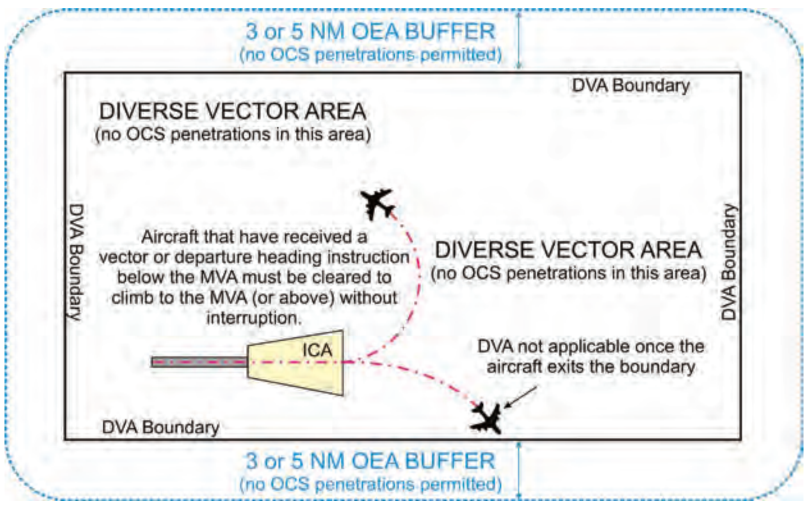


d. Define an Area (DoD Option). An area may be defined which excludes all obstacles (low, close-in obstacles are permitted) that penetrate the departure OCS (see figure 5-9).

(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.

FAA ORDER **8260.3B**

Army TM 95-226
Navy OPNAV Inst. 3722.16C
Coast Guard CG 318
Air Force AFMAN 11-226(I)

UNITED STATES STANDARD
FOR
TERMINAL
INSTRUMENT
PROCEDURES
(TERPS)

VOLUME 5

HELICOPTER AND POWERED LIFT INSTRUMENT PROCEDURE CONSTRUCTION

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