JULY 1976

UNITED STATES STANDARD

FOR

TERMINAL INSTRUMENT PROCEDURES

(TERPS)

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THIRD EDITION

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

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DEPARTMENT OF THE ARMY TECHNICAL MANUAL
DEPARTMENT OF THE NAVY
DEPARTMENT OF THE AIR FORCE MANUAL
UNITED STATES COAST GUARD MANUAL
FEDERAL AVIATION ADMINISTRATION HANDBOOK

TM 95-226
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UNITED STATES STANDARD

FOR

TERMINAL INSTRUMENT PROCEDURES (TERPS)

July 7, 1976

DEPARTMENTS OF THE ARMY, THE NAVY, AND THE AIR FORCE
THE UNITED STATES COAST GUARD, AND
THE FEDERAL AVIATION ADMINISTRATION

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FOREWORD

This publication 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.

The FAA recognizes that the increase in air traffic volume and technical improvements to air navigation systems require continuing emphasis on updating flight procedures standards.

This emphasis will be directed toward reassessment of three basic factors which contribute to overall system accuracy; e.g., ground element, airborne element, and flight technical (pilotage) element.

Analysis of individual ground system performance, using flight check information in the immediate vicinity of the facility used will be pursued in the development of standard values for assessing the dimensions of obstacle clearance areas.

Additionally, recognition will be given to airborne receiver performance to assure that credit is given to accepted improvements made in the state of the art. Concurrently, a review of airborne receiver performance is being conducted to determine whether existing standards need to be changed.

Pilotage error standards will be investigated to determine whether recent technological and operational advances indicate a change to the present standards is required.

Our overall objective is to assure that credit is allowed for improvements made in the ground and airborne environment and to assure that maximum safe use of airspace is realized.

With this in mind, an annual review of this publication by the signatory agencies, in coordination * with other interested parties, will be conducted at the call of the FAA, Office of Flight Operations. * More frequent reviews shall be conducted if required by a signatory agency. The FAA will provide approved changes to this publication by means of revision notices as required.

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 (USAATCA–ASO), Cameron Station, Alexandria, Va. 22314
* CHIEF OF NAVAL OPERATIONS, OP–554, Washington, D.C. 20350 *
HEADQUARTERS, U.S. Air Force XOORF, Washington, D.C. 20330
COMMANDANT, (G–OSR–2/73) U.S. Coast Guard, Washington, D.C. 20590

These criteria have been officially adopted by the Federal Aviation Administration, the United States Army, the United States Navy, the United States Air Force, and the United States Coast Guard. They are applicable at any location where the United States exercises jurisdiction over flight procedures in terminal areas. In addition, these criteria may be utilized for the development of special instrument approach procedures for use by U.S. military and air carriers at foreign airports.

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

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CHAPTER 1. ADMINISTRATIVE

SECTION 1. SCOPE

1. PURPOSE. This handbook contains criteria which shall 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 an appropriate United States agency exercises jurisdiction.

2. DISTRIBUTION. This order is distributed to selected Federal Aviation Administration (FAA) addressees. For distribution within the Department of Defense, see pages v and vi.

3. CANCELLATION. Order 8260.34, Glide Slope Threshold Crossing Height Requirements, dated 10/26/83, is canceled. This change also incorporates criteria contained in VN Supplements 2 and 3 to Order 8260.3B; therefore, VN SUP 2, dated 10/8/92, and VN SUP 3, dated 1/11/93, are canceled.

4. EXISTING PROCEDURES. Existing procedures shall comply with these standards. Approval of nonstandard procedures as required is specified in paragraph 141.

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

a. Precision Approach.

(1) Straight-In. A descent in an approved procedure where the navigation facility alignment is normally on the runway centerline and glide slope (GS) information is provided. For example, Precision Approach Radar (PAR), Instrument Landing System (ILS) and Microwave Landing System (MLS) procedures are precision approaches.

(2) Simultaneous. A procedure which provides for approaches to parallel runways. This procedure uses two or more ILS-equipped parallel runways. Simultaneous approaches, when authorized, shall be radar monitored. Military commanders may approve simultaneous approaches based upon dual precision radar.

b. Nonprecision Approach.

(1) Straight-In. A descent in an approved procedure in which the final approach course (FAC) alignment and descent gradient permits authorization of straight-in landing minimums.

(2) Circling. A descent to circling minimums from which a circle to land maneuver is performed, or an approach procedure which does not meet criteria for authorizing straight-in landing minimums.

c. Departure Procedures. Procedures designed to provide obstacle clearance during instrument departures.

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

a. Shall 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 shall be established as required by the directives of the appropriate military service.

b. Civil Airports. Instrument procedures shall 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 instrument flight procedure 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; or

(3) Military aircraft.

121. REQUESTS FOR PROCEDURES. Requests for military procedures are processed as described by the appropriate military service. No special form is required for requesting civil procedures. Civil requests may be made by letter to the appropriate Regional Office. Requests for civil procedures shall be accepted from any aviation source, provided the request shows that the airport owner/operator has been advised of this request. (This advice is necessary only when the request is for an original procedure to an airport not already served by an approach procedure.) Airport owners/ operators will be advised of additional requests for procedures by the FAA as soon as possible after receipt thereof.

122. APPROVAL. Where a military requirement or reasonable civil need has been established, a request for an instrument approach procedure (IAP) and/or instrument departure procedure for an airport shall be approved if the following minimum standards are met:

a. Airport. The airport landing surfaces must be adequate to accommodate the aircraft which can be reasonably expected to use the procedure. Appropriate runway markings, hold position markings, and signs, required by AC 150/5340-1, Marking of Paved Areas on Airports, shall be established and in place; and all runway design standards in AC 150/5300-13, Airport Design, must be met. Runway lighting is required for approval of night instrument operations. EXCEPTION: Do NOT deny takeoff and departure procedures at night due solely to the absence of runway edge lights. The airport must have been found acceptable for instrument flight rules (IFR) operations as a result of an airport airspace analysis conducted pursuant to Order 7400.2, Procedures for Handling Airspace Matters, and/or appropriate military directives, as applicable. Only circling minimums shall be approved to airports where the runways are not clearly defined.

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

c. Obstacle Marking and Lighting. Obstacles which penetrate 14 CFR Part 77 imaginary surfaces are obstructions and, therefore, should be marked and lighted, insofar as is reasonably possible under FAA Advisory Circular 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. Normally, objects which are shielded need not be removed or made conspicuous.

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 when the aircraft executing the missed approach reaches the missed approach altitude. At lower altitudes, communications shall be 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 which 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 shall 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 shall be canceled unless retention provides an operational advantage to the user. Before an instrument procedure is canceled, coordination with civil and military users shall be effected. Care shall be taken not to cancel procedures required by the military or required by air carrier operators at provisional or alternate airports Military procedures shall be retained or canceled as required by the appropriate military authority.

124.-129. RESERVED.

SECTION 3. RESPONSIBILITY AND JURISDICTION

130. RESPONSIBILITY.

a. Military Airports. The United States Army, Navy, Air Force, and Coast Guard, shall establish and approve instrument procedures for airports under their respective jurisdictions. The FAA will accept responsibility for the development and/or publication of military procedures when requested to do so by the appropriate military service through an interagency agreement. Military instrument procedures are official procedures. The FAA (AVN-100 Regional FPO) shall be informed when military procedures are canceled.

b. Civil Airports. The FAA shall establish and approve instrument procedures for civil airports.

c. Military Procedures at Civil Airports. Where existing FAA approach or departure procedures at civil airports do not suffice, the military shall request the FAA to develop procedures to meet military requirements. These requirements may be met by modification of an existing FAA procedure or development of a new procedure. The FAA shall formulate, coordinate with the military and industry, and publish and maintain such procedures. The military shall inform the FAA when such procedures are no longer required.

131. JURISDICTION. The United States Army, Navy, Air Force, Coast Guard, and Marine Corps Commanding Officers, or FAA Regional Directors having jurisdiction over airports are responsible for initiating action under these criteria to establish or revise TERPS when a reasonable need is identified, or where:

a. New facilities are installed.

b. Changes to existing facilities necessitate a change to an approved procedure.

c. Additional procedures are necessary.

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

132.-139. RESERVED.

SECTION 4. ESTABLISHMENT

140. FORMULATION. Proposed procedures shall be prepared under the applicable portion of this publication as determined by the type and location of navigation facility and procedure to be used. To permit use by aircraft with limited navigational equipment, the complete procedure should be formulated on the basis of a single navigation facility whenever possible. However, the use of an additional facility of the same or different type in the procedure to gain an operational advantage is permitted.

141. NONSTANDARD PROCEDURES. 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, simply computed progression to and from the en route system. Every effort shall be made to formulate procedures in accordance with these standards; however, peculiarities of terrain, navigation information, obstacles, or traffic congestion may require special consideration where justified by operational requirements. In such cases, nonstandard procedures which deviate from these criteria may be approved, provided they are fully documented and an equivalent level of safety exists. A nonstandard procedure is not a substandard procedure, but is one which 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 procedures. Military procedures which deviate from standards because of operational necessity, and in which an equivalent level of safety is not achieved, shall include a cautionary note to identify the hazard and shall be marked "not for civil use."

142. CHANGES. Changes in instrument procedures shall be prepared and forwarded for approval in the same manner as in the case of new procedures. Changes so processed will not be made solely to include minor corrections necessitated by changes in facility frequencies, variation changes, etc., or by other minor changes not affecting the actual instrument procedure. Changes which require reprocessing are those which affect fix, course, altitude, or published minimums.

143.-149. RESERVED.

SECTION 5. COORDINATION

150. COORDINATION. It is necessary to coordinate instrument procedures to protect the rights of all users of airspace.

a. Military Airports. All instrument procedures established or revised by military activities for military airports shall be coordinated with the FAA or appropriate agency or an overseas host nation. When a procedure may conflict with other military or civil activities, the procedure shall also be coordinated with those activities.

b. Civil Airports. Prior to establishing or revising instrument procedures for civil airports, the FAA shall, as required, coordinate such procedures with the appropriate civil aviation organizations. Coordination with military activities is required when a military operating unit is based at the airport or when the proximity of a military airport may cause procedures conflicts.

c. Air Traffic Control (ATC). Prior to establishing or revising instrument procedures for a military or civil airport, the initiating office shall coordinate with the appropriate FAA Air Traffic office to ensure compatibility with air traffic flow and to assess the impact of the proposed procedure on current or future air traffic programs.

d. Airspace Actions. Where action to designate controlled airspace for a procedure is planned, the airspace action should be initiated sufficiently in advance so that effective dates of the procedure and the airspace action will coincide.

e. Notice to Airmen (NOTAM). A NOTAM to **RAISE** minimums may be issued in case of emergencies; i.e., facility outages, facility out-of tolerance conditions, new construction which penetrates critical surfaces, etc. NOTAM's may also be issued to **LOWER** minimums when a supporting facility is added and a significant change in minimums (60 feet in MDA/DH or a reduction in visibility) will result. A NOTAM may be issued to **RAISE OR LOWER** minimums as appropriate on a no-FAF procedure when a procedure turn (PT) altitude is modified as the result of construction or terrain, or when a facility restriction is removed. However, a complete new procedure may not be issued by NOTAM, except where military requirements dictate. ATC shall be advised of the required NOTAM action prior to issuance and normal coordination shall be effected as soon as practicable.

151. COORDINATION CONFLICTS. In areas under the FAA jurisdiction, coordination conflicts which cannot be resolved at the field level shall be submitted to the appropriate FAA region for additional coordination and resolution. Problems which are unresolved at the regional level shall be forwarded to the FAA, AFS-400, for action. If the problem involves a military procedure, parallel action through military channels shall be taken to expedite coordination at the appropriate level.

152.-159. RESERVED.

SECTION 6. IDENTIFICATION OF PROCEDURES

160. IDENTIFICATION OF PROCEDURES. Instrument procedures shall be identified to be meaningful to the pilot, and to permit ready identification in ATC phraseology.

161. STRAIGHT-IN PROCEDURE IDENTIFICATION. Instrument procedures which meet criteria for authorization of straight-in landing minima shall be identified by a prefix describing the navigational system providing the final approach guidance and the runway to which the final approach course is aligned:

a. Non-RNAV. ILS runway (RWY) 18R, localizer (LOC) back course (BC) RWY 7, Tactical Air Navigational Aid (TACAN) RWY 36, localizer type directional aid (LDA) RWY 4, nondirectional radio beacon (NDB) RWY 21, VHF omnidirectional radio range (VOR) RWY 15, VOR/distance measuring equipment (DME) RWY 6, ILS or TACAN RWY 9, etc. A slash (/) indicates more than one type of equipment is required to execute the final approach; e.g., VOR/DME, etc. ILS procedures do not require DME to fly the final approach, even if a DME fix has been substituted for one of the marker beacons, hence ILS procedures will not be named ILS/DME. When a LOC procedure requires DME or RADAR to fly the final approach, and is charted on an ILS approach, the procedure name will be ILS. The chart will be noted to indicate DME or RADAR is required for localizer minima, as appropriate. When procedures are combined, the word "or" shall indicate either type of equipment may be used to execute the final approach; e.g., ILS or TACAN, ILS or NDB, VOR/DME or TACAN, etc. Where more than one approach using the same final approach guidance is developed to the same runway, identify each for the runway/navigational aid combination with alphabetical suffix beginning at the end of the alphabet; e.g., ILS Z RWY 28L (first procedure), ILS Y RWY 28L (second procedure), ILS X RWY 28L (third procedure), etc.

b. RNAV. Identify WAAS, Baro VNAV, and GPS approach procedures as RNAV RWY (Number); e.g., RNAV RWY 21.

NOTE: The published minima lines will identify required RNAV sensors; e.g., GLS, LNAV/VNAV (includes degraded WAAS and Baro VNAV), or LNAV (includes GPS and WAAS without glidepath). A single RNAV approach will be *published depicting GLS. and/or LNAV/VNAV, and/or LNAV minimums where they share the same courses and altitudes.*

c. OTHER RNAV. Identify VOR/DME and LORAN based RNAV procedures as (system) RNAV RWY (number); e.g., VOR/DME RNAV RWY 13, LORAN RNAV RWY 31.

162. CIRCLING PROCEDURE IDENTIFICATION. When an approach procedure does not meet criteria for straight-in landing minimums authorization, it shall be identified by the type of navigational aid (NAVAID) which provides final approach guidance, and an alphabetical suffix starting with the beginning of the alphabet. The first procedure formulated shall bear the suffix "A" even though there may be no intention to formulate additional procedures. If additional procedures are formulated, they shall be identified alphabetically in sequence, e.g., VOR-A, VOR/DME-B, NDB-C, NDB-D, LDA-E, RNAV-A, etc. A revised procedure will bear its original identification.

163. DIFFERENTIATION. Where high altitude procedures are required, the procedure identification shall be prefixed with the letters "HI" e.g., HI-VOR RWY 5.

164.-169. RESERVED.

SECTION 7. PUBLICATION

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

171. ISSUANCE. The following are designated as responsible offices for the release of approved instrument procedures for each agency.

a. Army. Director, U.S. Army Aeronautical Services Agency.

b. Navy and Marine Corps. Chief of Naval Operations (CNO), Naval Flight Information Group.

c. Air Force. Headquarters, Air Force Flight Standards Agency, Instrument Standards Division.

d. Coast Guard. Commandant, U.S. Coast Guard.

e. Civil. Administrator, FAA.

172. EFFECTIVE DATE. TERPS and revisions thereto shall be processed in sufficient time to permit publication and distribution in advance of the effective date. Effective dates should normally coincide with scheduled airspace changes except when safety or operational effectiveness is jeopardized. In case of emergency, or when operational effectiveness dictates, approved procedures may be disseminated by NOTAM (see paragraph 150e). Procedures disseminated by NOTAM must also be processed promptly in the normal fashion and published in appropriate instrument procedures charts and in the Federal Register when required.

173.-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.

201.-209. RESERVED.

SECTION 1. COMMON INFORMATION

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 feet) shall be expressed in feet above mean sea level (MSL); e.g. 17,900 feet. Published heights at and above the transition level (18,000 feet) shall be expressed as flight levels (FL); e.g., FL 180, FL 190, etc. Reference Title 14 of the Code of Federal Regulations (14 CFR) part 91.81, FAA Order 7110.65, Air Traffic Control, paragraph 85.

c. Distances. Develop all distances in nautical miles (NM) (6076.11548 feet or 1852 meters 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 (5280 feet per SM) and the appropriate fractions thereof. Expression of visibility values in NM is permitted in overseas areas where it coincides with the host nation practice. Runway visual range (RVR) shall be expressed in feet.

d. Speeds. Aircraft speeds shall be expressed in knots initiated airspeed (KIAS).

e. Determination of Correctness 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 shall 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 should 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 herein.

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 manual. The categories used and referenced throughout this manual are: CAT A, B, C, D, and/or E. Aircraft categories are defined in 14 CFR part 97.

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

214. PROCEDURE CONSTRUCTION. An IAP may have four separate segments. They are the initial, the intermediate, the final, and the 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 final approach fix (FAF). 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. When the final approach has been determined, the other segments should be blended with it to produce an orderly maneuvering pattern which is responsive to the local traffic flow. Consideration shall also be given to any accompanying controlled airspace requirements in order to conserve airspace to the extent it is feasible. See figure 1.

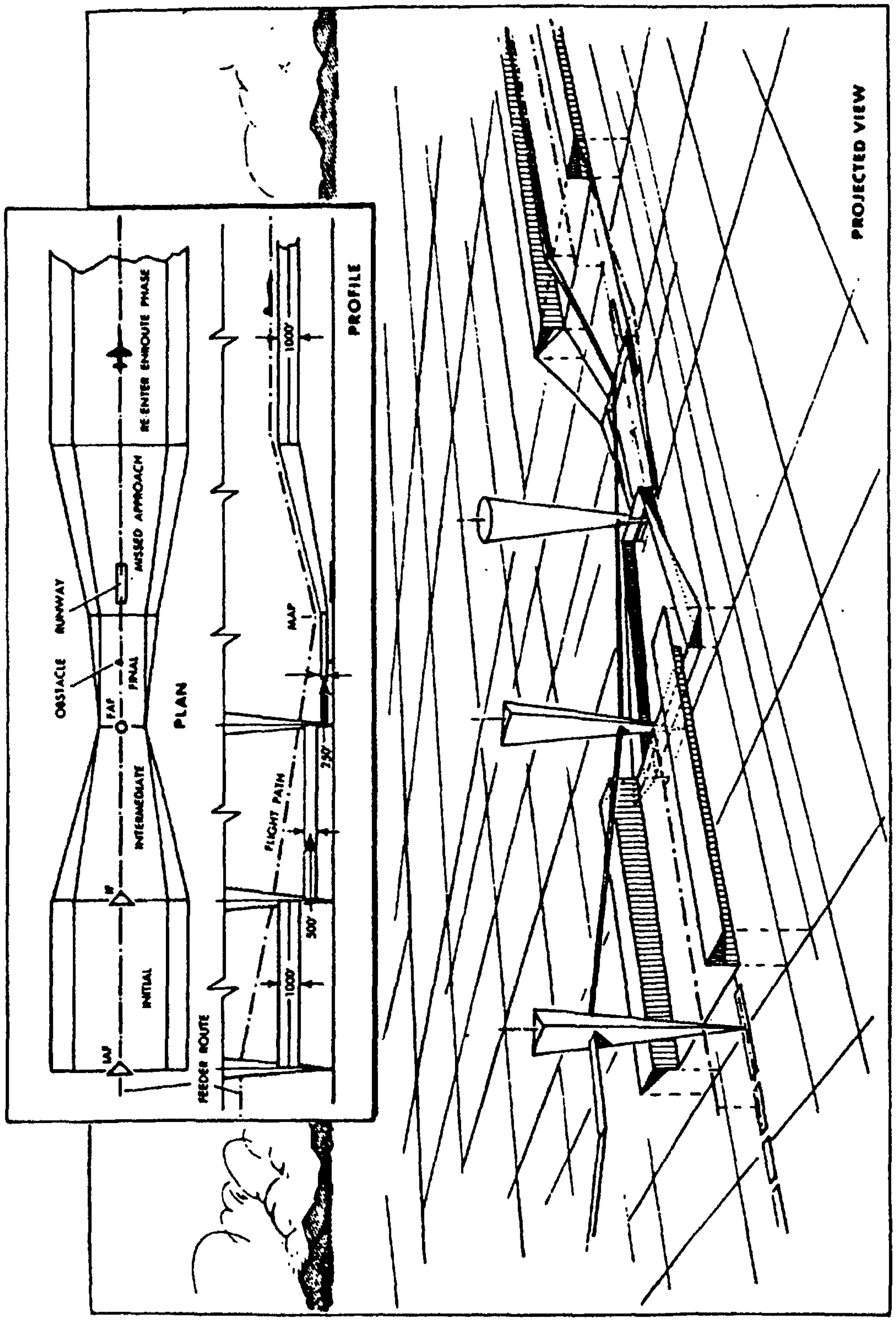


Figure 1. SEGMENTS OF AN APPROACH PROCEDURE. Par 214.

215. CONTROLLING OBSTACLE(S). The controlling obstacle in the final approach segment shall be identified in procedures submitted for publication.

216.-219. RESERVED.

SECTION 2. EN ROUTE OPERATIONS

220. FEEDER ROUTES. When the IAF is part of the en route structure, there may be no need to designate additional routes for aircraft to proceed to the IAF. In some cases, however, it is necessary to designate feeder routes from the en route structure to the IAF. Only those feeder routes which provide an operational advantage shall be established and published. These should coincide with the local air traffic flow. The length of the feeder route shall not exceed the operational service volume of the facilities which provide navigational guidance, unless additional frequency protection is provided. En route airway obstacle clearance criteria shall apply to feeder routes. The minimum altitude established on feeder routes shall not be less than the altitude established at the IAF.

a. *Construction of a feeder route connecting to a course reversal segment.* The area considered for obstacle evaluation is oriented along the feeder route at a width appropriate to the type of route (VOR or NDB). The area terminates at the course reversal fix, and is defined by a line perpendicular to the feeder course through the course reversal fix.

b. The angle of intersection between the feeder route course and the next straight segment (feeder/initial) course shall not exceed 120°.

c. Descent Gradient. The OPTIMUM descent gradient in the feeder route is 250 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 feet per mile. The OPTIMUM descent gradient for high altitude penetrations is 800 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible is 1,000 feet per mile.

221. MINIMUM SAFE/SECTOR ALTITUDES (MSA). A minimum safe altitude provides at least 1,000 feet of obstacle clearance for emergency use, within a specified distance from the RNAV WP/primary navigation facility upon which a procedure is predicated. Minimum altitudes are identified as minimum safe altitudes or emergency safe altitudes, and are rounded to the next higher 100-foot increment.

a. MSA. Establish an MSA for all procedures within a 25-mile radius of the WP/facility, including the area 4 miles beyond the outer boundary. When the distance from the facility to the airport exceeds 25 miles, extend the radius to include the airport landing surfaces up to a maximum distance of 30 miles. See figure 2-1. When the procedure does not use an omnidirectional facility; e.g., LOC BC with a fix for the FAF, use the primary omnidirectional facility in the area. If necessary to offer relief from obstacles, establish sector divisions, or a common safe altitude (no sectors) for the entire area around the facility. Sectors shall not be less than 90° 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 shall also provide 1,000 feet of obstacle clearance in any adjacent sector within 4 miles of the sector boundary line. For area navigation (RNAV) procedures establish a common safe altitude within the specified radius of the runway waypoint (RWY WP) for straight-in approaches; or the airport waypoint (APT WP) for circling procedures; for GPS approaches, from the WP used for the MSA center (see figure 2-2).

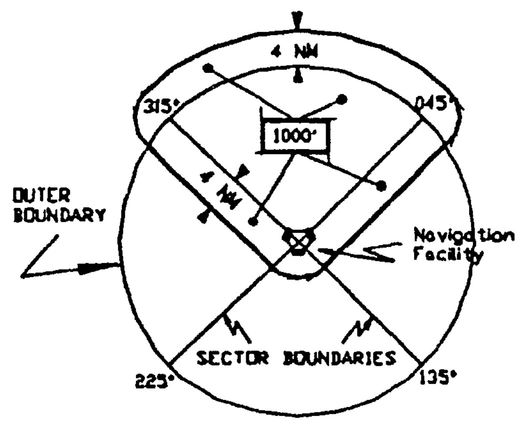


Figure 2-1. Non-RNAV MSA. Par 221.

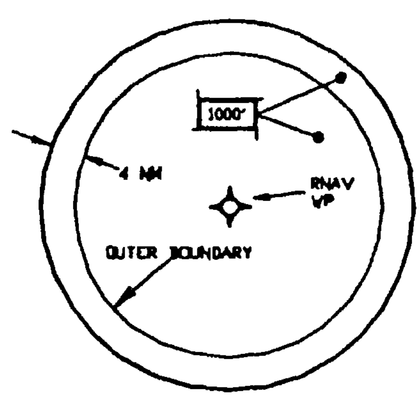


Figure 2-2. RNAV MSA. Par 221.

b. Emergency Safe Altitudes (ESA). ESA's are normally developed only for military procedures, and 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 2,000 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 shall be located within the holding pattern on the inbound holding course.

231. ALTITUDE SELECTION. Minimum altitudes in the initial approach segment shall be established in 100-foot increments; i.e., 1,549 feet may be shown as 1,500 feet and 1,550 feet shall be shown as 1,600 feet. The altitude selected shall not be below the 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 shall not exceed 120°. When the angle exceeds 90°, a radial or bearing which provides at least 2 miles of lead shall be identified to assist in leading the turn onto the intermediate course (see figure 3).

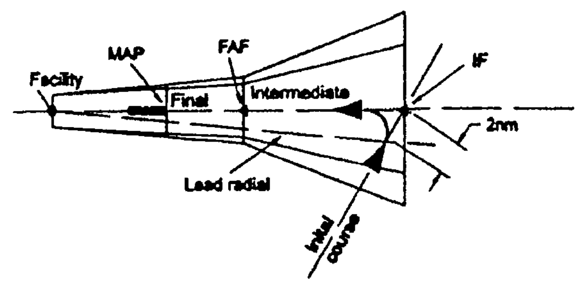


Figure 3. INITIAL APPROACH INTERCEPTION ANGLE GREATER THAN 90°. Par 232a(1).

(2) Arcs. An arc may provide course guidance for all or a portion of an initial approach. The minimum arc radius shall be 7 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 shall 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 shall not exceed 120°. When the angle exceeds 90°, a radial which provides at least 2 miles of lead shall be identified to assist in leading the turn on to the intermediate course. DME arc courses shall be predicated on DME collocated with a facility providing omnidirectional course information.

Table 1. DESCENT GRADIENT ON AN ARC. 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

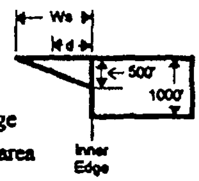
b. Area. The initial approach segment has no standard length. The length shall be sufficient to permit the altitude change required by the procedure and shall not exceed 50 miles unless an operational requirement exists. The total width of the initial approach segment shall be 6 miles on each side of the initial approach course. This width is divided into a primary area, which extends laterally 4 miles on each side of the course, and a secondary area, which extends laterally 2 miles on each side of the primary area. See figure 10. When any portion of the initial approach is more than 50 miles from the navigation facility, the criteria for en route airways shall apply to that portion.

c. Obstacle Clearance. The obstacle clearance in the initial approach primary area shall be a minimum of 1,000 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.

$$\text{Secondary ROC} = 500 \times \frac{Ws - d}{Ws}$$

Where d = distance from inner edge

Ws = Width of secondary area



Allowance for precipitous terrain should be made as specified in paragraph 323a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to nearest 100 feet. See paragraph 231.

d. Descent Gradient. The OPTIMUM descent gradient in the initial approach is 250 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM gradient is 500 feet per mile. The OPTIMUM descent gradient for high altitude penetrations is 800 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM gradient is 1,000 feet per mile.

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

a. Alignment. Each DR course shall intercept the extended intermediate course. For LOW altitude procedures, the intercept point shall be at least 1 mile from the IF for each 2 miles of DR flown. For HIGH altitude procedures, the intercept point may be 1 mile for each 3 miles of DR flown. The intercept angle shall:

(1) Not exceed 90°

(2) Not be less than 45° except when DME is used OR the DR distance is 3 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 6 miles on each side of the course, expanding by 15° outward until joining the points shown in figures 4-1, 4-2, 4-3, 4-4, and 4-5.

c. Obstacle Clearance. The obstacle clearance in the DR initial approach segment shall be a minimum of 1,000 feet. There is no secondary area. Allowance for precipitous terrain should be considered as specified in paragraph 323a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet (see paragraph 231).

d. Descent Gradient. The OPTIMUM descent gradient in the initial approach is 250 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 feet per mile. The OPTIMUM descent gradient for high altitude penetrations is 800 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 1,000 feet per mile.

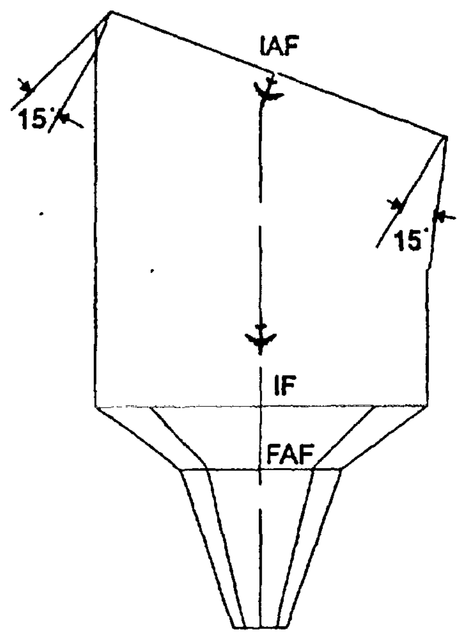


Figure 4-1. MOST COMMON DR SEGMENT. Par 233b.

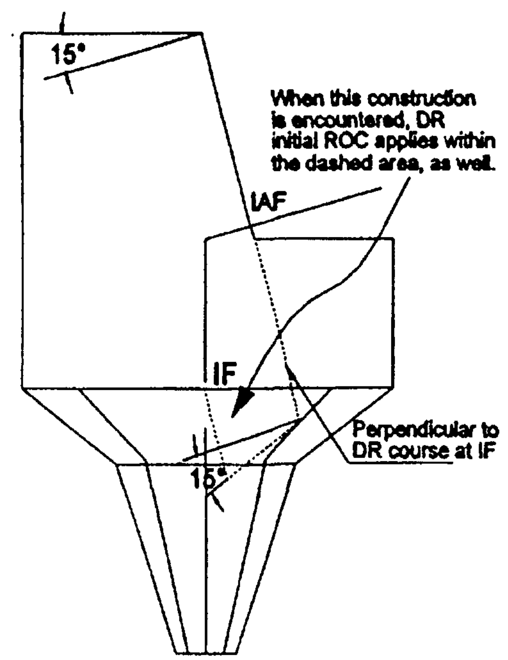


Figure 4-2. DR SEGMENT WITH BOUNDARY INSIDE THE INTERMEDIATE SEGMENT. Par 233b.

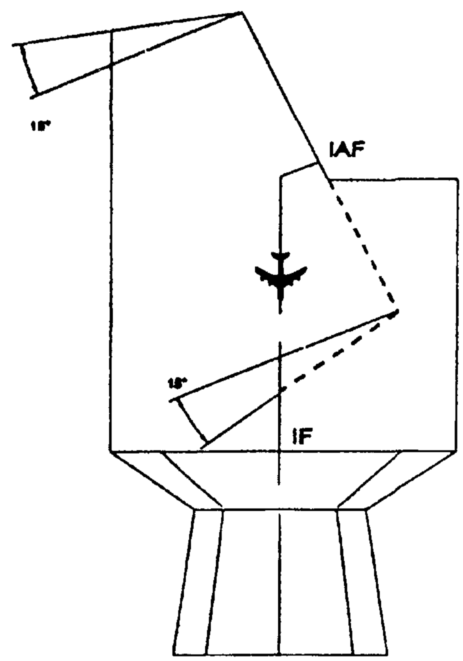


Figure 4-4. DR INITIAL SEGMENT WITH BOUNDARY INSIDE THE STRAIGHT INITIAL SEGMENT. Par 233b.

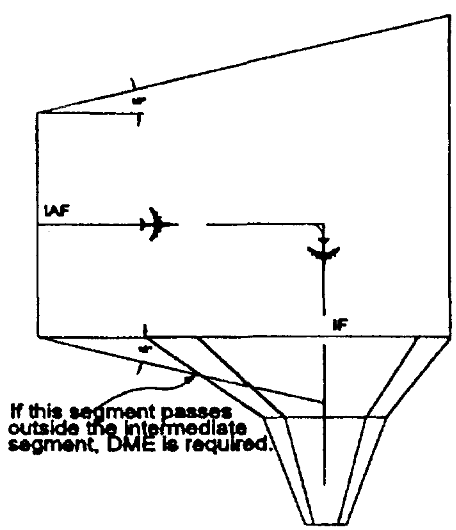


Figure 4-3. DR SEGMENT WITH BOUNDARY INTERCEPTING THE INTERMEDIATE SEGMENT. Par 233b.

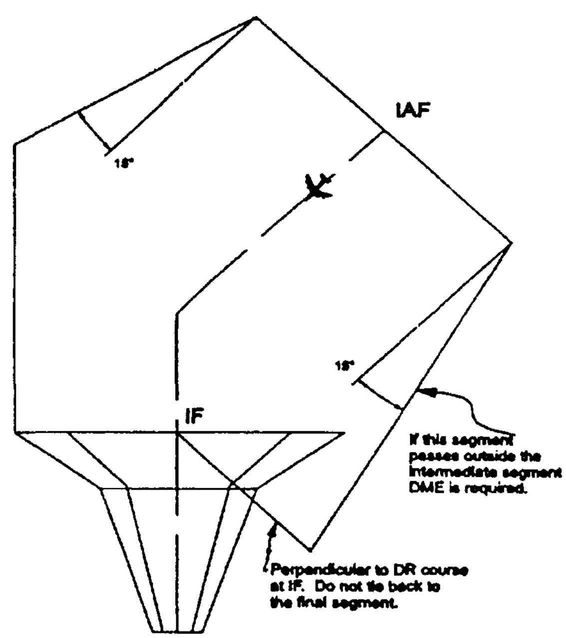


Figure 4-5. DR INITIAL SEGMENT WITH BOUNDARY OUTSIDE THE INTERMEDIATE SEGMENT. Par 233b.

234. INITIAL APPROACH SEGMENT BASED ON A PT. A PT shall 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 shall specify the PT fix, the outbound and inbound course, the distance within which the PT shall 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 shall be a MINIMUM of 15° or a MAXIMUM of 30° (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 shall 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 5 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.

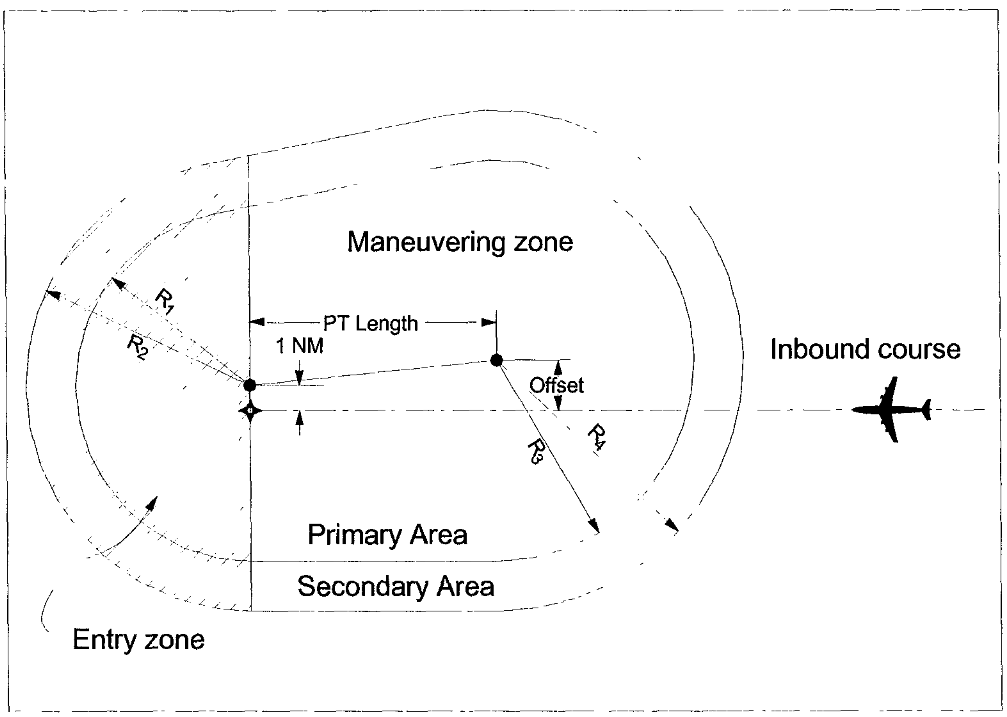


Figure 5. PROCEDURE TURN AREA, Par 234b.
(See Table 1A to determine radius values.)

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

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

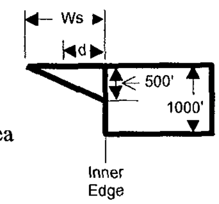
Where d = PT Length

c. Obstacle Clearance. A minimum of 1,000 feet of clearance shall be provided in the primary area. 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 (see figure 6). Allowance for precipitous terrain should be considered as specified in paragraph 323a. 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). The altitudes selected by application of the obstacle clearance as specified in this paragraph may be rounded to the nearest 100 feet (see paragraph 231).

$$\text{Secondary ROC} = 500 \times \frac{Ws - d}{Ws}$$

Where d = distance from inner edge

Ws = Width of secondary area



d. Descent Gradient. The OPTIMUM descent gradient in the initial approach is 250 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 feet per 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 shall 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 shall be increased at the rate of 1 mile for each 200 feet of required altitude.

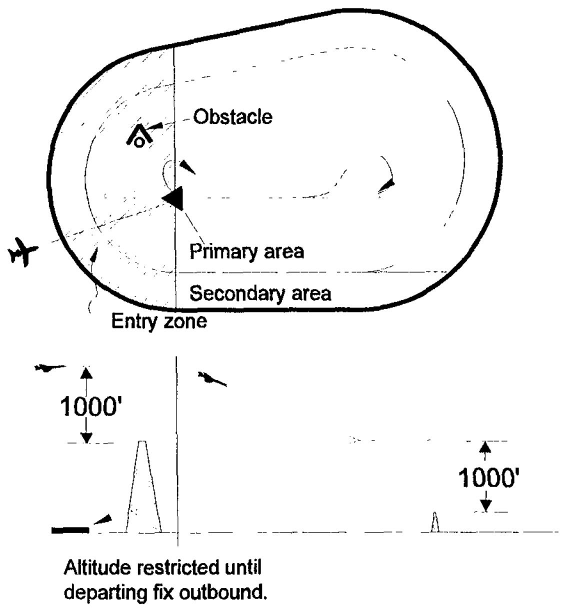


Figure 6. PT INITIAL APPROACH AREA. Par 234c.

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, the minimum holding altitude (MHA) shall not be more than 300 feet above the altitude specified for crossing the FAF inbound.

(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 PENETRATION TURN DIS-TANCE (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 5 miles, the distance in excess of 5 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.

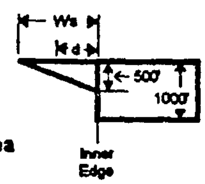
(3) **Primary and Secondary Areas.** All of the penetration turns area, except the outer 2 miles of the 6-mile obstacle clearance area on the outer side of the penetration track, is primary area. See figure 7. The outer 2 miles is secondary area. The outer 2 miles on both sides of the inbound penetration course should be treated as secondary area.

c. **Obstacle Clearance.** Obstacle clearance in the initial approach primary area shall be a MINIMUM of 1,000 feet. Obstacle clearance at the inner edge of the secondary area shall be 500 feet, tapering to zero feet at the outer edge.

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

Where d = distance from inner edge

Ws = Width of secondary area



Where no IF is available, a 10 NM intermediate segment is assumed and intermediate segment required obstacle clearance (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. Allowance for precipitous terrain should be considered in the penetration turn area as specified in paragraph 323a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet. See paragraph 231.

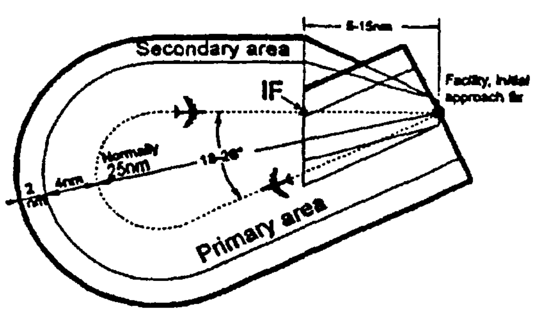


Figure 7. TYPICAL PENETRATION TURN INITIAL APPROACH AREA. Par 235.

d. **Descent Gradient.** The OPTIMUM descent gradient is 800 feet per mile. The MAXIMUM gradient is 1,000 feet per mile.

e. **Penetration Turn Altitude.** When an IF is NOT provided, the penetration turn completion altitude shall not be more than 4,000 feet above the FAF altitude.

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

a. **Common Criteria.**

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

(2) **A flightpath radius** of 2.8 NM shall be used for procedures where the altitude at the turn point fix is at or before 10,000 feet, or 4 NM for procedures where the altitude at the turn point fix is above 10,000 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 shall 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 shall be the turn point fix.

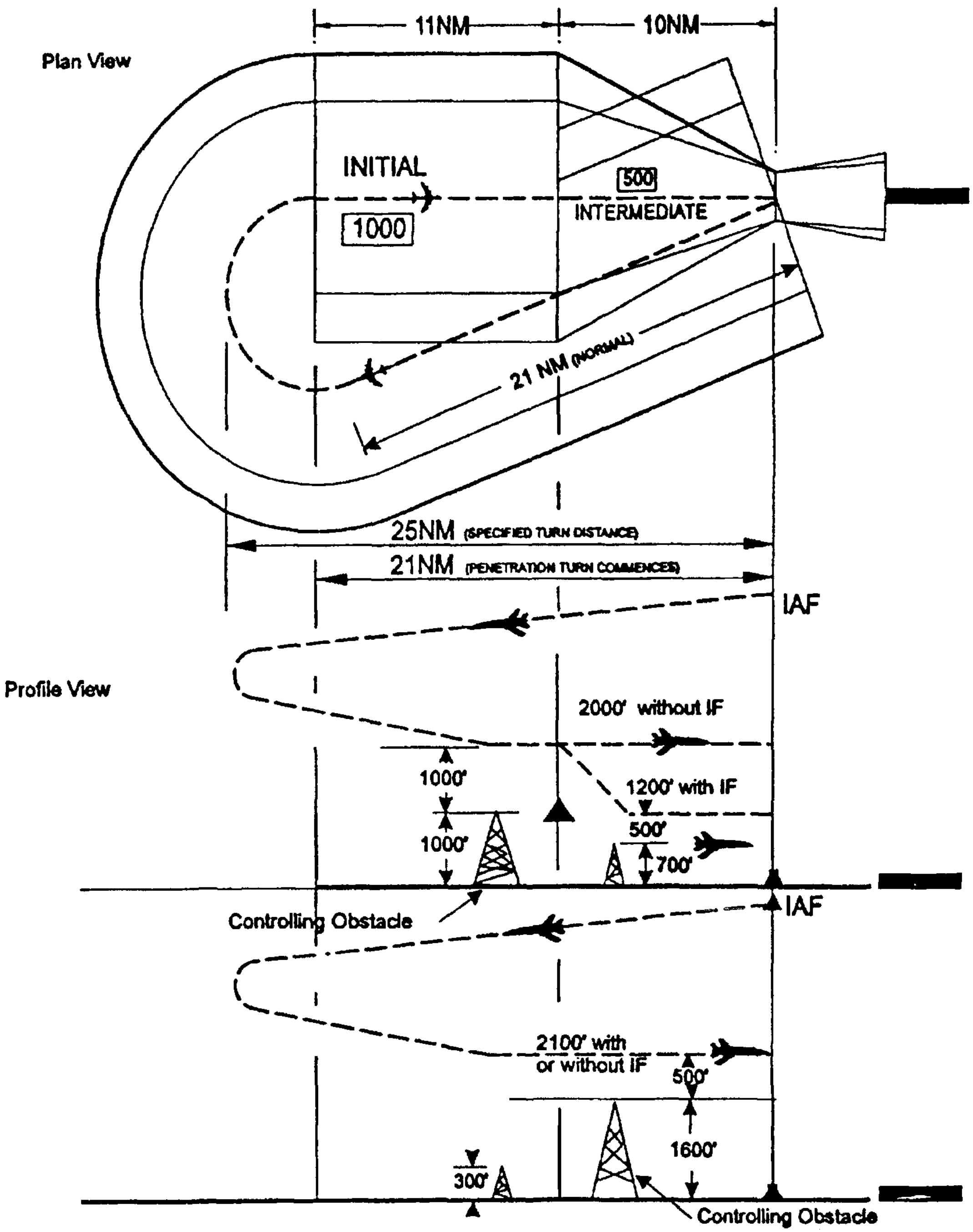
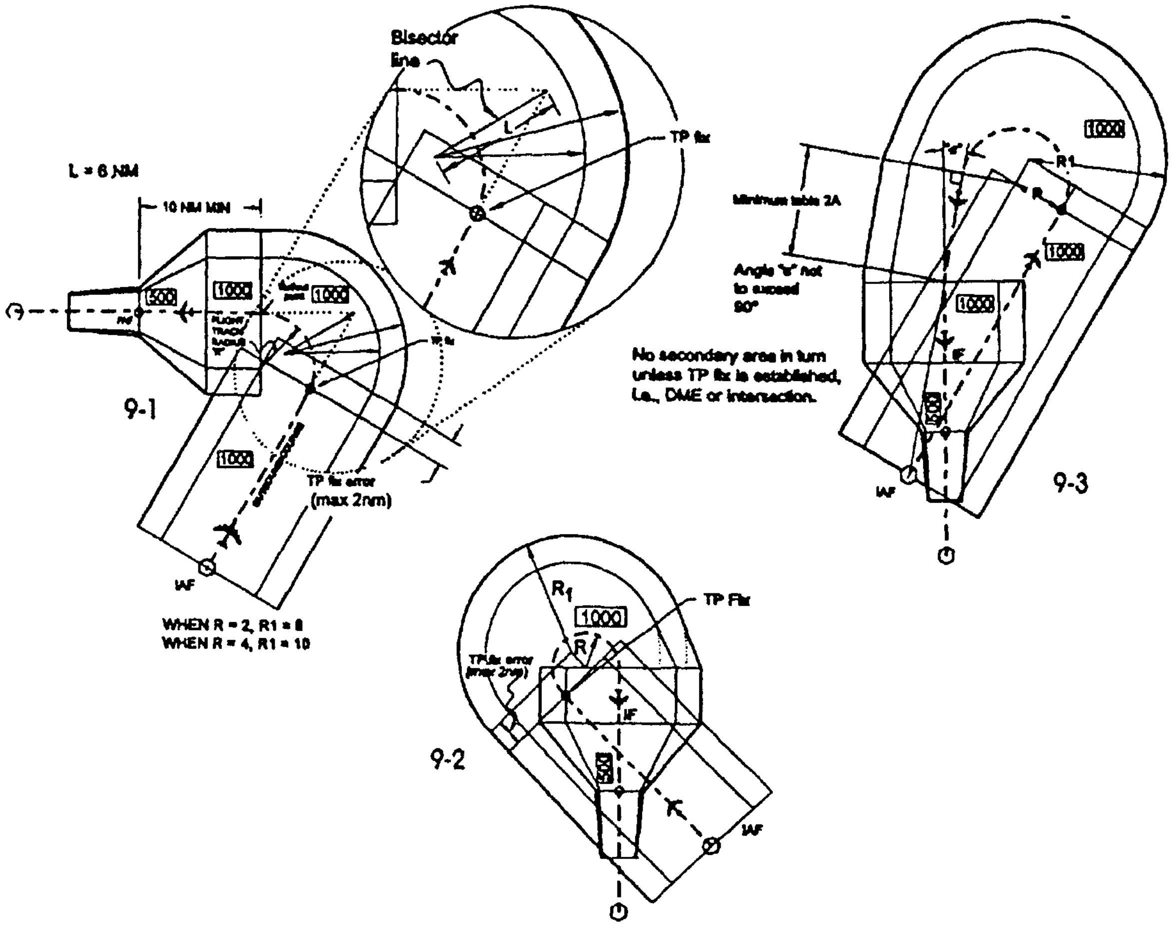


Figure 8. PENETRATION TURN INITIAL APPROACH OBSTACLE CLEARANCE. Par 235c.



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 shall be at or prior to the IF/point (paragraph 242 applies). The angle shall be 90° or less.

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

(3) Paragraph 235 and table 2 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 flightpath 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 FAF. There are two types of intermediate segments; the "radial" or "course" intermediate segment and the "arc" intermediate segment. In either case, PCG shall be provided. See figure 10 for typical approach segments.

241. ALTITUDE SELECTION. The MINIMUM altitude in the intermediate segment shall be established in 100-foot increments; i.e., 749 feet may be shown as 700 feet and 750 feet shall be shown as 800. In addition, the altitude selected for arrival over the FAF shall be low enough to permit descent from the FAF to the airport for a straight-in landing whenever possible.

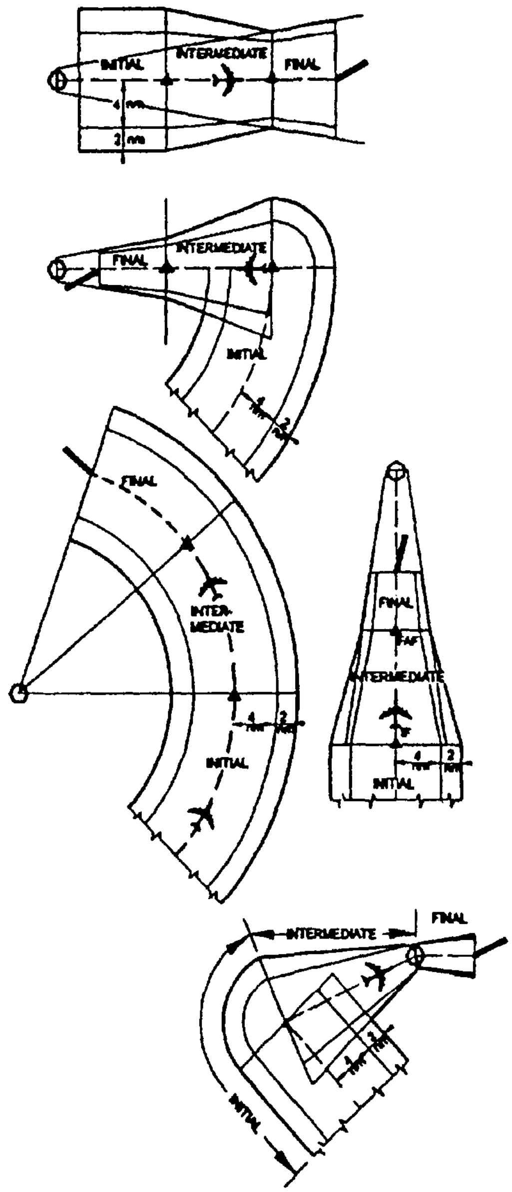


Figure 10. TYPICAL APPROACH SEGMENTS. Par 232b and 240.

242. INTERMEDIATE APPROACH SEGMENT BASED ON STRAIGHT COURSES.

a. Alignment. The course to be flown in the intermediate segment shall 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 shall not differ from the FAC by more than 30°.

b. Area.

(1) **Length.** The intermediate segment shall not be less than 5 miles (except as provided for in chapters 9 and 10) nor more than 15 miles in length, measured along the course to be flown. The OPTIMUM length is 10 miles. A distance greater than 10 miles should not be used unless an operational requirement justifies a greater distance. When the angle at which the initial approach course joins, the intermediate course exceeds 90° (see figure 3), the MINIMUM length of the intermediate course is as shown in table 3.

(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).

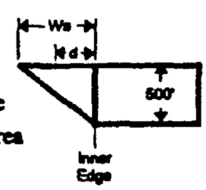
ANGLE (DEGREES)	MINIMUM LENGTH (MILES)
91 - 96	6
>96 - 102	7
>102 -108	8
>108 -114	9
>114 - 120	10

c. Obstacle Clearance. A MINIMUM of 500 feet of obstacle clearance shall be provided in the primary area of the intermediate approach segment. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge.

$$\text{Secondary ROC} = 500 \times \frac{Ws - d}{Ws}$$

Where d = distance from inner edge

Ws = Width of secondary area



Allowance for precipitous terrain should be considered as specified in paragraph 323a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet. See paragraph 241.

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 feet per mile. The MAXIMUM gradient is 318 feet per 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 3°) is permissible. Higher gradients resulting from arithmetic rounding are also permissible.

NOTE: When the descent gradient exceeds 318 feet per 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 5 miles and its descent gradient should not exceed 318 feet per mile.

243. INTERMEDIATE APPROACH SEGMENT BASED ON AN ARC. Arcs with a radius of less than 7 miles or more than 30 miles from the navigation facility shall NOT be used. DME arc courses shall be predicated on DME collocated with a facility providing omnidirectionalional course information.

a. Alignment. The same arc shall be used for the intermediate and the final approach segments. No turns shall be required over the FAF.

b. Area.

(1) Length. The intermediate segment shall NOT be less than 5 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.

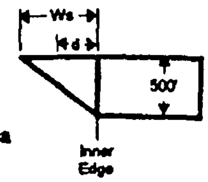
(2) Width. The total width of an arc intermediate segment is 6 miles on each side of the arc. For obstacle clearance purposes, this width is divided into a primary and a secondary area. The primary area extends 4 miles laterally on each side of the arc segment. The secondary areas extend 2 miles laterally on each side of the primary area (see figure 10).

c. Obstacle Clearance. A MINIMUM of 500 feet of obstacle clearance shall be provided in the primary area. In the secondary area, 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge.

$$\text{Secondary ROC} = 500 \times \frac{Ws - d}{Ws}$$

Where d = distance from inner edge

Ws = Width of secondary area



Allowance for precipitous terrain should be considered as specified in paragraph 323a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet. (see paragraph 241).

d. Descent Gradients. Criteria specified in paragraph 242d shall 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 shall 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 shall be only 5 NM long, and the intermediate approach shall 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 shall 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 shall not exceed 4 NM.

(d) 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.

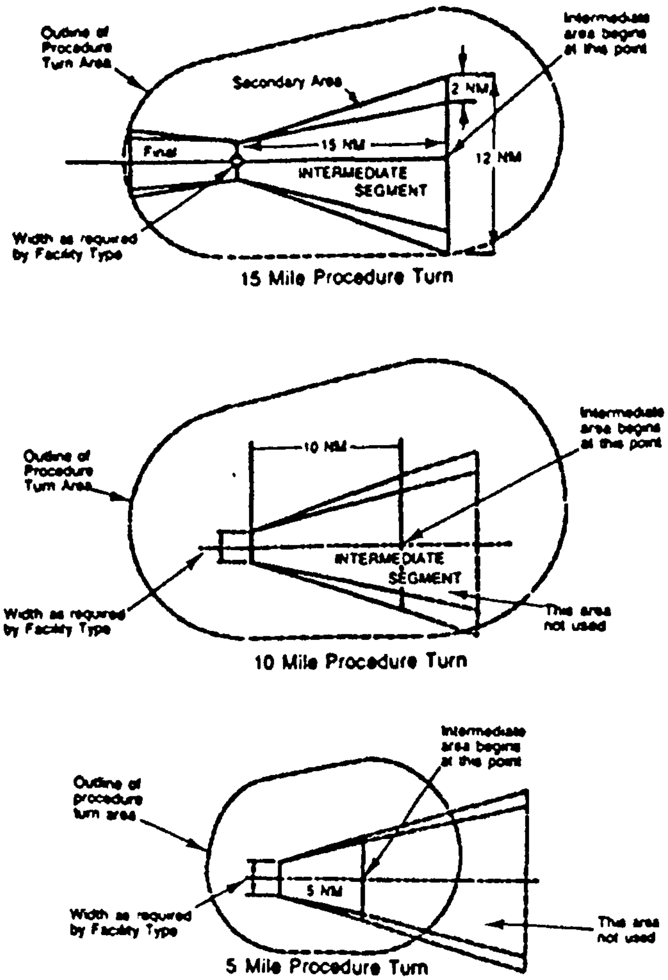


Figure 11. INTERMEDIATE AREA WITHIN A PT AREA. FAF is the Facility. Par 244a.

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 intermediate 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 intermediate segment that underlies the PT maneuvering area.

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

(d) 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.

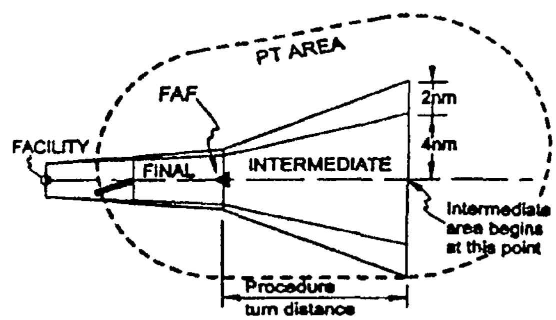


Figure 12. INTERMEDIATE AREA WITHIN THE PT AREA. FAF is not the Facility. Par 244b.

c. PT Over a Facility/Fix AFTER 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.

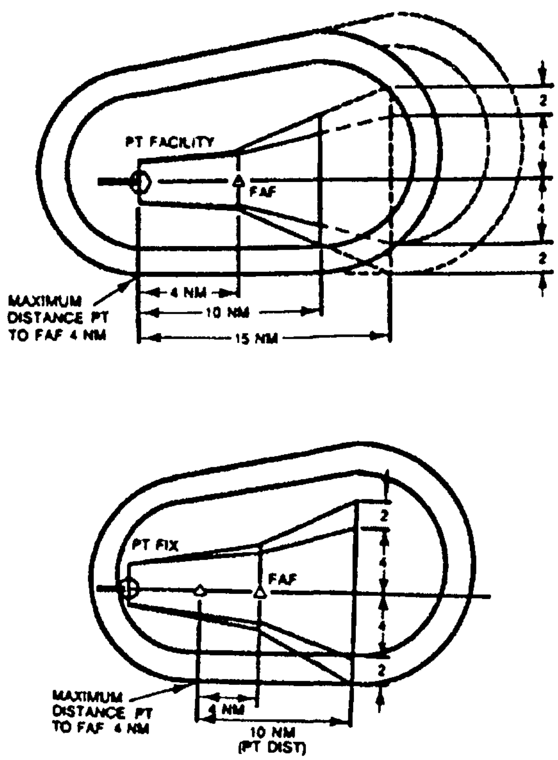


Figure 13. INTERMEDIATE AREA WITHIN THE PT AREA. PT Over the Facility/Fix After the FAF. Par 244c.

(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.

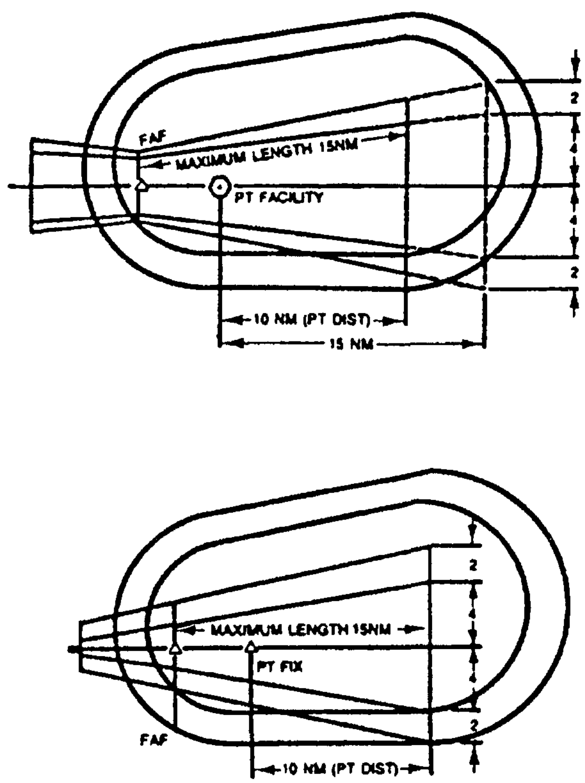


Figure 14-1. INTERMEDIATE AREA WITHIN THE PT AREA. PT Over the Facility/Fix Prior to the FAF. Par 244d.

(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.

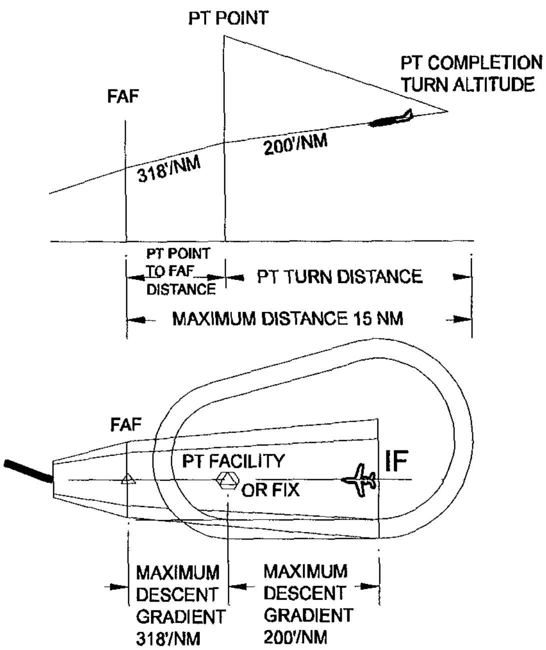


Figure 14-2. INTERMEDIATE AREA WITHIN PT AREA. PT Facility/Fix Used as a Stepdown Fix. Par 244d(4).

(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 feet/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 feet/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 stepdown 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 feet/NM. The MAXIMUM descent gradient from the stepdown fix to the FAF is 318 feet/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

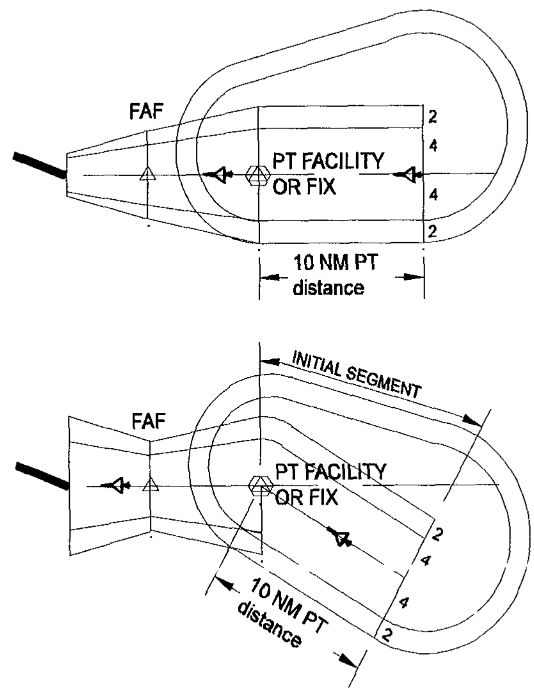


Figure 14-3. USE OF PT FIX FOR IF. Par 244e.

(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 shall 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 feet/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 shall 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 feet/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. The final approach segment considered for obstacle clearance begins at the FAF or points and ends at the runway or missed approach point (MAP), whichever is encountered last. A visual portion within the final approach segment may be included for straight-in nonprecision approaches (see paragraph 251). Final approach may be made to a runway for a straight-in landing or to an airport for a circling approach. Since the alignment and dimensions of the non-visual portions of the final approach segment vary with the location and type of navigation facility, applicable criteria are contained in chapters designated for specific navigation facilities.

251. VISUAL PORTION OF THE FINAL APPROACH SEGMENT. Evaluate the visual area associated with each usable runway at an airport. Apply the STANDARD visual area described in paragraph 251a(1) to runways to which an aircraft is authorized to circle. Apply the STRAIGHT-IN area described in paragraph 251a(2) to runways with approach procedures aligned with the runway centerline. Apply the OFFSET visual area described in paragraph 251a(3) to evaluate the visual portion of a straight-in approach that is not aligned with the runway centerline. These evaluations determine if night operations must be prohibited because of close-in unlighted obstacles, or if visibility minimums must be restricted.

Note: If a runway is served by an approach procedure not aligned with the runway centerline, and is authorized for landing from a circling maneuver on an approach procedure to a different runway, it will receive both standard and offset evaluations.

a. Area.

(1) Standard.

(a) Alignment. Align the visual area with the runway centerline extended.

(b) Length. The visual area begins 200 feet from the threshold (THR) at THR elevation and extends 10,000 feet out the runway centerline (see figure 14-4).

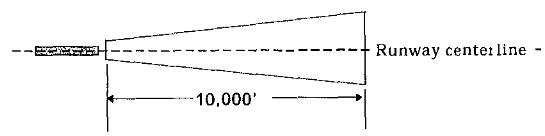


Figure 14-4. VISUAL AREA, Par. 251a(1)(b)

(c) Width. The beginning width of the visual area is 400 feet (200' either side of runway centerline) (see figure 14-5). The sides splay outward relative to runway centerline. Calculate the width of the area at any distance 'd' from its origin using the following formula:

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

where ½W = Perpendicular distance from centerline to edge of area
d = Distance (ft) measured along centerline from area origin

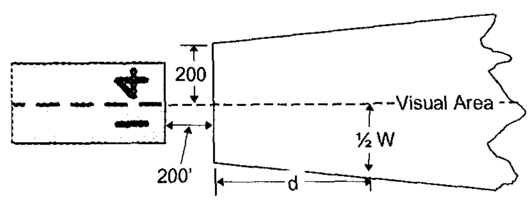


Figure 14-5. VISUAL AREA ORIGIN, Par 251a(1)(c).

(2) Straight-in. (need not meet straight-in descent criteria)

(a) Alignment. Align the visual area with the runway centerline extended.

(b) Length. The visual area begins 200 feet from the threshold (THR) at THR elevation and DH for precision procedures for the VDP location (even if one is not published) for nonprecision procedures (see paragraph 253).

NOTE: When more than one set of minimums are published, use the lowest MDA to determine VDP location.

(c) **Width.** The beginning width of the visual area is 800 feet (400 feet either side of runway centerline). The sides splay outward relative to runway centerline (see figure 14-6). Calculate the width of the area at any distance "d" from its origin using the following formula:

$$\frac{1}{2}W = (0.138 \times d) + 400$$

Where ½W = Perpendicualr distance in feet from centerline to edge of area

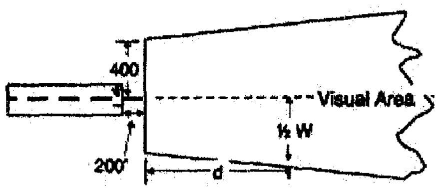


Figure 14-6 VISUAL AREA ORIGIN, Par 251a(2).

(3) **Offset.** When the final course does not coincide with the runway centerline extended (± 0.05°), modify the visual area as follows: (See figure 14-6A)

(a) **STEP 1.** Draw the area aligned with the runway centerline as described in paragraph 251a(2).

(b) **STEP 2.** Extend a line perpendicular to the final approach course (FAC) from the visual descent point (VDP) (even if one is not published) to the point it crosses the runway centerline (RCL) extended .

(c) **STEP 3.** Extend a line from this point perpendicular to the RCL to the outer edge of the visual area, noting the length (L) of this extension.

(d) **STEP 4.** Extend a line in the opposite direction than the line in Step 2 from the VDP perpendicular to the FAC for the distance (L).

(e) **STEP 5.** Connect the end of the line constructed in Step 4 to the end of the inner edge of the area origin line 200 feet from runway threshold.

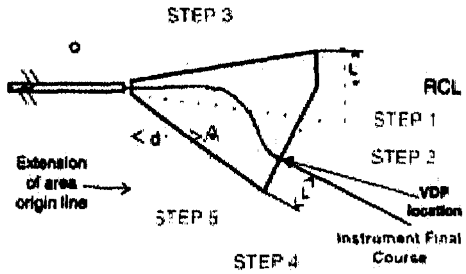


Figure 14-6A. VISUAL SEGMENT FOR OFFSET COURSE, Par 251a(3).

b. **Obstacle Clearance.** Two obstacle identification surfaces (OIS) overlie the visual area with slopes of 20:1 and 34:1, respectively. When evaluating a runway for circling, apply the 20:1 surface. When evaluating a runway for an approach procedure satisfying straight-in alignment criteria, apply the 20:1 and 34:1 surfaces. Calculate the surface height above threshold at any distance "d" from an extension of the area origin line using the following formulae:

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

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

(1) **If the 34:1 surface is penetrated,** take ONE of the following actions:

(a) **Adjust the obstacle height** below the surface or remove the penetrating obstacles.

(b) **Limit minimum visibility** to ¾ mile.

(2) **In addition to the 34:1 evaluation,** if the 20:1 surface is penetrated, take ONE of the following actions:

(a) **Adjust the obstacle height** below the surface or remove the penetrating obstacles.

(b) **Do not publish a VDP,** limit minimum visibility to 1 mile, and take action to have the penetrating obstacles marked and lighted.

(c) **Do not publish a VDP,** limit minimum visibility to 1 mile, and do not authorize night IFR operations to this runway.

252. DESCENT ANGLE / GRADIENT. The OPTIMUM nonprecision final segment descent gradient is 318 ft/NM which approximates a 3.00° angle. The MAXIMUM descent gradient is 400 ft/NM which approximates a descent angle of 3.77°. Calculate descent gradients from the plotted position of the FAF or stepdown fix to the plotted position of a stepdown fix or final endpoint (FEP) as appropriate (see figure 14-7). The FEP is formed by the intersection of the final approach course (FAC) and a line perpendicular to the FAC that extends through the runway threshold (first usable landing surface for circling only procedures). When the maximum descent gradient is exceeded, straight-in minimums are NOT authorized; however, circling only minimums may be authorized if the maximum circling descent gradient is not exceeded (see paragraph 252d). In these cases, publish the actual descent gradient to TCH rather than to CMDA.

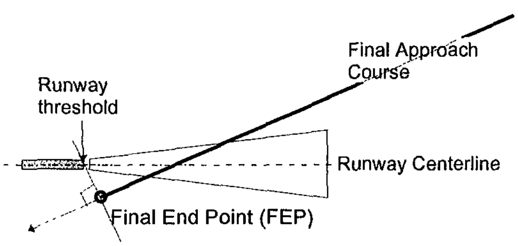


Figure 14-7. FINAL END POINT, Par 252.

a. Non-RNAV approaches. FAF and/or last step-down fix (S/D) location and altitude should be selected to provide a descent angle and TCH coincident (±0.20°, ± 3') with the lowest published visual glide slope indicator (VGSI) glide slope angle, when feasible; or, when VGSI is not installed, the FAF and/or last S/D location and altitude should be selected so as to achieve a near optimum final segment descent gradient. To determine the FAF or S/D altitude necessary to align the descent angle with the lowest VGSI, calculate the altitude gain of a plane with the slope of the lowest published VGSI glide slope angle emanating from the lowest published VGSI threshold crossing height (TCH) to the FAF or S/D location. To determine the OPTIMUM FAF or S/D altitude, calculate the altitude gain of a 318 ft/NM gradient (3° angle) extending from the visual TCH (when there is not a VGSI, see table 18A) to the FAF or S/D location. Round this altitude up or down to the 100' increment for the FAF or 20' increment for the S/D. Ensure that ROC requirements are not violated during the rounding process. If the gradient from TCH to S/D is greater than the gradient from TCH to FAF, continue the greater gradient to the FAF and adjust the FAF altitude accordingly. If ATC, application of hold-in-lieu of PT criteria in paragraph 234e(1), or intermediate segment obstacles prohibit this altitude, consider relocating the FAF to achieve an altitude that will satisfy these requirements and the VGSI or optimum descent gradient (see figure 14-8).

SL in NM:

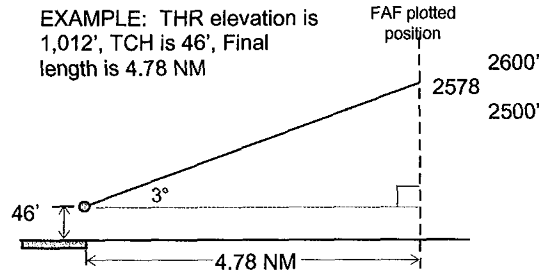
$$FAF \text{ Altitude} = THRe + TCH + (318 \times SL)$$

SL in feet:

$$\text{FAF Altitude} = THRe + TCH + (\tan(\text{VGSI angle}) \times SL \times 6076\ 11548)$$

where: THRe = THR Elevation

SL = Segment Length



$$2578\ 04 = 1012 + 46 + (318 \times 4\ 78)$$

or

$$2580\ 12 = 1012 + 46 + \tan(3°) \times (4\ 78 \times 6076\ 11548)$$

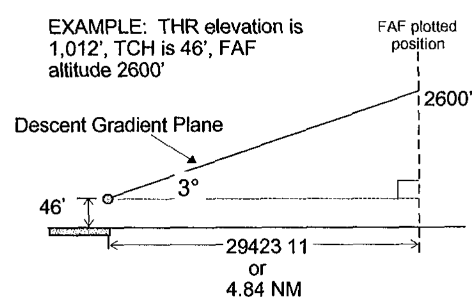
Figure 14-8. FAF ACTIVITIES GIVEN FINAL LENGTH, Par 252a.

b. RNAV Approaches. If feasible, place the FAF waypoint where the optimum descent angle, or the lowest published VGSI (if installed) glidepath angle intersects the intermediate altitude or the altitude determined by application hold-in-lieu of PT criteria in paragraph 234e(1). When an S/D is used, the S/D altitude should be at or below the published VGSI glide slope angle (lowest angle for multi-angle systems). See figure 14-9.

$$SL = \frac{(\text{FAF Altitude} - (\text{THRe} + \text{TCH}))}{\tan(3° \text{ or VGSI angle})}$$

where: SL = Segment Length in feet

THRe = Threshold Elevation



$$29423\ 11 = \frac{2600 - (1012 + 46)}{\tan(3°)}$$

Figure 14-9. FINAL LENGTH GIVEN FAF ALTITUDE, Par 252b.

c. Determining Final Segment Descent Gradient and Angle.

(1) Final Without Stepdown Fixes. Calculate the final descent gradient by dividing the height loss from FAF to TCH by the segment length in NM.

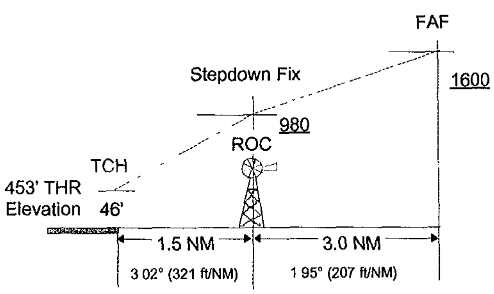
$$\text{Descent Gradient} = \frac{\text{Height Loss}}{\text{Segment Length (NM)}}$$

The descent gradient divided by 6076.11548 is the tangent of the segment descent angle(θ).

$$\text{Tan}(\theta) = \frac{\text{Descent Gradient}}{6076.11548}$$

For RNAV SIAPs, this angle is the glide slope computer setting.

(2) Final With Stepdown Fix. The maximum descent angle is calculated using the difference between the FAF/stepdown altitude and the stepdown/TCH altitude as appropriate. Descent gradient and angle computations apply to each stepdown segment. Height loss in the last segment flown is from the stepdown fix minimum altitude to the TCH (see figure 14-10).



$$\text{Descent Gradient} = \frac{(1600 - 980)}{3\ 0}$$

$$\text{Descent Gradient} = 207 \text{ ft / NM}$$

$$\text{Tan}(\theta) = \frac{207}{6076.11548}$$

$$\theta = 1\ 95°$$

$$\text{Descent Gradient} = \frac{(980 - (453 + 46))}{1.5}$$

$$\text{Descent Gradient} = 321 \text{ ft / NM}$$

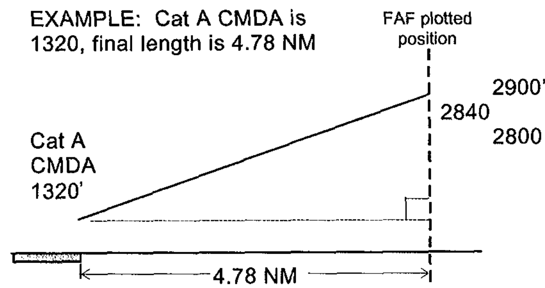
$$\text{Tan}(\theta) = \frac{321}{6076\ 11548}$$

$$\theta = 3.02°$$

Figure 14-10. DESCENT GRADIENT AND ANGLE, Par 252c(2).

d. Circling Approaches. The maximum descent angle is calculated using the difference between the FAF/stepdown altitude and stepdown/lowest circling minimum descent altitude (CMDA) as appropriate (see figure 14-11).

$$\text{FAF Altitude} = \text{CMDA} + (318 \times \text{Seg Len. in NM})$$



To calculate FAF altitude for a given descent gradient:

$$2840.04 = 1320 + (318 \times 4.78)$$

Figure 14-11, FAF NET GIVEN SEGMENT LENGTH, Par 252d.

To calculate Descent Gradient and Angle given a FAF altitude and final length:

$$\text{Descent Gradient} = \frac{(2900 - 1320)}{4.78}$$

$$\text{Descent Gradient} = 331$$

$$\text{Tan}(\theta) = \frac{331}{6076.11548}$$

$$\theta = 3.12°$$

253. VISUAL DESCENT POINT (VDP) (applicable to straight-in procedures only). When dual minimums are published, use the lowest minimum descent altitude (MDA) to calculate the VDP distance. **PUBLISH A VDP FOR ALL STRAIGHT-IN NONPRECISION APPROACHES** except as follows:

- Do not publish a VDP associated with an MDA based on part-time or full time remote altimeter settings.

- Do not publish a VDP if the visual descent angle passes below a required altitude at a stepdown fix.

- If the VDP is between the MAP and the runway, do not publish a VDP.

a. For runways served by a VGSI, using the VGSI TCH, establish the distance from THR to a point where the lowest published VGSI glidepath angle reaches an altitude equal to the MDA. Use the following formula:

$$\text{VDP Distance} = \frac{\text{MDA} - (\text{TCH} + \text{THR Elevation})}{\text{Tan}(\text{VGSI Angle})}$$

• If the difference between the calculated descent angle (paragraph 252) and the VGSI angle is greater than ±0.20°, do not publish a VDP.

b. For runways NOT served by a VGSI, using an appropriate TCH from table 18A, establish the distance from THR to a point where the greater of a 3° or the final segment descent angle reaches the MDA. Use the following formula:

$$VDP\ \text{Distance} = \frac{\text{MDA} - (\text{TCH} + \text{THR Elevation})}{\text{Tan}(*\ \text{Angle})}$$

* final segment descent angle or 3°, whichever is higher.

c. Marking VDP Location.

(1) For Non-RNAV SIAP's, mark the VDP location with a DME fix. The DME must be collocated with the facility providing final approach course guidance (USN/USA/USAF NA) If DME is not available, do not establish a VDP. Maximum fix error is ± 0.5 NM.

(2) For RNAV SIAP's, 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 THR as a vertex, swing an arc of a radius equal to the VDP distance across the final approach course (see figure 14-12) 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.)

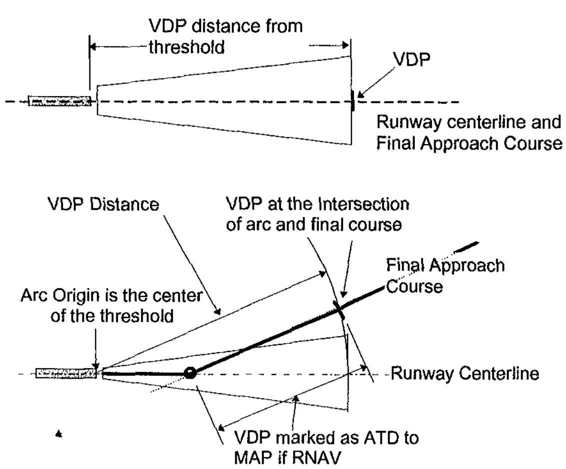


Figure 14-12. VDP LOCATION, Par 253c(3).

254.-259. RESERVED.

SECTION 6. CIRCLING APPROACH

260. CIRCLING APPROACH AREA. This is the obstacle clearance area which shall be considered for aircraft maneuvering to land on a runway which is not aligned with the FAC of the approach procedure.

a. Alignment and Area. The size of the circling area varies with the approach category of the aircraft, as shown in table 4. To define the limits of the circling area for the appropriate category, draw an arc of suitable radius from the center of the end of each usable runway. Join the extremities of the adjacent arcs with lines drawn tangent to the arcs. The area thus enclosed is the circling approach area (see figure 15).

Table 4. CIRCLING APPROACH AREA RADII. Par 260a.

Approach Category	Radius (Miles)
A	1.3
B	1.5
C	1.7
D	2.3
E	4.5

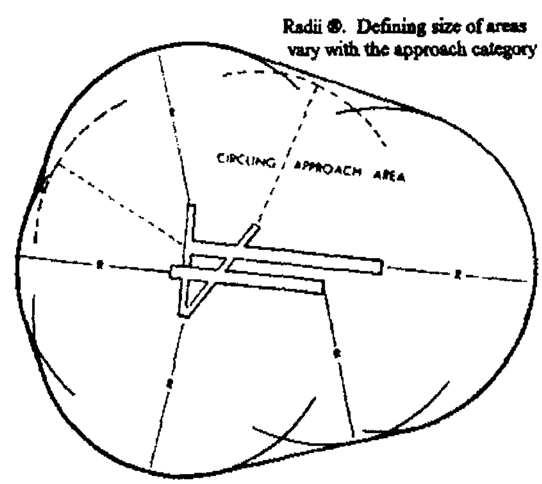


Figure 15. CONSTRUCTION OF CIRCLING APPROACH AREA. Par 260a.

b. Obstacle Clearance. A minimum of 300 feet of obstacle clearance shall be provided in the circling approach area. There is no secondary obstacle clearance area for the circling approach (see paragraph 322).

261. CIRCLING APPROACH AREA NOT CONSIDERED FOR OBSTACLE CLEARANCE. It will be permissible to eliminate from consideration a particular sector where prominent obstacles exist in the circling approach area, provided the landing can be made without maneuvering over this sector and further provided that a note to this effect is included in the procedure. Sectors within which circling is not permitted should be identified with runway centerlines, and where necessary, illumination of certain runway lights may be required. Circling restrictions shall be noted on the procedure.

262.-269. RESERVED.

SECTION 7. MISSED APPROACH.

270. MISSED APPROACH SEGMENT. (See ILS and PAR chapters for special provisions,) A missed approach procedure shall be established for each IAP. The missed approach shall be initiated at the decision height (DH) or MAP in nonprecision approaches. The missed approach procedure must be simple, specify an altitude, and a clearance limit. The missed approach altitude specified in the procedure shall 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 and expands uniformly to the width of the initial approach 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 2 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° inward relative to the course until it reaches initial segment width.

NOTE: Only the primary missed approach procedure shall 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 DH, 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 shall 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° 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.

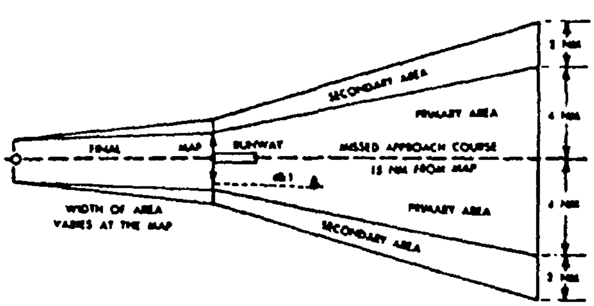


Figure 16. STRAIGHT MISSED APPROACH AREA. Par 270 and 273.

274. STRAIGHT MISSED APPROACH OBSTACLE CLEARANCE. Within the primary missed approach area, no obstacle shall 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 323 from the MDA. It ascends uniformly at the rate of 1 foot vertically for each 40 feet horizontally (40:1). See figure 17. Where the 40:1 surface reaches a height of 1,000 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 IAW 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. 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.

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).

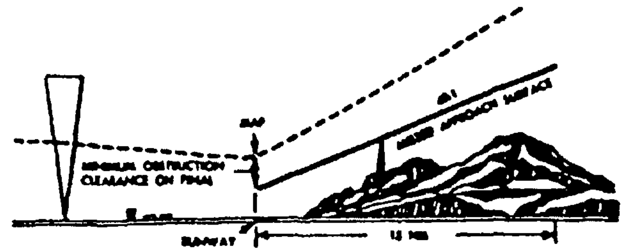


Figure 17. STRAIGHT MISSED APPROACH OBSTACLE CLEARANCE. Par 274.

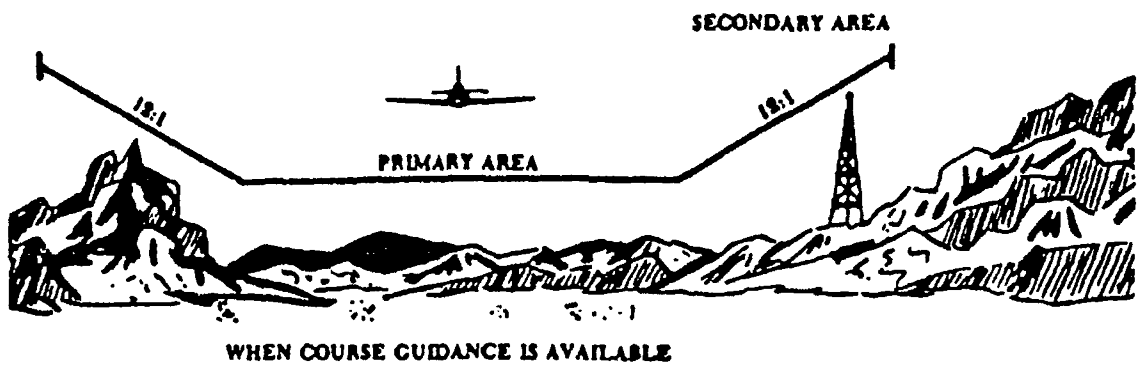


Figure 18. MISSED APPROACH CROSS SECTION. Par 274.

275. TURNING MISSED APPROACH AREA. (See ILS and PAR chapters for special provisions). If a turn of more than 15° from the FAC is required, a turning missed approach area must be constructed.

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:

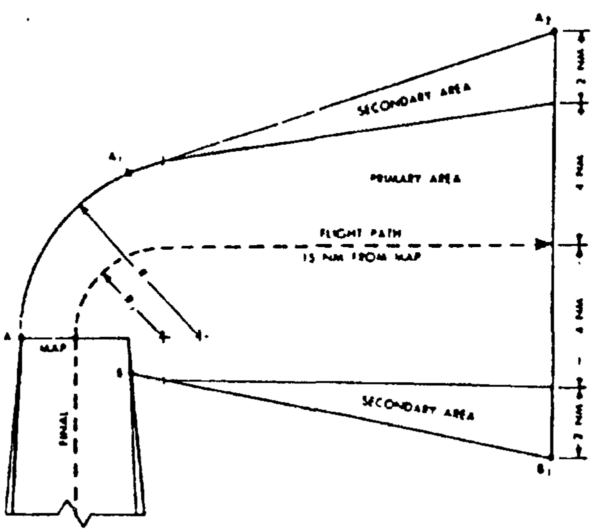


Figure 19. TURNING MISSED APPROACH AREA. 90° Turn or Less. Narrow Final Approach Area at MAP. Par 275c(1).

(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:

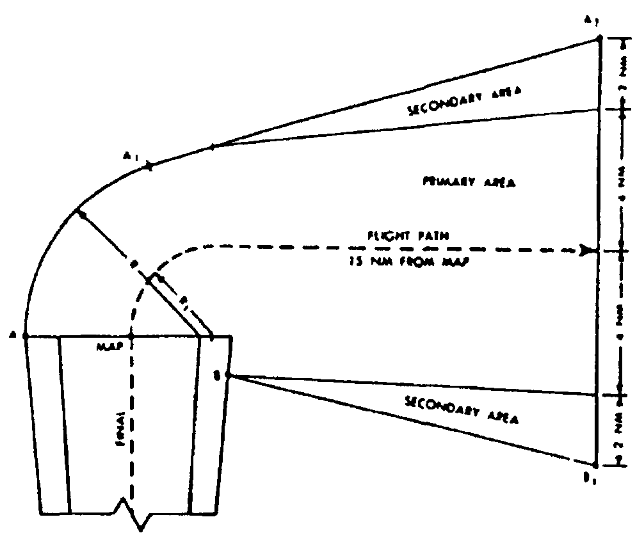


Figure 20. TURNING MISSED APPROACH AREA. 90° Turn or Less. Wide Final Approach Area at MAP. Par 275c(2)

(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:

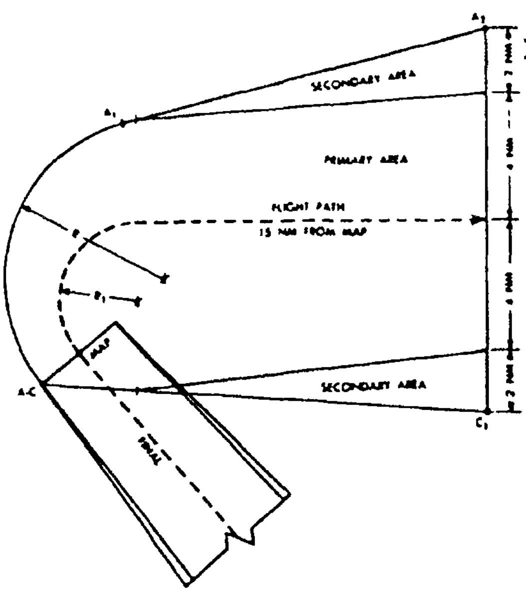


Figure 21. TURNING MISSED APPROACH AREA. More Than 90° Turn. Narrow Final Approach Area at MAP. Par 275c(3).

(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 135°). 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:

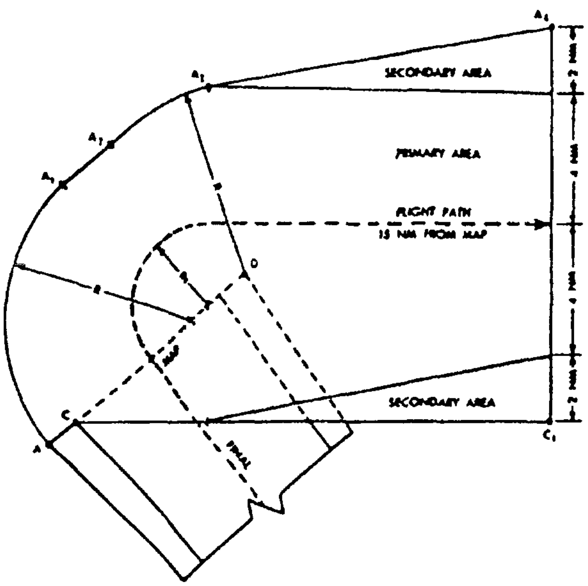


Figure 22. TURNING MISSED APPROACH AREA. More Than 90° Turn. Wide Final Approach Area at MAP. Par 275c(4).

(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:

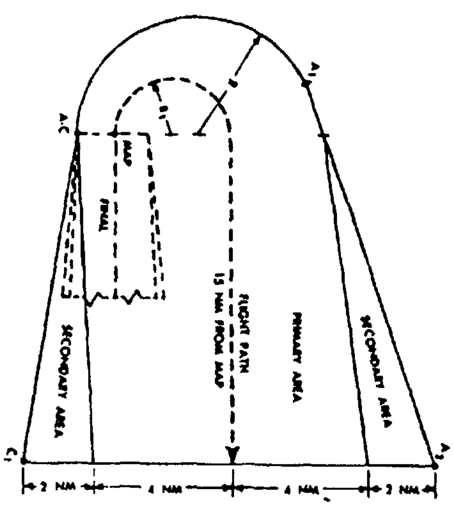


Figure 23. TURNING MISSED APPROACH AREA. 180° Turn. Narrow Final Approach Area at MAP. Par 275c(5).

(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:

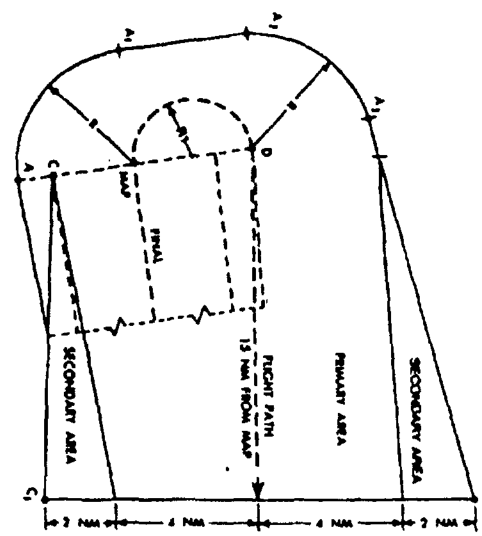


Figure 24. TURNING MISSED APPROACH AREA. 180° Turn. Wide Final Approach Area at MAP. Par 275c(6).

(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.

(c) Now connect "A4" and "C1" with a straight line.

(d) Draw a 90° arc with the appropriate radius (R) from point "A" to "A1". 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 "A2" to point "A3". Compute the number of degrees by subtracting 90° from the total turn magnitude.

(f) Connect points "A1" and "A2", with a straight line.

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

(h) Connect points "A3" and "A4", and points "C" and "C1"with straight lines. (The line "A3-A4" 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.

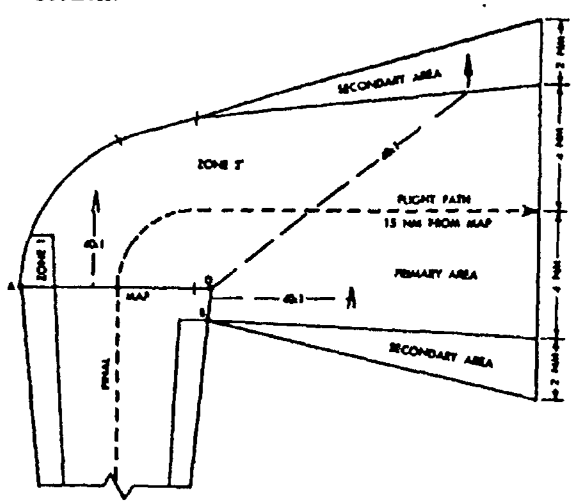


Figure 25. TURNING MISSED APPROACH OBSTACLE CLEARANCE. 90° Turn or Less. Par 276a.

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."

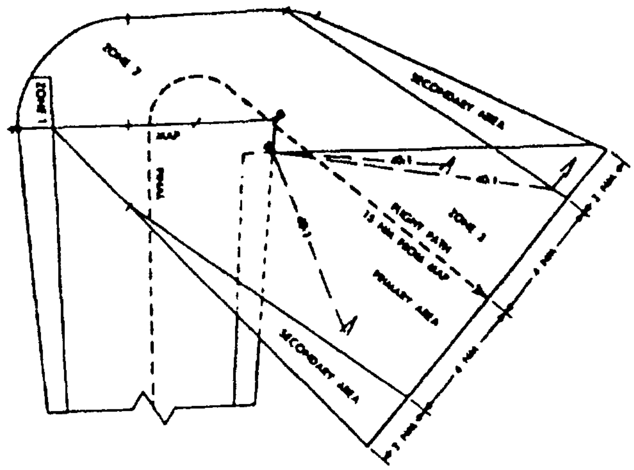


Figure 26. TURNING MISSED APPROACH OBSTACLE CLEARANCE. More Than a 90° Turn. Par 276b.

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).

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' x 40 = 21,600' − length of section 1.
6. Missed approach instructions.
   a. "Climb to 900' before starting right turn to, etc."

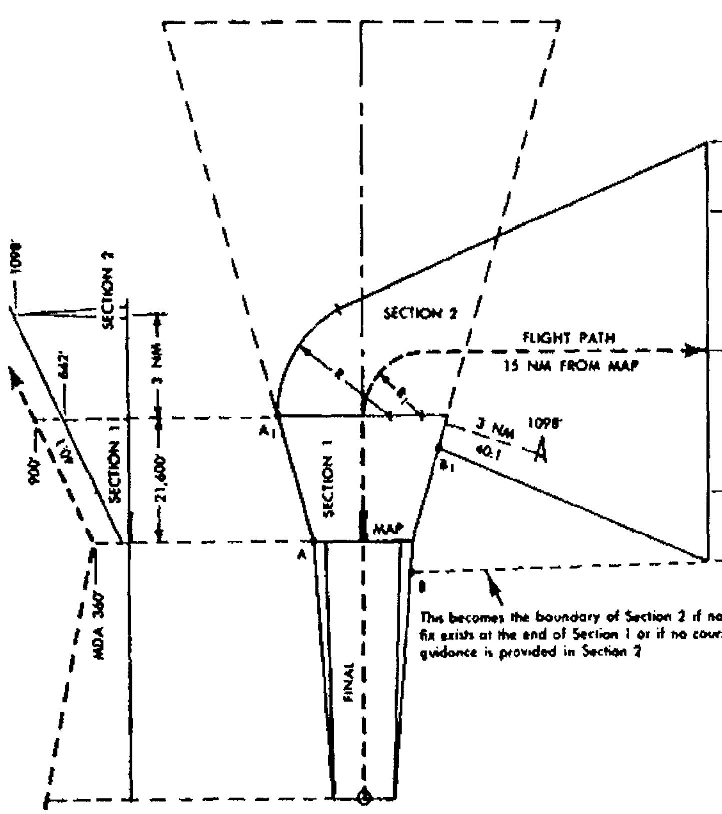


Figure 27. COMBINATION MISSED APPROACH AREA. Par 277(a).

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 paragraph 912.

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.

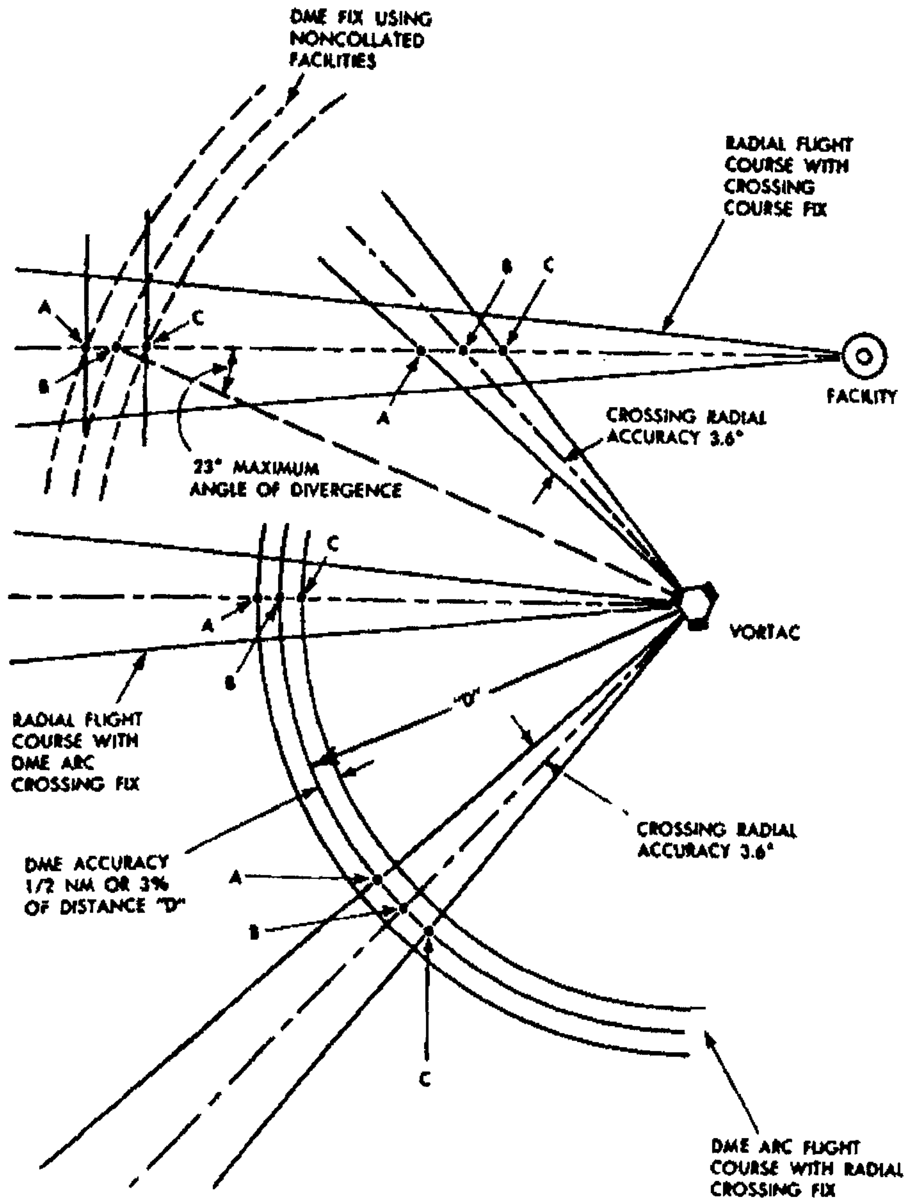


Figure 28. INTERSECTION FIX DISPLACEMENT. Par 281 and 282a.

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 which follows the fix. Measurements are made from the plotted fix position (see figure 29).

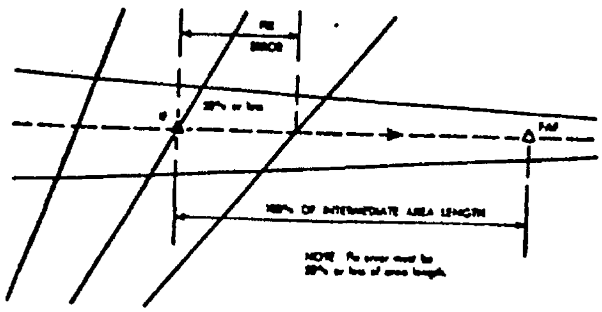


Figure 29. INTERMEDIATE, INITIAL, OR FEEDER APPROACH FIX ERRORS. Par 287.

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.

For example, if the intersection is formed by radials from VOR's 30 and 45 miles away, the minimum angle is 45°. If one of the facilities is NDB, the minimum angle is 60° (see figure 30).

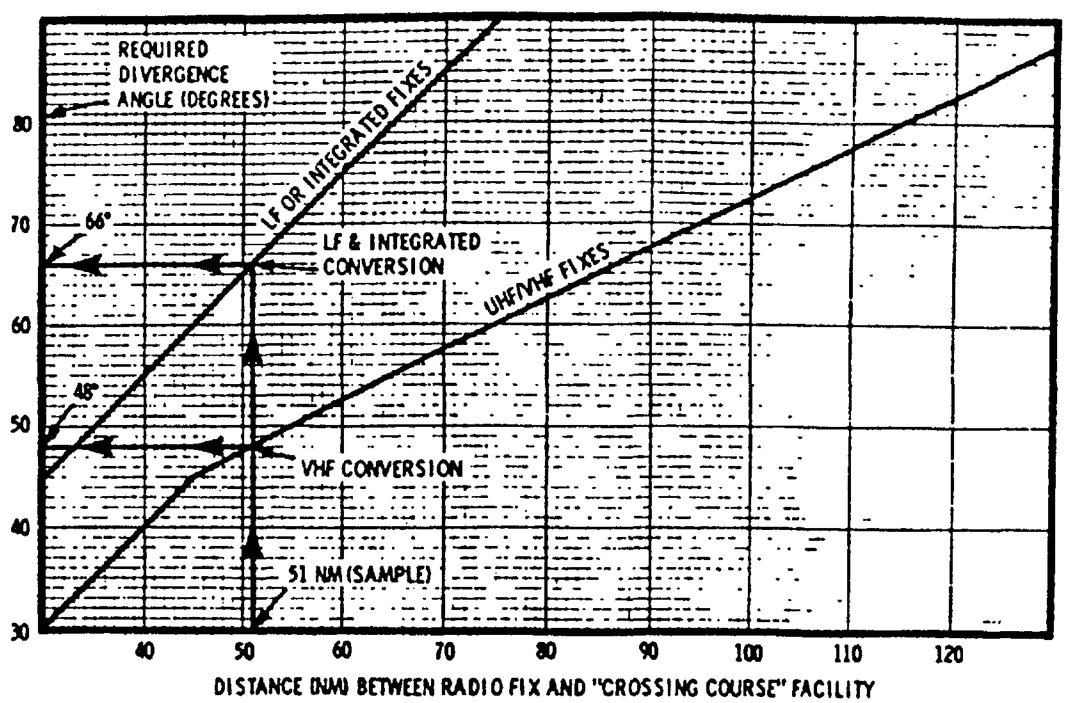


Figure 30. MINIMUM DIVERGENCE ANGLE FOR HOLDING FIXES. Par 287b(4)(b)

e. 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).

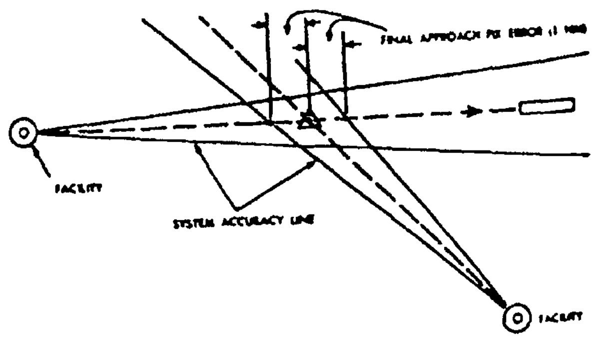


Figure 31-1. MEASUREMENT OF FAF ERROR. Par 287c

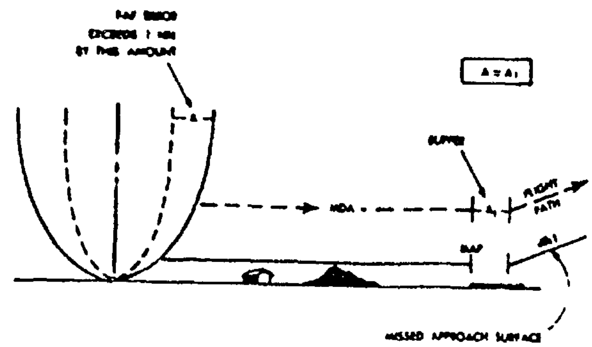
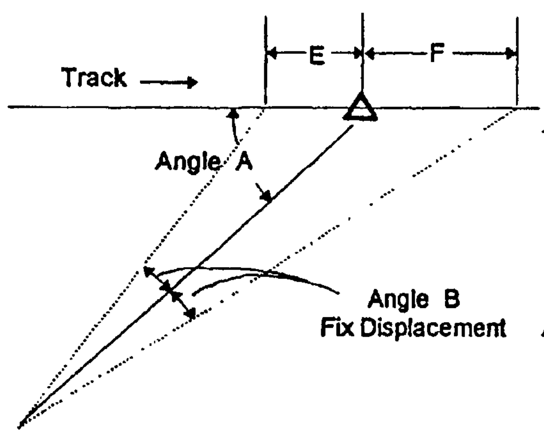


Figure 32. FAF ERROR BUFFER. Par 287c(2).

Calculate fix displacement using the following formulas:



Formula	*Example*
$E = \frac{6076.11548 \times D \times Sin\,B}{Sin\,(A+B)}$	$E = \frac{6076.11548 \times 30 \times Sin\,4.5^\circ}{Sin\,(50+4.5^\circ)}$
	$\frac{14301.80}{0.81411} = 17567.62$
$F = \frac{6076.11548 \times D \times Sin\,B}{Sin\,(A-B)}$	$F = \frac{6076.11548 \times 30 \times Sin\,4.5^\circ}{Sin\,(50^\circ-4.5^\circ)}$
	$\frac{14301.80}{0.71325} = 20051.59$

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).

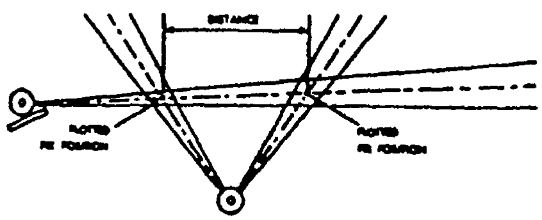


Figure 33. DISTANCE FOR DESCENT GRADIENT APPLICATION. Par 288a.

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 shall 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).

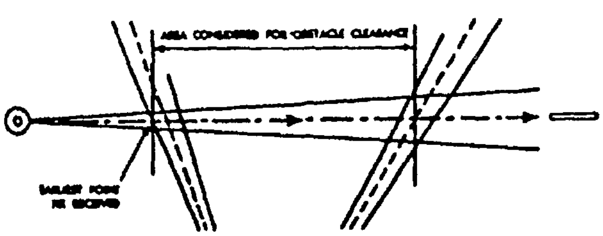


Figure 34-1. OBSTACLE CLEARANCE AREA BETWEEN FIXES. Par 288b.

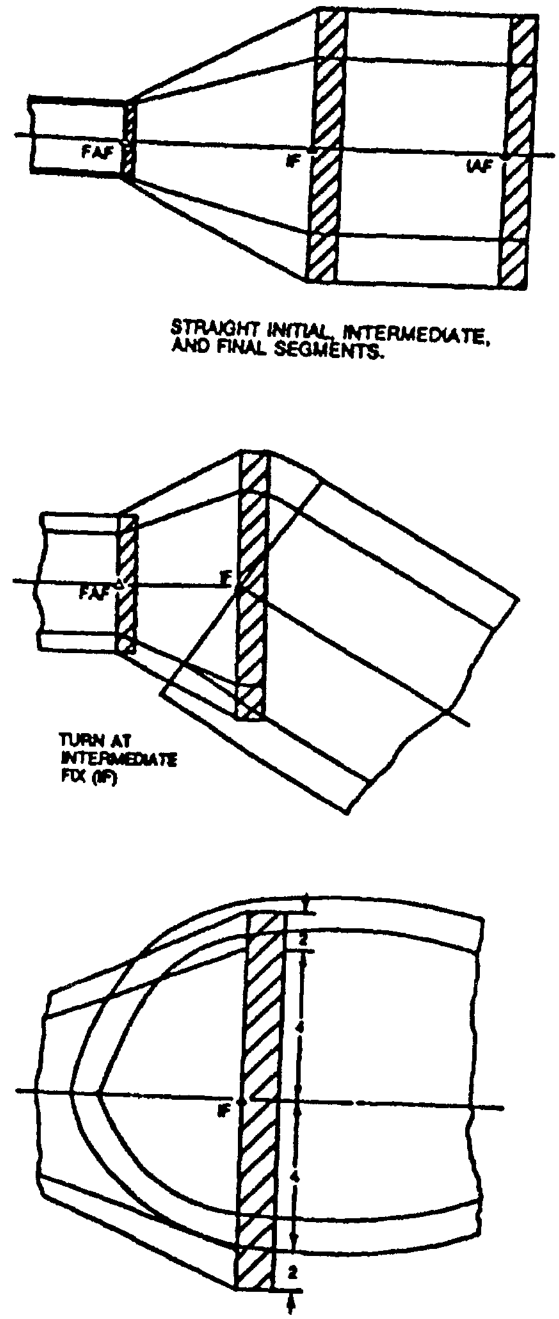


Figure 34-2. CONSTRUCTION OF FIX DISPLACEMENT AREA FOR OBSTACLE CLEARANCE. Par 288b.

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 shall 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 FAF, IF, or IAF:

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

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

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

(3) Altitude at the Fix. The minimum altitude at each stepdown fix shall 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 shall 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 shall 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 shall not exceed 1 NM.

(c) Minimums shall 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.

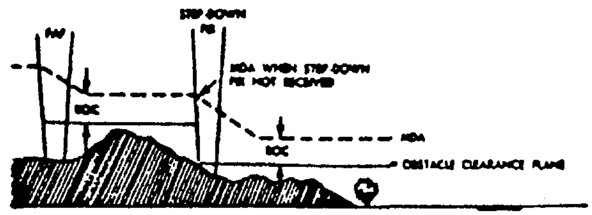


Figure 35. FINAL SEGMENT STEPDOWN FIX. Par 288c.

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. Existing obstacles close to the FAF/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 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 adjustments from paragraphs 323a, b, or c, as applicable) from the minimum altitude required at the fix. The surface slopes downward 1 foot vertically for each 7 feet horizontally toward the MAP.

c. Obstacles eliminated from consideration by application of this paragraph shall 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

$$\text{OIS height} = FixAlt - ROC - \left[\frac{Obst\ Dist}{7}\right]$$

$$\text{MinFixAlt} = ObstElev + ROC + \left[\frac{Obst\ Dist}{7}\right]$$

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

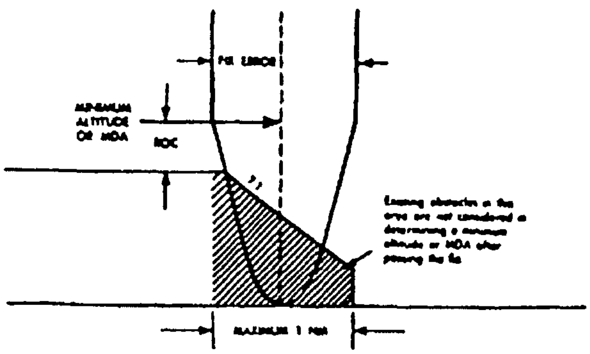


FIGURE 36. OBSTACLES CLOSE-IN TO A FIX. Par 289.

SECTION 9. HOLDING

290. HOLDING PATTERNS. Criteria for holding pattern airspace are contained in FAA 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 shall 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 shall not differ by more than 30°.

292. AREA.

a. The primary obstacle clearance area shall be based on the appropriate holding pattern area specified in FAA 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 shall 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 shall encompass the departure or missed approach segment width at the holding fix (see figure 37-2).

f. A secondary area 2 miles wide surrounds the perimeter of the primary area

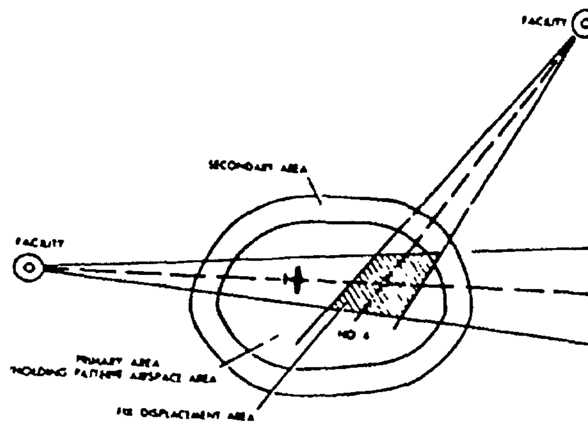


FIGURE 37-1. HOLDING PATTERN TEMPLATE APPLICATION. Par 292.

293. OBSTACLE CLEARANCE.

a. *Level Holding.* A minimum of 1,000 feet of obstacle clearance shall be provided throughout the primary area. In the secondary area 500 feet of obstacle clearance shall be provided at the inner edge, tapering to zero feet at the outer edge. For computation of obstacle clearance in the secondary area see paragraph 232c. Allowance for precipitous terrain should be considered as stated in paragraph 323a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet. See paragraph 231.

b. Climbing in a Holding Pattern. When a climb in hold is used, as in a departure or missed approach, no obstacle shall 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 FAA Order 7130.3, paragraph 35.

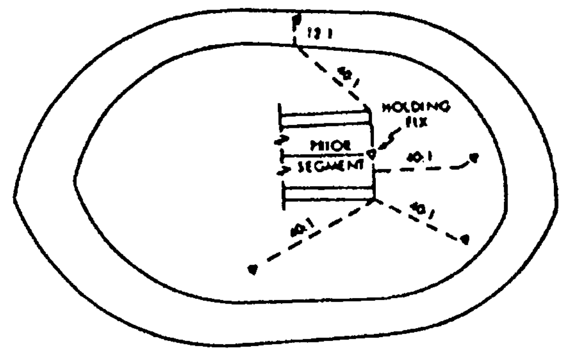


FIGURE 37-2. CLIMBING IN A HOLDING PATTERN. Par 293b.

294. - 299. RESERVED.

CHAPTER 3. TAKEOFF AND LANDING MINIMUMS

300. APPLICATION. The minimums specified in this chapter are the lowest which can be approved at any location for the type facility concerned.

301.-309. RESERVED.

SECTION 1. GENERAL INFORMATION

310. ESTABLISHMENT. The minimums established for a particular airport shall be the lowest permitted by the criteria contained in this order. Each procedure shall specify minimums for the various conditions stated in the procedure; i.e., straight-in, circling, alternated, and takeoff, as required. The elements of minimums are the MDA (or DH) and the weather. The weather minimums shall include the visibility required by the procedure, and may include a ceiling value which is equal to or greater than the height of the MDA or DH above airport elevation. Where ceilings are not specified, the height of the straight-in MDA or DH above the highest elevation in the touchdown zone (or the airport elevation in circling approaches) shall be shown on the procedure. Alternate minimums, when specified, shall be stated as ceiling and visibility. Takeoff minimums, when specified, shall be stated as visibility only, except where the need to see and avoid an obstacle makes it necessary to specify a ceiling value. Military services may specify alternate and takeoff minimums in separate directives.

311. PUBLICATION. Minimums should be published for each approach category which can be accommodated at the airport. Where the airport landing surface is not adequate, or other restrictions exist which prohibit certain categories of aircraft from making an instrument approach at an airport, "NA" (not authorized) shall be entered in lieu of the minimums values. Approach Category "E" minimums should be published only on high altitude procedures, except where a special requirement exists for their publication or other procedures. Minimums on military procedures shall be published as prescribed by the appropriate Service.

312.-319. RESERVED.

SECTION 2. ALTITUDES

320. MINIUM DESCENT ALTITUDE (MDA). The MDA is the lowest altitude to which descent shall be authorized in procedures not using a glide slope. Aircraft are not authorized to descend below the MDA until the runway environment (see glossary) is in sight, and the aircraft is in a position to descend for a normal landing. The MDA shall be expressed in feet above MSL and is determined by adding the required obstacle clearance to the MSL height of the controlling obstacle in the final approach segment and circling approach area for circling approaches.

321. MDA FOR STRAIGHT-IN APPROACH. The MDA for a straight-in approach shall provide at least the minimum required clearance over obstacles in the final approach segment. It shall also be established high enough to ensure that obstacles in the missed approach area do not penetrate the 40:1 missed approach surface (see paragraph 274). The MDA shall be rounded off to the next HIGHER 20-foot increment. For example, 2,104 feet becomes 2,120.

322. MDA FOR CIRCLING APPROACH. The height of the circling MDA above the airport (HAA) shall not be less than the minimum shown in paragraph 351. In addition, the MDA shall provide at least the minimum required final obstacle clearance in the final approach segment and the minimum required circling obstacle clearance in the circling approach area. It shall also meet the missed approach requirements specified in paragraph 321. Round the MDA to the next higher 20-foot increment. For example, 2,109 feet shall become 2,120. The published circling MDA shall not be above the FAF altitude or below the straight-in MDA.

323. MINIMUMS ADJUSTMENTS. Raising the MDA or DH above that required for obstacle clearance may be necessary under the following conditions:

a. Precipitous Terrain. When procedures are designed for use 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 which result when winds of 20 knots or more move over such terrain. Where these conditions are known to exist, required obstacle clearance in the final approach segment should be increased. Procedures specialists and approving authorities should be aware of the hazards involved and make appropriate addition, based on their experience and good judgment, to limit the time in which an aircraft is exposed to lee-side turbulence and other weather phenomena associated with precipitous terrain. This may be done by increasing the minimum altitude over the intermediate and final approach fixes so as to preclude prolonged flight at low altitudes. User comments should be solicited to obtain the best available local information.

b. Remote Altimeter Setting Source (RASS). When the altimeter setting is obtained from a source more than 5 NM from the airport reference point (ARP) for an airport, or the heliport reference point (HRP) for a heliport or vertiport, the ROC shall be increased by the amount of RASS adjustment for the final (except precision final), step-down, circling, and intermediate segments. For precision finals, the DH shall be increased by the amount of RASS adjustment. When two altimeter sources are used, RASS shall be applied to the missed approach climb-to-altitude. RASS adjustment does not apply to MSA's, initials, en route, feeder routes, or segment/areas based on en route criteria. 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 6,000 feet. To determine which adjustment shall apply, evaluate the airport/heliport/vertiport for adverse atmospheric pressure pattern effects. Comments should be solicited 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) to obtain the best available climatological information.

(1) Where intervening terrain does not adversely influence atmospheric pressure patterns, the following formula shall be used to compute the basic adjustment in feet:

$$\text{Adjustment} = 2.30d_R + 0.14e$$

where "d_R" is the horizontal distance in nautical miles from the altimeter source to the ARP/HRP; and "e" is the elevation differential in feet between the elevation of the RASS and the elevation of the airport/heliport/vertiport (see figure 37B).

(2) Where intervening terrain adversely influences atmospheric pressure patterns, an elevation differential area (EDA) shall 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 (see figure 37C). The following formula shall be used to compute the basic adjustment feet.

$$\text{Adjustment} = 2.30d_R + 0.14E$$

where "d_R" is the horizontal distance in nautical miles from the altimeter source to the ARP/HRP; and "E" is the terrain elevation differential in feet between the lowest and highest terrain elevation points contained within the EDA (see figure 37C).

(3) For the intermediate segment, use 60 percent of the basic adjustment from paragraphs 323b(1) or (2), and increase the intermediate segment of ROC by the amount this value exceeds 200 feet.

(4) For a missed approach climb-to-altitude when two altimeter sources are available and the climb-to-altitude is less than the missed approach clearance limit altitude, apply RASS adjustment to the climb-to-altitude or to the section 2 and zone 2/3 40:1 surface height as follows:

(a) Decrease the starting height of the 40:1 surface for section 2 and zone 2/3 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 height of the 40:1 surface at the MAP.

(b) If application of 323b(4)(a) results in a 40:1 surface penetration that cannot be resolved by other methods, provide a second climb-to-altitude using the least accurate altimeter source by adding the difference between the RASS adjustments to the climb-to-altitude and rounding to the next higher 20-foot increment. DO NOT lower the section 2 and zone 2/3 40:1 surfaces. This application shall not increase the climb-to-altitude above the missed approach clearance limit altitude.

For example: MISSED APPROACH
Climb to 5,900 (6,100 when using Denver/Stapleton altimeter setting) then … ..

(5) Point-in-Space Approach (PINSA). When the MAP is more than 5 NM from the PINSA altimeter setting source, RASS adjustment shall be applied. For application of the RASS formula, define "d_R as the distance from the altimeter setting source to the MAP, -- and define "e," or "E," as in paragraph 323b(1) or (2).

(6) Minimum Reception Altitude (MRA). Where a minimum altitude is dictated by the MRA, the MRA shall be increased by the amount of the RASS adjustment factor.

(7) Where the altimeter is based on a remote source, the procedure shall be annotated, or provided a second set of minima.

c. Excessive Length of Final Approach. When a final approach fix is incorporated in the procedure, and the distance from that fix to the nearest landing surface exceeds 6 miles, the required obstacle clearance in the final approach segment shall be increased at the rate of 5 feet for each one-tenth of a mile over 6 miles. Where a step-down fix is incorporated in the final approach segment, the basic obstacle clearance may be applied between the step-down fix and the MAP, provided the fix is within 6 miles of the landing surface. These criteria are applicable to nonprecision approach procedures only.

324. DECISION HEIGHT (DH). The decision height applies only where an electronic glide slope provides the reference for descent, as in ILS or PAR. The decision height is the height, specified in feet above MSL, above the highest runway elevation in the touchdown zone at which a missed approach shall be initiated if the required visual reference has not been established. Decision heights shall be established with respect to the approach obstacle clearance requirements specified in the ILS and PAR chapters, and shall NOT be less than the HAT shown in the appropriate table in paragraph 350.

325.-329. RESERVED.

Section 3. Visibilities.

330. ESTABLISHMENT OF VISIBILITY MINIMUMS.

a. Straight-in minimums for NONPRECISION approaches shall be established for an approach category when:

(1) The final approach course runway alignment criteria have been met, AND

(2) The visibility requirements of paragraph 331 are met, AND

(3) The height of the MDA above the touchdown zone (TDZ) and the associated visibility are within the tolerances specified in paragraph 331, AND

(4) The descent gradient from the final approach fix to the runway does not exceed the maximum specified in the applicable facility chapter of this order.

b. Straight-in minimums for PRECISION approaches shall be established for an approach category when the final approach course runway alignment criteria have been met.

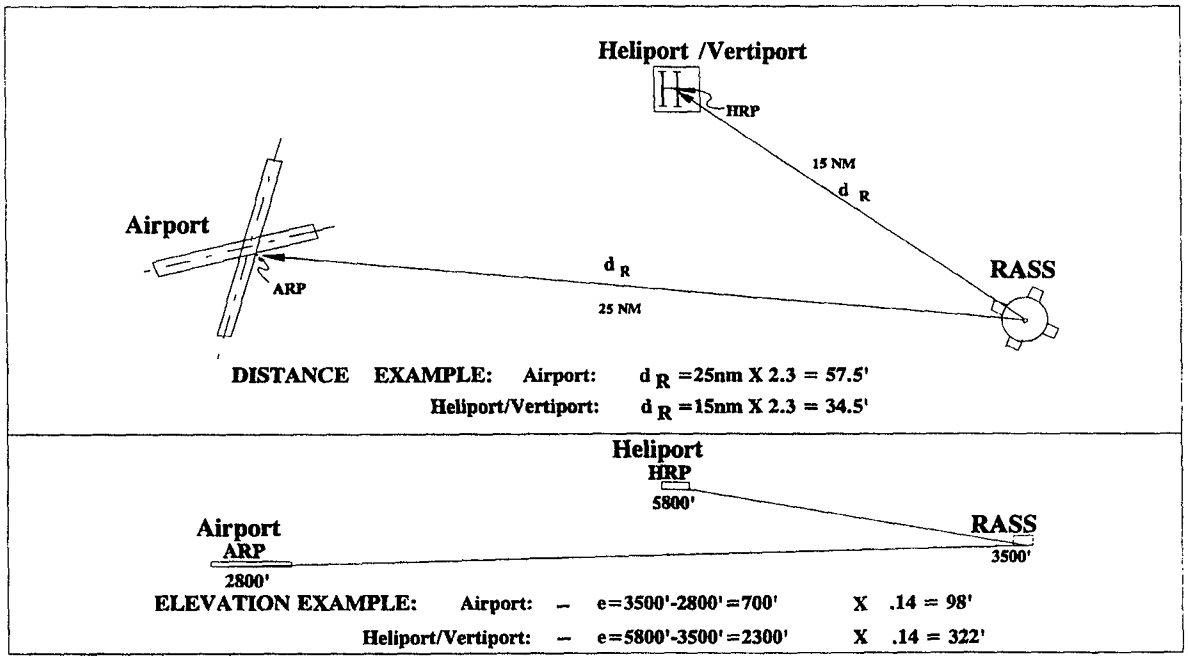
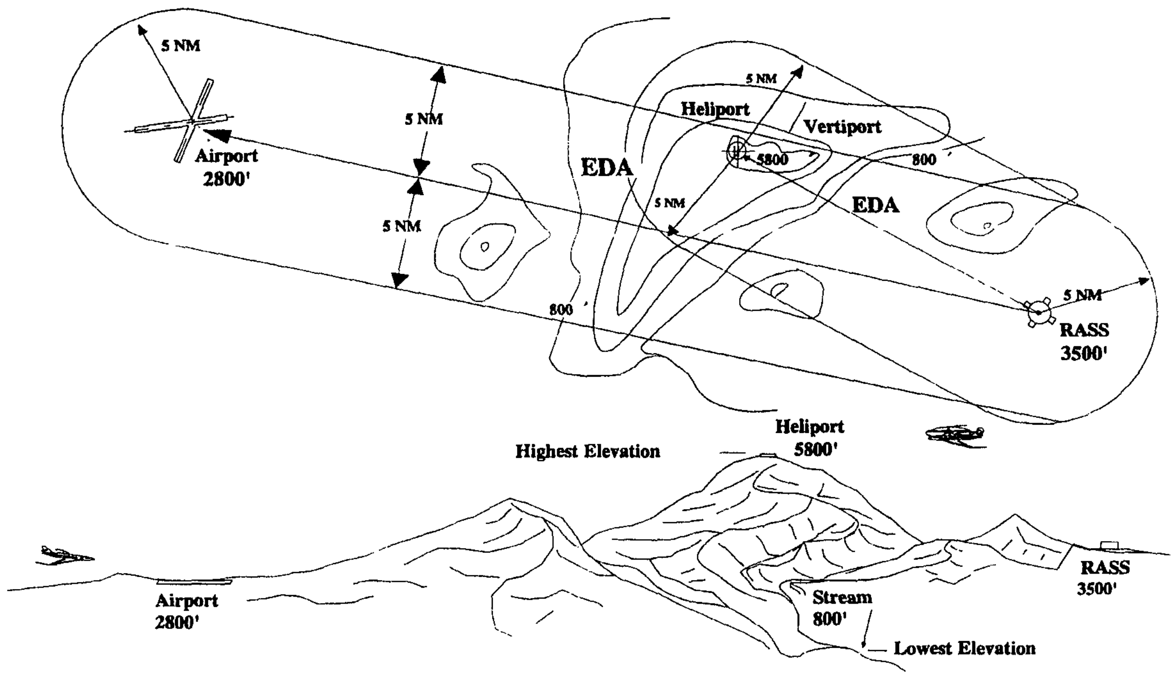


Figure 37B. DISTANCE REMOTED (d_R) AND ELEVATION. Par 323b.



EXAMPLE: ELEVATION DIFFERENTIAL: Airport: – E=5800'-800'=5000' X .14 = 700'
Heliport/Vertiport: – E=5800'-800'=5000' X .14 = 700'

Figure 37C. ELEVATION DIFFERENTIAL AREA (EDA). Par. 323b. WHERE INTERVENING TERRAIN INFLUENCES ATMOSPHERIC PRESSURE PATTERNS.

Table 6. EFFECT OF HAT/HAA ON VISIBILITY MINIMUMS

HAT/HAA (ft.)	250-320	321-390	391-460	461-530	531-600	601-670	671-740	741-810	811-880	881-950	951 & above
CAT A	1 mi ----------									1¼-	
CAT B	1 mi ----------							1¼ ----------			1½

HAT/HAA	250-400	401-500	501-600	601-670	671-740	741-810	811-880	881-950	951 & above
CAT C	1 mi	1¼	1½	1¾	2	2¼	2½	2¾	3

HAT/HAA	250-341	342-426	427-511	512-600	601-670	671-740	741-810	811-880	881-950	951 & above
CAT D	1 mi	1¼	1½	1¾	2	2¼	2½	2¾	3 ----------	

HAT/HAA	250-320	321-390	391-460	461-530	531-600	601-670	671-740	741-810	811-880	881-950	951 & above
CAT E	1 mi	1¼	1½	1¾	2	2¼	2½	2¾	3 ----------		

c. The minimum visibility prior to applying credit for lights shall be the higher of the following values:

(1) The MAP to threshold distance (where the MAP is reached before the threshold).

(2) Those given in table 6 or 6a, paragraph 331.

This subparagraph does not apply to a procedure where the MAP is more than 2 statute miles from the airport and the procedure is noted, "Fly visual to airport" in which case the required visibility shall be at least 2 miles, but not less than the visibility specified in Table 6.

d. When straight-in minimums are not authorized, only circling MDA's and visibilities will be established. In establishing circling visibility minimums, paragraph 331 applies. These minimums shall be no lower than those specified in paragraph 351.

e. Circling landing minimums shall NOT be lower than straight-in landing minimums.

331. EFFECT OF HAT/HAA AND FACILITY DISTANCE ON STRAIGHT-IN AND CIRCLING VISIBILITY MINIMUMS. The minimum standard visibility required for the pilot to establish visual reference in time to descend safely from the MDA and maneuver to the runway or airport varies with the aircraft category, the HAT/HAA, and the accuracy of the navigation system. Table 6 specifies the minimum standard visibility as determined by HAT/HAA. Table 6A specifies the minimum standard visibility as determined by distance from the facility to the runway.

NOTE: The higher of the visibilities derived from the table applies.

Table 6A. EFFECT OF FACILITY DISTANCE ON VISIBILITY MINIMUMS

NAVAID TYPE	CAT	DISTANCE FROM FACILITY TO MAP OR RWY THLD (whichever is farther)				
		0-10	>10-15	>15-20	>20-25	>25-30
ASR	A B C D-E	1 1 1 1	1 1¼ 1½ 2	1 1¼ 1½ 2	N/A	N/A
NDB DF	A B C D-E	1 1 1 1	1 1¼ 1½ 2	N/A	N/A	N/A
VOR TACAN LOC SDF LDA	A B C D-E	1 1 1 1	1 1 1 1¼	1 1 1¼ 1½	1 1¼ 1½ 1¾	1 1¼ 1½ 2

332. EFFECT OF OBSTACLES. Visibility minimums must be at or above certain values when obstacles penetrate the visual assessment surfaces (see paragraph 251).

333. RUNWAY VISUAL RANGE (RVR). RVR is a system of measuring the visibility along the runway. It is an instrumentally derived value that represents the horizontal distance a pilot will see down the runway from the approach end. It is based on the sighting of either high intensity runway lights or the visual contrast of other targets, whichever yields the greater visual range.

334. RUNWAY REQUIREMENTS FOR APPROVAL OF RVR. RVR may be authorized for straight-in approach procedures and takeoff when the following requirements are met with respect to the runway to be used.

a. Transmissometers shall be located under standards established by the approval authority (e.g., FAA Standard 008).

b. High intensity runway lights spaced at consecutive intervals of not more than 200 feet shall be operative.

c. Instrument runway markings or touchdown zone and centerline (TDZ/CL) lighting are required for nonprecision approaches. Precision instrument (all-weather) runway markings are required for all runways served by a precision approach. Precision markings are also required for nonprecision or instrument procedure with vertical guidance (IPV) approaches with visibility minimums less than ¾ statute mile Except for PAR, TDZ/CL lighting is required for precision approaches with RVR 1800. Where sufficient runway lengths are not available to accommodate standard all-weather markings, the approving authority will determine the runway markings to be used. Where required runway markings are not available and credit for lights is not granted, but TDZ/CL's are available, RVR equal to the visibility minimum without lights is authorized.

335. COMPARABLE VALUES OF RVR AND GROUND VISIBILITY. If RVR minimums for takeoff or landing are prescribed in an instrument approach procedure but RVR is not reported for the runway of intended operation, the RVR minimums shall be converted to ground visibility in accordance with table 7, and observed as the applicable visibility minimum for takeoff or landing on that runway.

Table 7. COMPARABLE VALUES OF RVR AND GROUND VISIBILITY

RVR	VIS (Statute Miles)	RVR	VIS (Statute Miles)
1600	¼	4500	7/8
2400	½	5000	1
3200	5/8	6000	1-1/4
4000	¾		

336.-339. RESERVED.

SECTION 4. VISIBILITY CREDIT FOR LIGHTS

340. GENERAL. 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. This section identifies lighting systems and prescribes the operational conditions which must exist in order to reduce straight-in visibility minimums. Table 9 for civil and table 10 for military in paragraph 350 specify the **LOWEST** civil and military visibility minimums which can result from application of this section.

341. STANDARD LIGHTING SYSTEMS. Listed in table 8 are the types of standard lighting systems and the required operational coverage for each type.

342. OPERATIONAL CONDITIONS. Credit to reduce straight-in landing minimums for standard or equivalent approach light systems may be given when the following conditions exist for the straight-in landing runway:

a. Markings. The runway must have nonprecision instrument or precision instrument (all-weather) markings or TDZ/CL's as specified in paragraph 334c, and in the directives of the appropriate approving authority.

b. Approach Course. The final approach course must place the aircraft within the operational coverage of the lighting system at a distance from the landing threshold equal to the standard visibility required without lights. See paragraph 330 and figure 37D for guidance.

Table 8. STANDARD LIGHTING SYSTEMS

ABBREV. IFR	LIGHTING SYSTEM	Oper. Coverage (Degrees) Lateral (±)	Vertical (abv Hor.)
ALSF-I	Standard approach light system with sequenced flashers	21.0* 12.5#	12.0* 12.5#
ALSF-II	Standard approach light system with sequenced flashers & CAT II mod.	21.0* 12.5#	12.0* 12.5#
SSALS	Simplified short approach light system	21.0	12.0
SSALF	Simplified short approach light system with sequenced flashers	21.0* 12.5#	12.0* 12.5#
SSALR	Simplified short approach light system with runway alignment indicator lights	21.0* 12.5#	12.0* 12.5#
MALS	Medium intensity approach light system	10.0	10.0*
MALSF	Medium intensity approach light system with sequenced flashers	10.0* 12.5#	10.0* 12.5#
MALSR	Medium intensity approach light system with runway alignment indicator lights	10.0* 12.5#	10.0* 12.5#
ODALS	Omnidirectional approach light system	360#	+2- +10#
VFR			
REIL	Runway end identifier lights	12.5	12.5
LDIN	Lead-in lighting system (can be * or #)	12.5	12.5
VASI	Visual approach slope indicators	10.0	3.5

RUNWAY LIGHT SYSTEMS

HIRL	High intensity runway lights
MIRL	Medium intensity runway lights
LIRL	Low intensity runway lights
TDZ/CL	Touchdown zone and centerline lights

NOTE: *Descriptions of lighting systems may be found in appendix 5 and FAA Order 6850.2.*

**Steady-burning* *#Sequenced flashers*

343. VISIBILITY REDUCTION. Standard visibility requirements are computed by applying the criteria contained in paragraph 331. When the visibility without lights value does not exceed 3 statute miles, these requirements may be reduced by giving credit for standard or equivalent approach light system as follows (see paragraph 341 and appendix 5):

a. **The provisions of paragraphs** 332, 342, 935, or 1025, as appropriate, must be met.

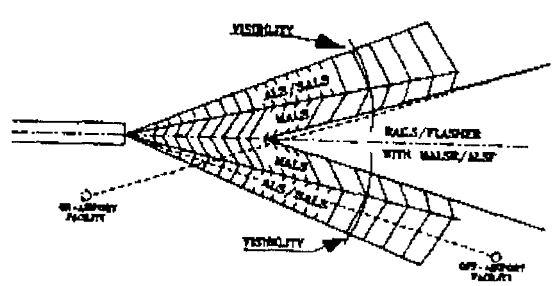


Figure 37D. APPLICATION OF LATERAL COVERAGE ANGLES OF TABLE 8, Par 342b.

NOTE: The final approach course to an 'on-airport' facility transits all approach light operational areas within limits of visibility arc, whereas the final approach course from the 'off-airport' facility may be restricted only to an ALS or SALS for visibility credit.

b. Where the visibility required without lights does not exceed one mile, visibility as low as that specified in the appropriate table in paragraph 350 with associated DH or HAT and lighting may be authorized.

c. For civil application, where the visibility required without lights exceeds 1 mile, a reduction of ½ mile may be made for SSALR, MALSR or ALSF-1/2 provided such visibility minimum is not less than that specified in paragraph 350. Reduction for CAT D aircraft in NDB approach procedures shall not exceed 1/4 mile or result in visibility minimums lower than 1 mile.

d. For military applications, where the visibility required without lights exceeds 1 mile, a reduction of 1/4 mile may be made for SSALS, SALS, MALS, or ODALS, and a reduction of 1/2 mile may be made for ALS, SSALR, or MALSR provided such visibility minimum is not less than that specified in paragraph 350.

e. Where visibility minimums are established in order to see and avoid obstacles, visibility reductions shall not be authorized.

f. Visibility reductions are NOT cumulative.

344. OTHER LIGHTING SYSTEMS. In order for variations of standard systems and other systems not included in this chapter to receive visibility reduction credit, the operational conditions specified in paragraph 342 must be met. Civil airport lighting systems which do not meet known standards or for which criteria do not exist, will be handled UNDER the provisions of paragraph 141. Military lighting systems may be equated to standard systems for reduction of visibility as illustrated in appendix 5. Where existing systems vary from the configurations illustrated there and cannot be equated to a standard system, they shall be referred to the appropriate approving authority for special consideration.

345.-349. RESERVED.

SECTION 5. STANDARD MINIMUMS

350. STANDARD STRAIGHT-IN MINIMUMS. Tables 9 and 10 specify the lowest civil and military minimums which may be prescribed for various combinations of electronic and visual navigation aids. Lower minimums based on special equipment or air crew qualifications may be authorized only by approving authorities. Higher minimums shall be specified where required by application of criteria contained elsewhere in this order.

351. STANDARD CIRCLING MINIMUMS. Table 11 specifies the lowest civil and military HAA and visibility which may be prescribed for circling approaches. See also paragraph 330c. The MDA established by application of the minimums specified in this paragraph shall be rounded to the next higher 20 feet.

352.-359. RESERVED.

SECTION 6. ALTERNATE MINIMUMS

360. STANDARD ALTERNATE MINIMUMS. Minimums authorized when an airport is to be used as an alternate airport appear in table 12. The ceiling and visibility specified shall NOT be lower than the circling HAA and visibility, or as specified in military directives for military operations.

361.-369. RESERVED.

SECTION 7. DEPARTURES

370. STANDARD TAKEOFF MINIMUMS. Where applicable, civil standard takeoff minimums are specified by the number of engines on the aircraft. Takeoff minimums are stated as visibility only, except where the need to see and avoid an obstacle makes a ceiling value necessary (see table 13). In this case, the published procedure shall identify the location of the controlling obstacle. Takeoff minimums for military operations shall be as stated in the appropriate service directives.

Table 9. CIVIL STANDARD STRAIGHT-IN MINIMUMS

	NONPRECISION APPROACHES					
	NONPRECISION APPROACHES Procedures associated with 14 CFR Part 97.23, 25, 27, 31, 33, and 35					
	APPROACH LIGHT CONFIGURATION	CAT →	A – B – C		D	
		HAT[1]	Vis	or RVR	Vis	or RVR
1	NO LIGHTS	250	1	5000	1	5000
2	ODALS	250	3/4	4000	1	5000
3	MALS	250	3/4	4000	1	5000
4	SSALS/SALS	250	3/4	4000	1	5000
5	MALSR	250	1/2[2]	2400	1[3]	5000
6	SSALR	250	1/2[2]	2400	1[3]	5000
7	ALSF-1	250	1/2[2]	2400	1[3]	5000
8	DME Arc Any Light Configuration	500	1	5000	1	5000

[1] Add 50 ft to HAT for VOR without FAF or NDB with FAF.
Add 100 ft to HAT for NDB without FAF.
[2] For NDB approaches, 3/4 mile or RVR 4000.
[3] For LOC, 3/4 miles or RVR 4000.

	PRECISION APPROACHES					
	14 CFR Part 97.29					
	APPROACH LIGHT CONFIGURATION	CAT →	A – B – C		D	
		HAT[4]	Vis	or RVR	Vis	or RVR
9	NO LIGHTS	200	3/4	4000	3/4	4000
10	MALSR	200	1/2	2400	1/2	2400
11	SSALR	200	1/2	2400	1/2	2400
12	ALSF-1	200	1/2	2400	1/2	2400
13	ALSF-1-TDZ/CL MALSR-TDZ/CL SSALR-TDZ/CL	200	-	1800	-	1800

[4]ILS includes LOC, GS, and OM (or FAF). With Offset LOC (max 3°). HAT is 250 and RVR below 2400 is not authorized.

NOTE: HIRL is required for RVR. Runway edge lights required for night.

Table 10. MILITARY STANDARD STRAIGHT-IN MINIMUMS

		NO LIGHTS		AKS TDZ/CL		ALS		SSALR		SALS or SSALS		MALSR		MALS		ODALS	
PRECISION																	
HAT	CAT	MILE	RVR[1]	MILE	RVR	MILE	RVR	MILE	RVR	MILE	RVR	MILE	RVR	MILE	RVR	MILE	RVR
100	A–E	½	24	—	12	1/4	18	1/4	16	1/4	16	½	24	1/2	24	1/2	24
200	A–B	¾	40	1/2	18	1/2	24	1/2[2]	24[2]	1/2	24	½	24	3/4	40	1/2	24
200	C D.E	¾	40	1/2[2]	24[2]	1/2[2]	24[2]	1/2[2]	24[2]	3/4	40	1/2[2]	24[2]	3/4	40	3/4	40
250	A–B	3/4[4]	40[4]	1/2	24	1/2[3]	24[3]	1/2	24	3/4	40	½	24	3/4	40	3/4	40
250	C.D E.	1	50	1/2	24	1/2[3]	24[3]	1/2	24	3/4	40	½	24	3/4	40	1	50
NONPRECISION																	
AS REQUIRED	A-B	1	50	1/2	24	1/2	24	1/2	24	3/4	40	½	24	3/4	40	3/4	40
AS REQUIRED	C.D E	5	50	3/4	40	3/4	40	3/4	40	3/4	40	¾	40	3/4	40	3/4	40
DME ARC APPROACH																	
AS REQUIRED	A–E	1	50	(REDUCTION BELOW ONE MILE NOT AUTHORIZED)													

[1]RVR shown in hundreds of feet, i.e., RVR 24=2,400 feet.
[2]Minimum length of approach lights is 2,000 feet.
[3]For non-standard ALS lengths of:
a. 2,400 to 2,900 feet, use SSALR.
b. 1,000 to 2,300 feet, use SSALS.
[4]When the MAP is located 3/4 mile or less from the threshold.

INSTRUCTIONS FOR ESTABLISHING MILITARY STRAIGHT-IN MINIMUMS (Use Table 10)

STEP 1.	Determine the required DH or MDA by applying criteria found in the appropriate facility chapter of this Order.
STEP 2.	Determine the height above touchdown zone elevation (HAT).
STEP 3.	Determine the visibility value as follows: a. Precision Approaches. (1) HAT 250 feet or less. Enter "precision" portion of table 10 at HAT value for aircraft approach category. Read across table to determine minimum visibility for the appropriate light system. If the HAT is not shown on the table, use the next higher HAT. (2) HAT greater than 250 feet. Use the instructions for the nonprecision minimums in paragraph b below. Paragraph 331 does not apply. b. Nonprecision Approaches. Determine the basic visibility by application of criteria in paragraphs 330 and 331. If the basic visibility is 1 mile, enter table 10 with aircraft approach category being considered. Read across the table to determine minimum visibility for the appropriate light system.
STEP 4.	Establish ceiling values in 100-foot increments in accordance with paragraph 310.

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Table 11. STANDARD CIRCLING MINIMUMS					
	Approach Category				
	A	B	C	D	E
Height Above Airport Elevation in feet	350	450	450	550	550
Visibility in Miles	1	1	1 ½	2	2

Table 12. STANDARD ALTERNATE MINIMUMS		
Type of Approach Facility	**Ceiling**	**Visibility**
VOR, VORTAC, LOC, LDA, ASR, NDB	800	2
ILS or Par	600	2

*

Table 13. STANDARD CIVIL TAKEOFF MINIMUMS	
Number of Engines	**Visibility (Statute Miles)**
1 or 2	1
3 or more	½

371.-399. RESERVED.

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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.

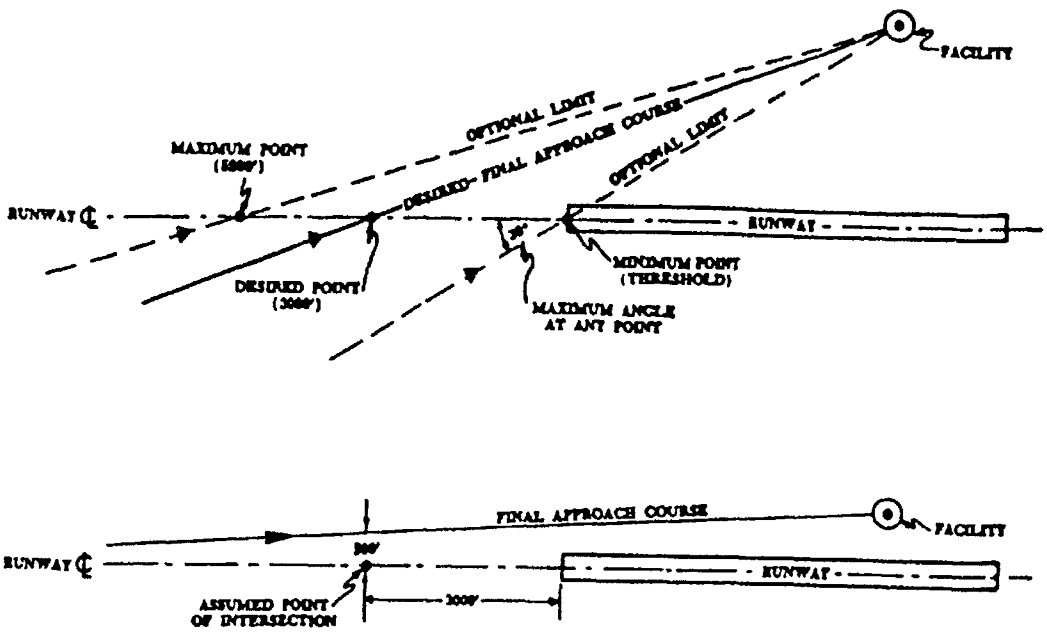


Figure 38. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. On-Airport VOR, No FAF. Straight-in Approach Procedure. Par. 413a(1).

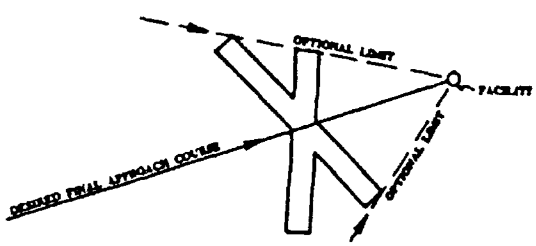


Figure 39. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. On-Airport VOR. No FAF. Circling Approach Procedure. Par 413a(2).

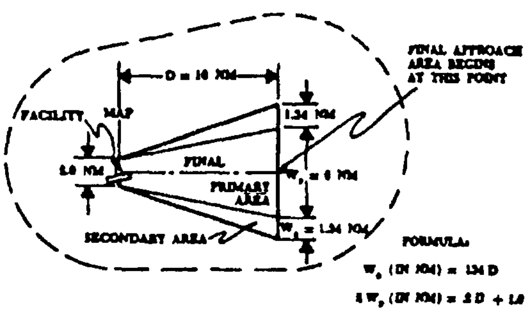


Figure 40. FINAL APPROACH PRIMARY AND SECONDARY AREAS. On-Airport VOR. No FAF. Par 413b.

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.

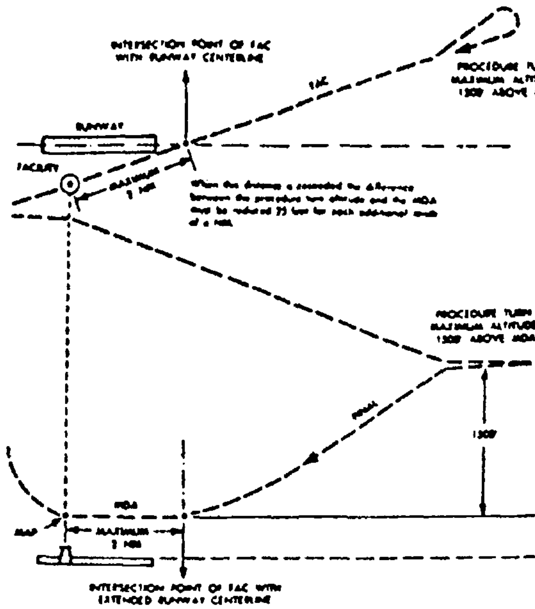


Figure 41. PT ALTITUDE.
On-Airport VOR, No FAF. Par 413d.

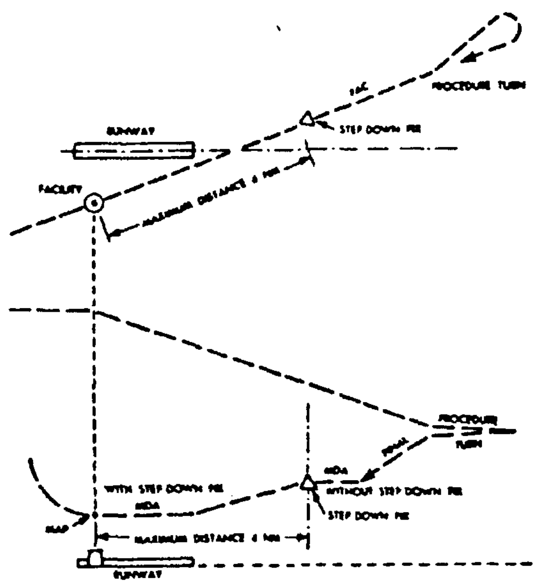


Figure 42. USE OF STEPDOWN FIX. On-Airport VOR. No FAF. Par 413e.

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.

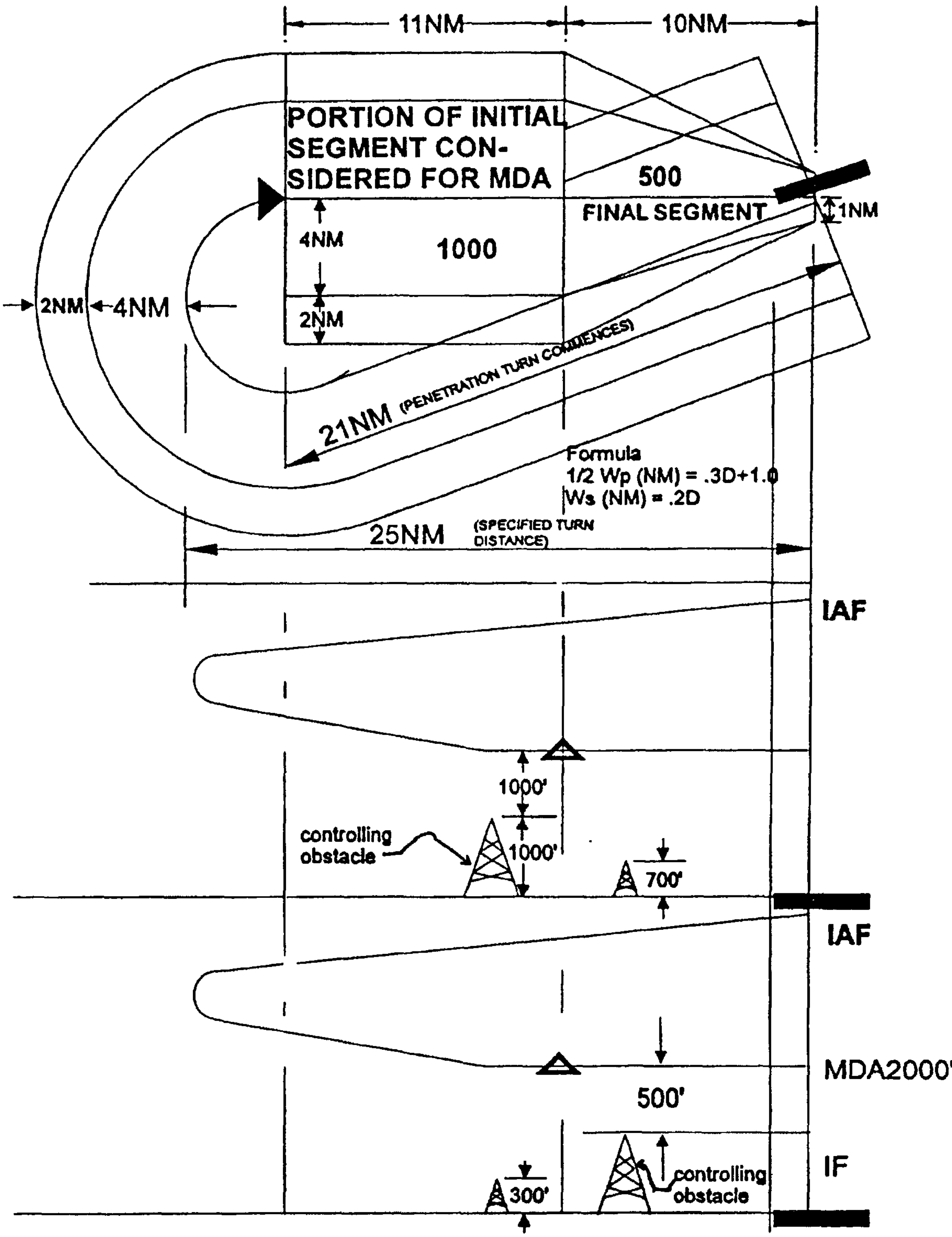


Figure 43. PENETRATION TURN. On-Airport VOR. No FAF. Par 423.

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.

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.

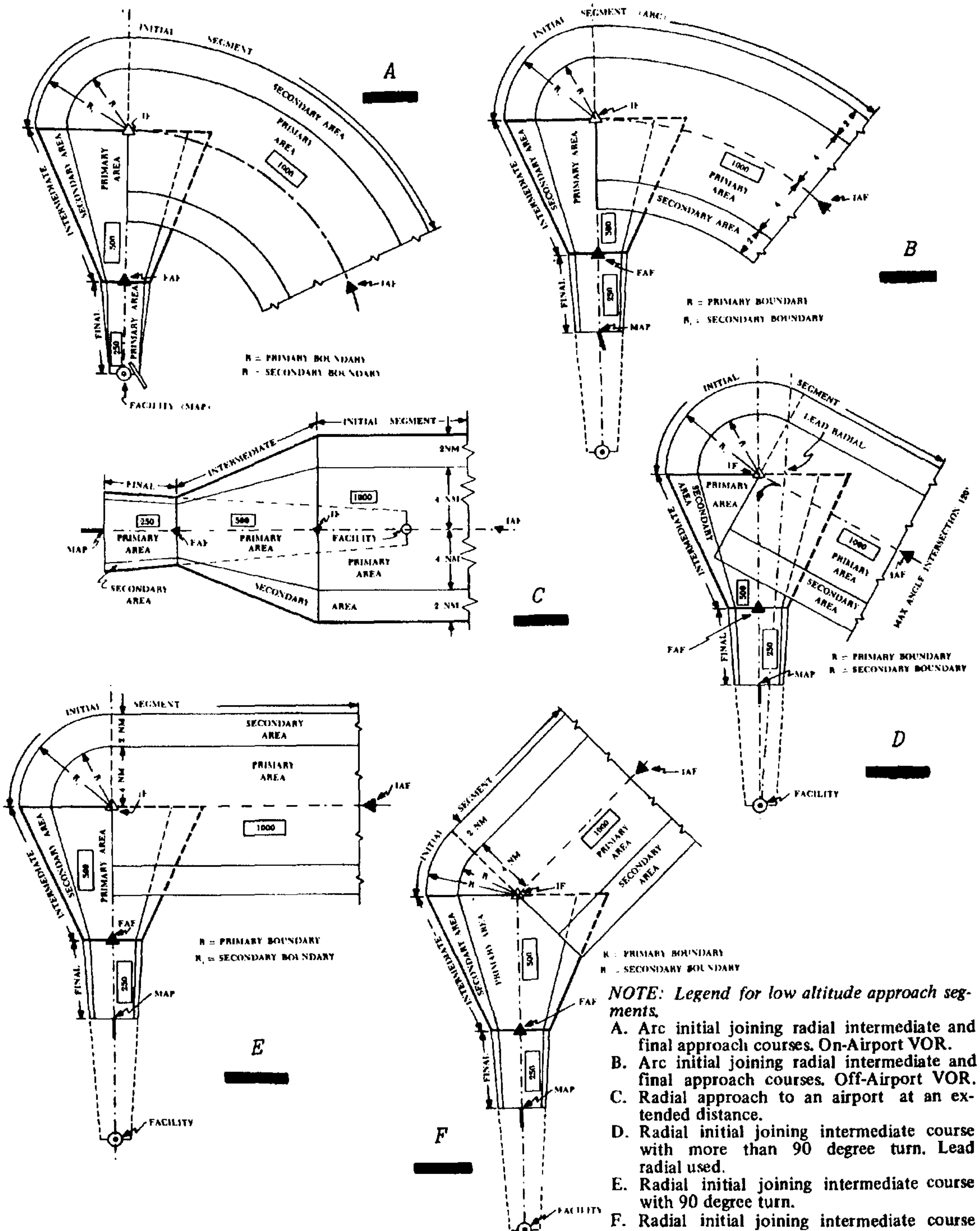
(a) *Straight-In.* The angle of convergence of the final approach course and the extended runway centerline shall not exceed 30 degrees. The final approach course should be aligned to intersect the runway centerline at the runway threshold. However, when an operational advantage can be achieved, the 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.

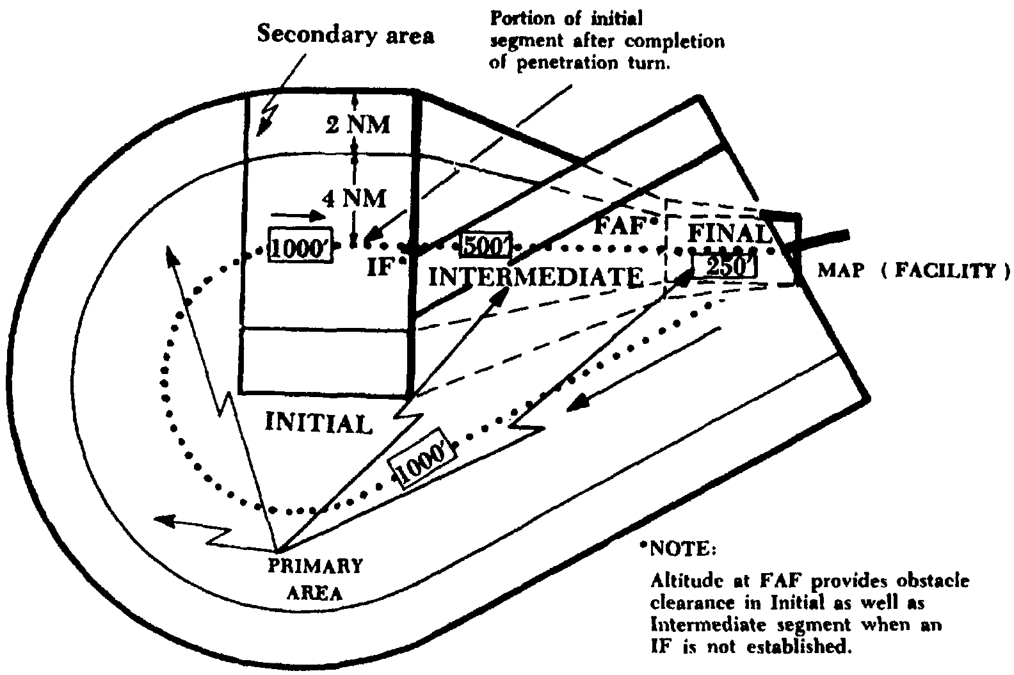


Figure 45. TYPICAL HIGH ALTITUDE SEGMENTS. VOR with FAF. Par 511 and 512.

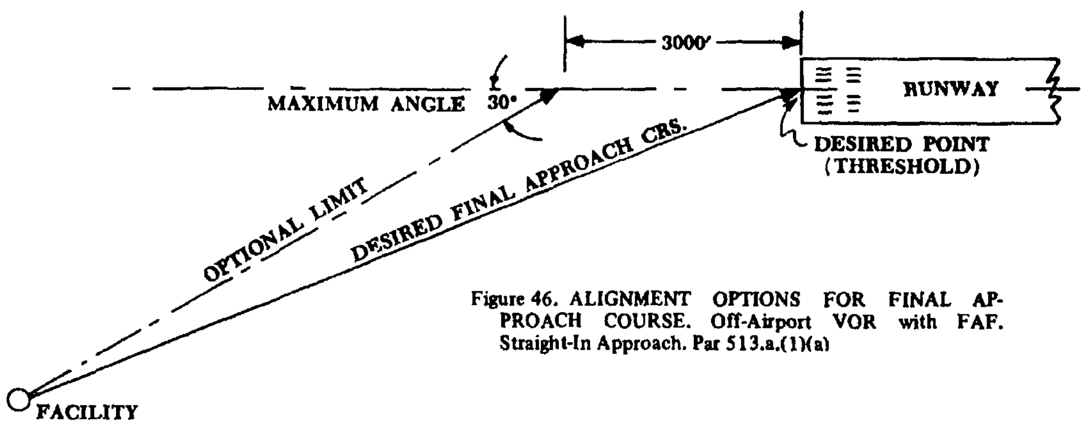


Figure 46. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. Off-Airport VOR with FAF. Straight-In Approach. Par 513.a.(1)(a)

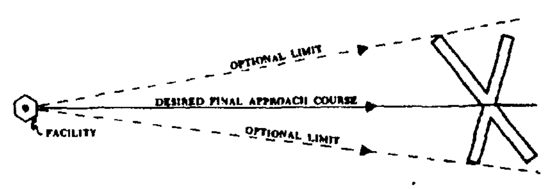
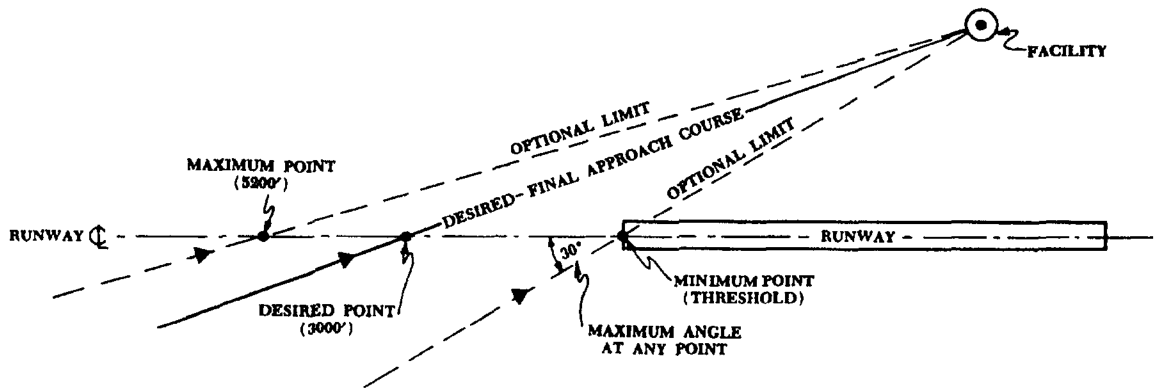


Figure 47. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. Off-Airport VOR with FAF. Circling Approach. Par. 513.a.(1)(b).



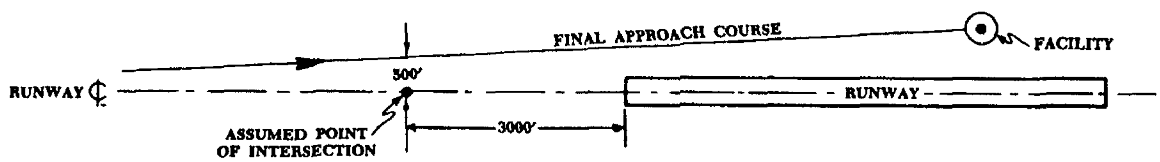


Figure 48. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. On-Airport VOR with FAF. Straight-In Approach. Par 513.a.(2)(a)

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

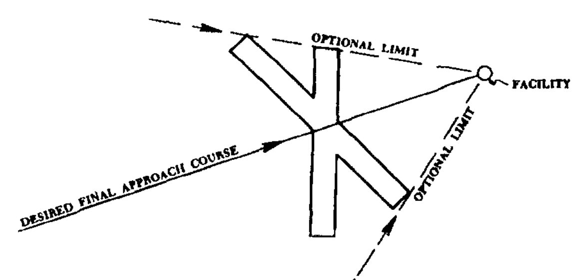


Figure 49. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. On-Airport VOR with FAF. Circling Approach. Par 513.a.(2)(b).

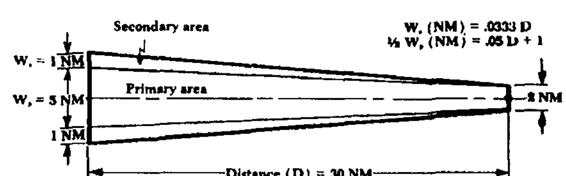


Figure 50. FINAL APPROACH TRAPEZOID. VOR with FAF. Par 513.b.

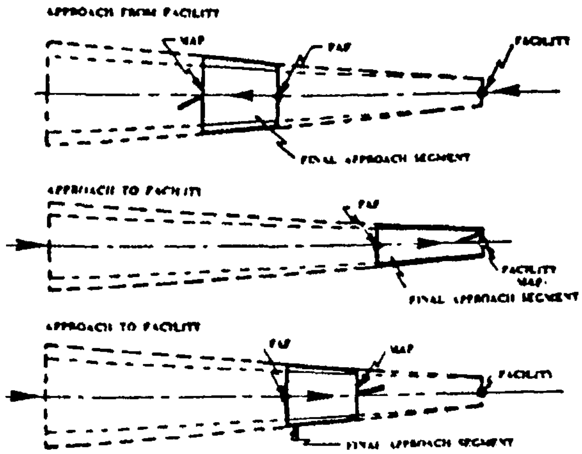


Figure 51. TYPICAL STRAIGHT-IN FINAL APPROACHES. VOR WITH FAF. Par 513b.

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.

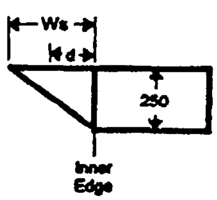
c. **Obstacle Clearance.**

(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).

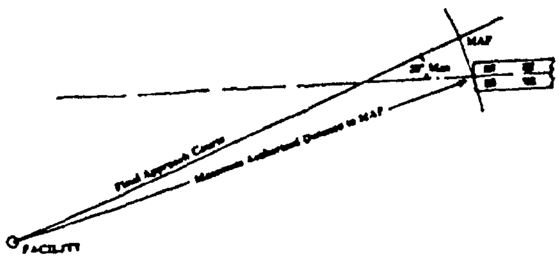


Figure 52. MAP.
Off-Airport VOR with FAF. Par 514a(1).

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.

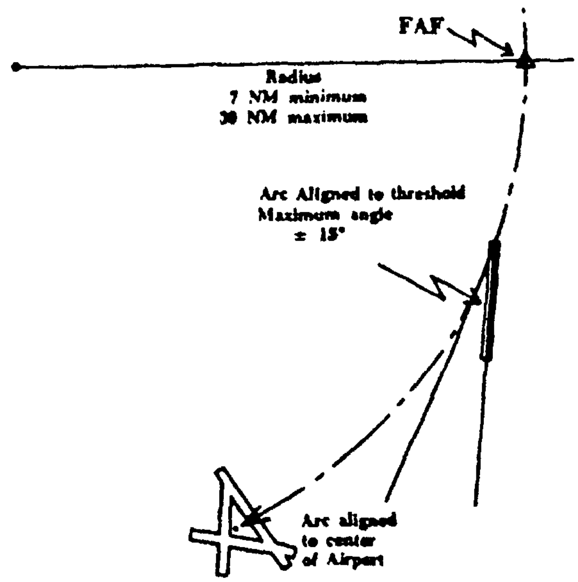


Figure 53. ARC FINAL APPROACH ALIGNMENT. Arc Aligned to Threshold. TACAN or VOR/DME. Par 523b(1).

(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).

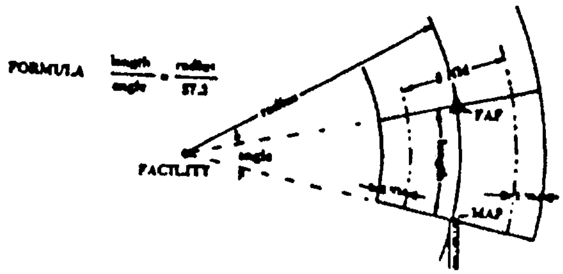
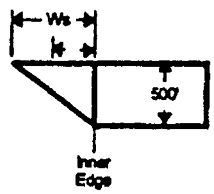


Figure 54. ARC FINAL APPROACH AREA. TACAN or VOR/DME. Par 523b(2)

(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.

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).

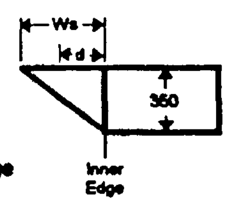
b. Area. Figure 57 illustrates the final approach primary and secondary areas. The primary area is longitudinally centered on the FAC and is 10 miles long. The primary area is 2.5 miles wide at the facility and expands uniformly to 6 miles wide at 10 miles from the facility. A secondary area is on each 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:

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

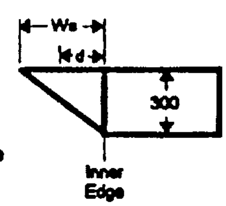
Where Ws = Width of Secondary
d = distance from inner edge



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).*

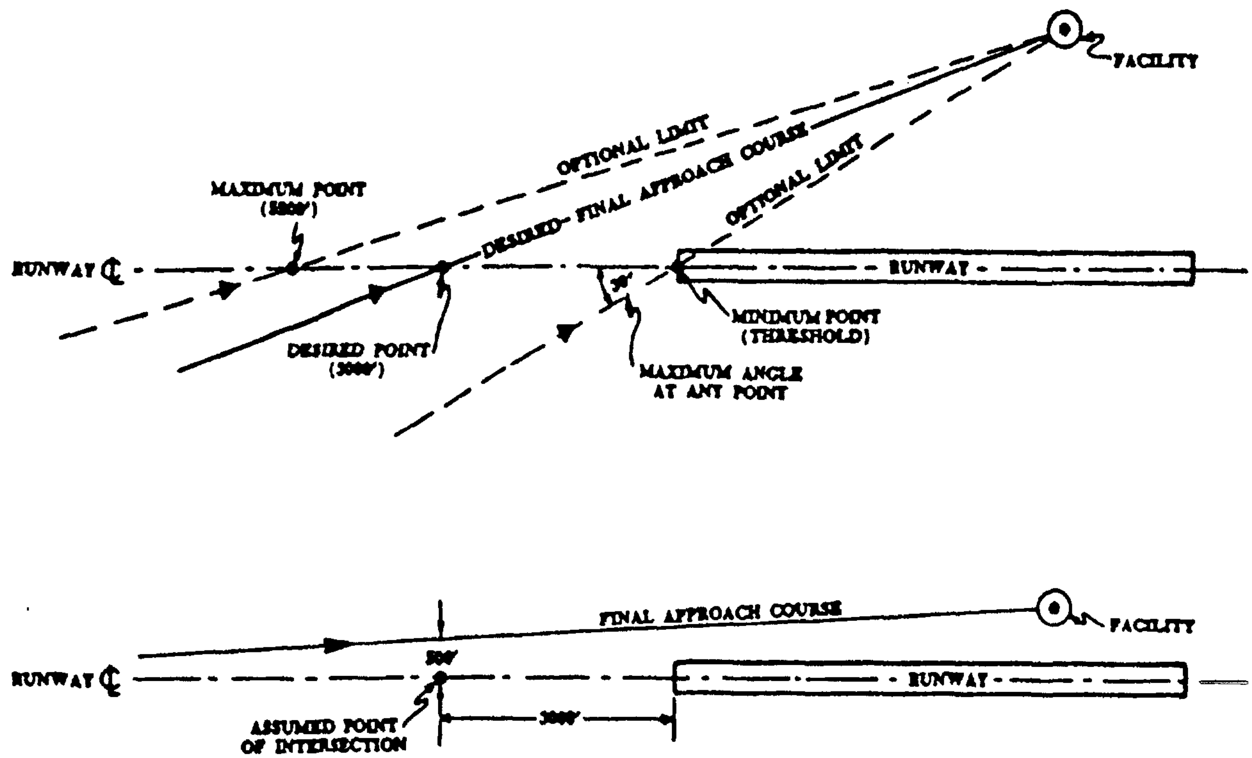


Figure 55. ALIGNMENT OPTIONS FOR FAC. On-Airport NDB. No FAF. Straight-In Procedure. Par 613a(1).

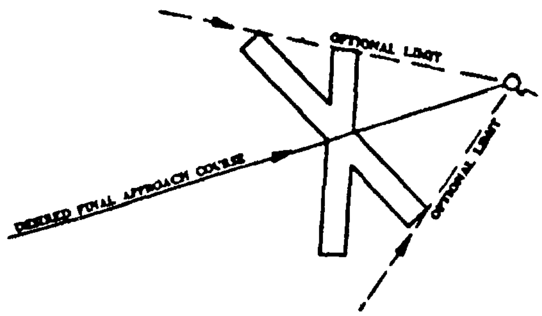


Figure 56. ALIGNMENT OPTIONS FAC. On-Airport NDB. No FAF. Circling Approach. Par 613a(2).

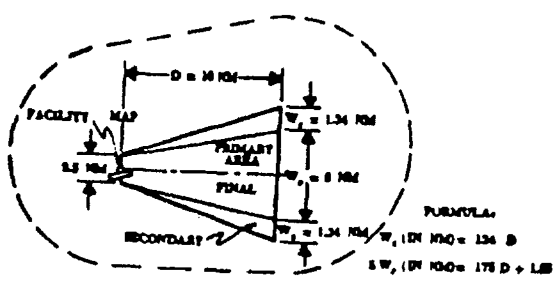


Figure 57. FINAL APPROACH PRIMARY AND SECONDARY AREAS. On-Airport NDB. No FAF. Par 613b.

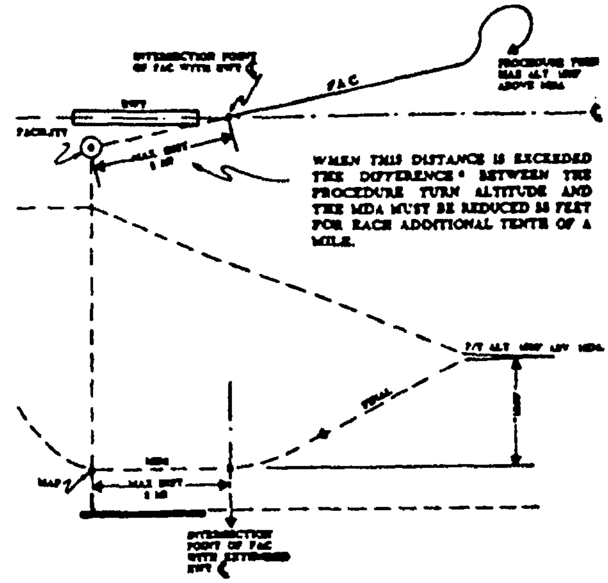


Figure 58. PT ALTITUDE. On-Airport NDB. No FAF. Par 613d.

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.

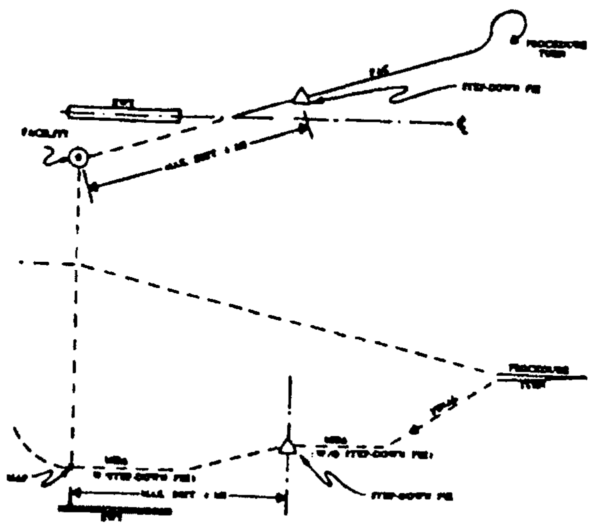


Figure 59. USE OF STEPDOWN FIX. On-Airport NDB. No FAF. Par 613e.

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.

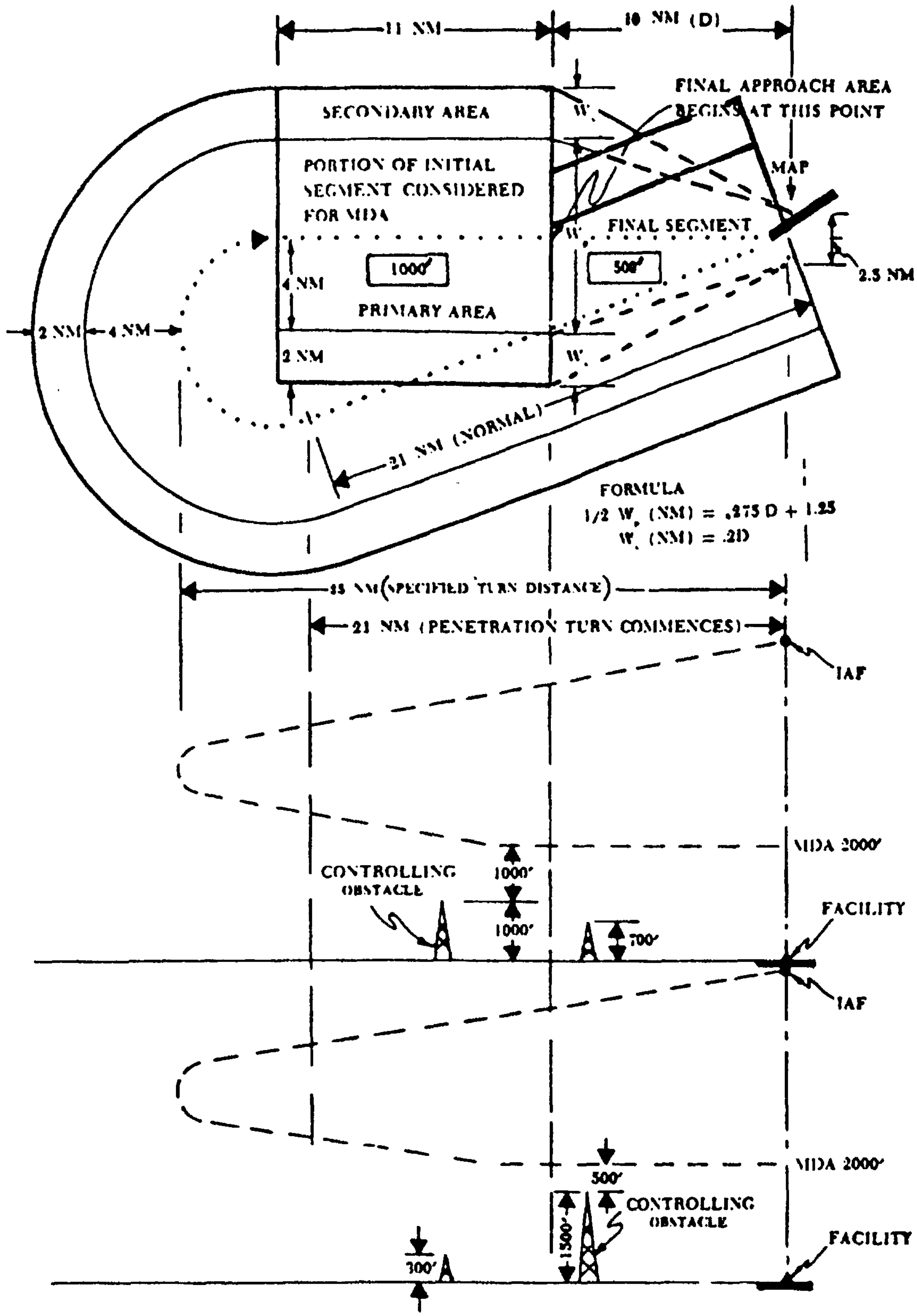


Figure 60. PENETRATION TURN. On-Airport NDB. No FAF. Par 623.

* 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.

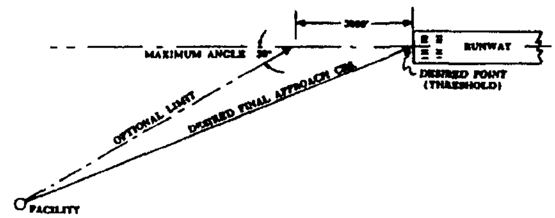


Figure 61. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. Off-Airport NDB with FAF. Straight-in Approach. Par 713.a.(1)(a).

(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.

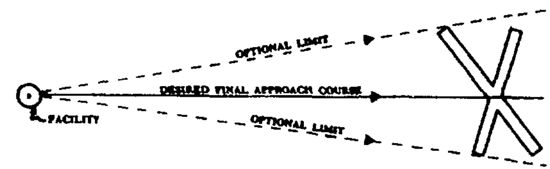


Figure 62. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. Off-Airport NDB with FAF. Circling Approach. Par 713.a.(1)(b).

(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

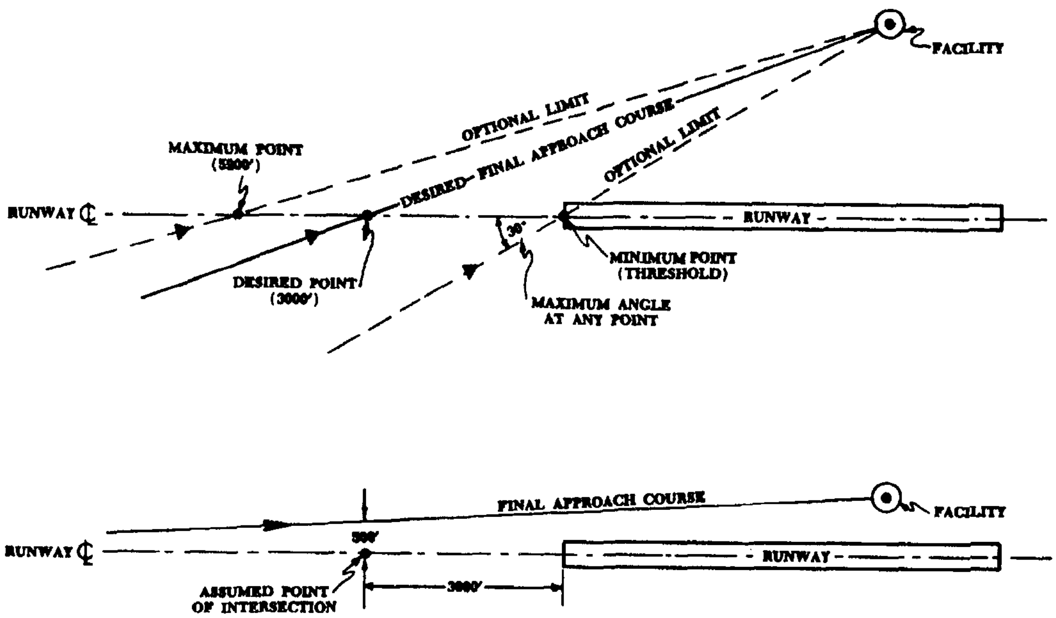


Figure 63 ALIGNMENT OPTIONS FOR FINAL APPROACH On-airport NDB. Par 713.a.(2)(a).

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.

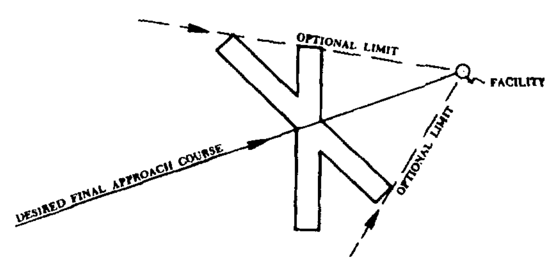


Figure 64. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. On-Airport NDB with FAF. Circling Approach. Par 713.a.(2)(b).

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

*

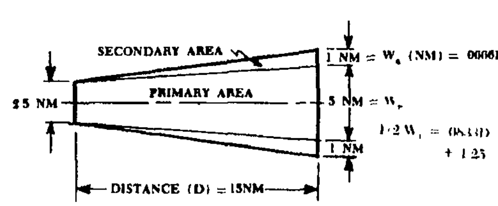


Figure 65. FINAL APPROACH TRAPEZOID. NDB with FAF. Par 713.b. *

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.

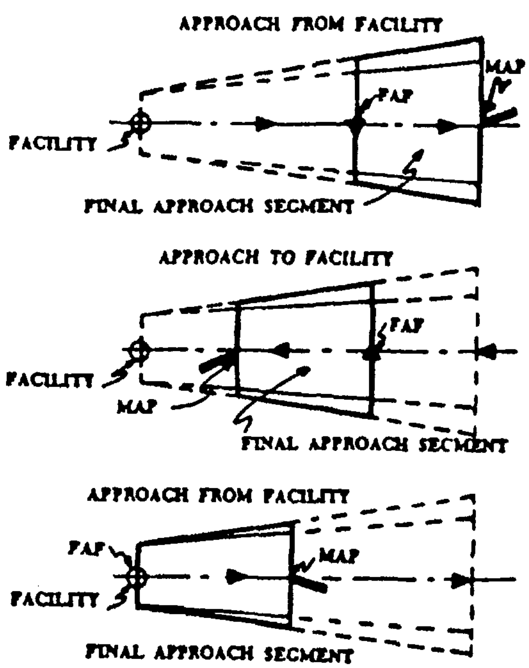


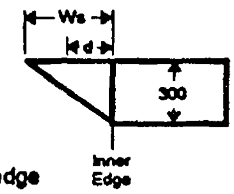
Figure 66. TYPICAL FINAL APPROACH AREAS. NDB with FAF. Par 713b.

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:

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

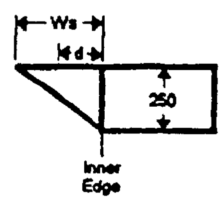
Where Ws = Width of Secondary
d = distance from inner edge



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).

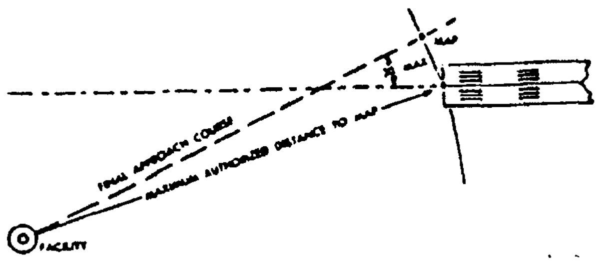


Figure 67. MAP.
Off-Airport NDB with FAF. Par 714a(1).

(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.

(1) 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 68.

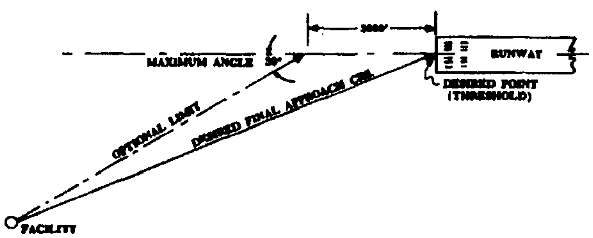


Figure 68. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. L/MF Range with FAF. Straight-In approach. Par 733.a.(1).

(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 area. See Figure 69.

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 rectangle which is 10 miles long and 3.4 miles wide, centered longitudinally on the final approach course. There is no secondary area. See Figure 70. Final approaches may be made to airports which are a MAXIMUM of 10 miles from the facility. However, only that portion of the 10 mile rectangle which falls between the final approach fix and the missed approach point shall be considered as the final approach segment for obstacle clearance purposes. See Figure 71. 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 course alignment.

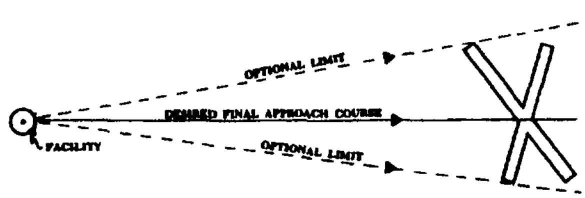


Figure 69. ALIGNMENT OPTIONS FOR FINAL APPROACH COURSE. L/MF Range with FAF. Circling approach. Par 733.a.(2).

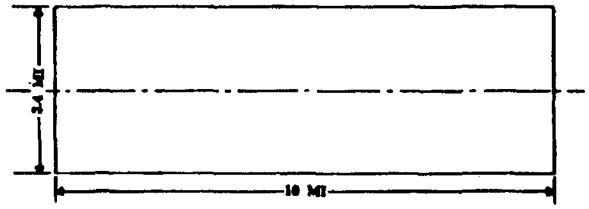


Figure 70. FINAL APPROACH OBSTACLE AREA. L/MF Range with FAF. Par 733.b.

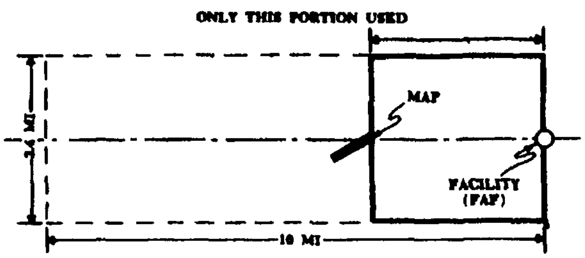


Figure 71. FINAL APPROACH SEGMENT. L/MF Range with FAF. Par 733.b.

Table 17. MINIMUM LENGTH OF FINAL APPROACH SEGMENT (MILES) L/MFR

Approach Category	Magnitude of Turn over the Facility		
	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 degrees are required, or if the minimum lengths specified in the table are not available for the procedure, straight-in minimums are not authorized.

c. Obstacle Clearance.

(1) Straight-In. The minimum obstacle clearance in the final approach segment is 300 feet.

(2) Circling Approach. In addition to the minimum requirements specified in Paragraph 733.c.(1) above, obstacle clearance in the circling area shall be as prescribed in Chapter 2, Section 6.

d. Descent Gradient. The OPTIMUM descent gradient in the final approach segment should not exceed 300 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 400 feet per mile. See also Paragraph 251.

(1) Straight-In. The descent gradient shall be computed using the distance from the FAF to the runway threshold and the difference in altitude between the altitude over the FAF and the touchdown zone elevation.

(2) Circling Approach. The descent gradient shall be computed using the distance from the FAF to the first usable portion of the landing surface, and the difference in altitude between the altitude over the FAF and the circling MDA.

NOTE: Where straight-in descent gradient criteria are exceeded, only circling MDA shall be authorized.

e. Use of Fixes. Criteria for the use of radio fixes are contained in Chapter 2, Section 8.

f. Minimum Descent Altitude. Criteria for determining the MDA are contained in Chapter 3, Section 2.

734. MISSED APPROACH SEGMENT. Criteria for the missed approach segment are contained in Chapter 2, Section 7. The missed approach point and surface shall be established as follows:

a. Straight-In. The missed approach point is a point on the final approach course which is NOT farther from the FAF than the runway threshold. See Figure 66. The missed approach surface shall commence over the missed approach point at the required height. See Paragraph 274.

b. Circling Approach. The missed approach point is a point on the final approach course which is NOT farther from the final approach fix than the first usable portion of the landing area. The missed approach surface shall commence over the missed approach point at the required height. See Paragraph 274.

735. – 799. RESERVED.

CHAPTER 8. VHF/UHF DF PROCEDURES

800. GENERAL. These criteria apply to Direction Finding procedures for both high and low altitude aircraft. DF criteria shall be the same as criteria provided for 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. ENROUTE OPERATIONS. Enroute 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 1000 feet (2000 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 1000 feet (2000 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.

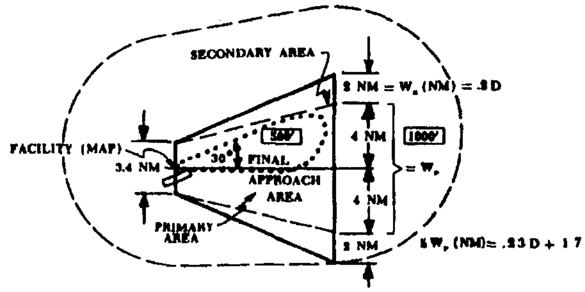


Figure 72. LOW ALTITUDE DF APPROACH AREA. Par 811.

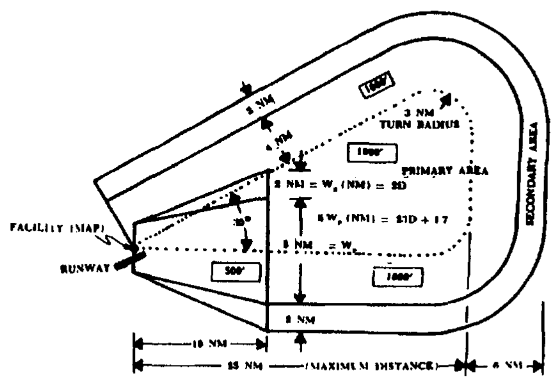


Figure 73. HIGH ALTITUDE DF APPROACH AREA. Par 811.

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 Paragraph 234.a., 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 Paragraph 235.a., 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.

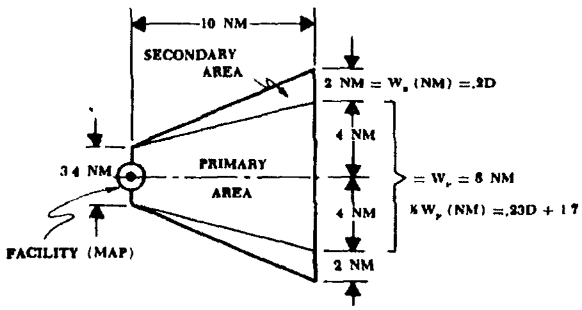


Figure 74. DF INTERMEDIATE APPROACH AREA.
Par 812.

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 which 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. Paragraph 613.a.(1) and (2) apply.

(2) Off-Airport Facilities. Paragraph 713.a.(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 623.b. 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 is shown in Appendix 2, Figure 123.

(2) Circling Approach. In addition to the minimum requirements specified in Paragraph 813.c.(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 1500 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 1000 feet but not more than 4000 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 1000 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. *Enroute 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 Equip.).

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.

CHAPTER 9. INSTRUMENT LANDING SYSTEM (ILS)

900. GENERAL. This chapter applies to approach procedures based on the Instrument Landing System (ILS).

901. DEFINITION OF TYPES.

a. ILS Category I. An ILS approach procedure which provides for approach to a decision height of not less than 200 feet.

b. ILS Category II. See Section 6. Criteria to be incorporated at a later date.

c. ILS Category III. See Section 7. Criteria to be incorporated at a later date.

d. Localizer and LDA. Approach procedures which do not use the glide slope component of the ILS.

e. Simultaneous ILS. An ILS approach procedure based on ILS installations which serve parallel runways and provides for simultaneous approaches to authorized minimums.

902.-909. RESERVED.

Section 1. ILS Category I Components

* **910. SYSTEM COMPONENTS.** The Category I ILS procedures are based upon the components listed below. Substitution is permitted only as specified in paragraphs 283, 911, 912, and 930.

a. Localizer (LOC), Category I quality or better.

b. Glide Slope (GS), Category I quality or better.

c. Outer Marker (OM).

911. OUTER COMPASS LOCATOR (LOM). Compass locator radio facilities installed at outer marker sites are not considered basic components of the ILS. However, when installed, they may be used in lieu of the outer marker. *

912. DISTANCE MEASURING EQUIPMENT (DME). When installed with the ILS, DME may be used in lieu of the outer marker. When a unique operational requirement exists, DME information derived from a separate facility, as specified in paragraph 282, may also be used to provide ARC initial approaches, a FAF for back course (BC) approaches, or as a substitute for the outer marker. When used as a substitute for the outer marker, the fix displacement error shall NOT exceed plus or minue 1/2 mile and the angular divergence of the signal sources shall NOT exceed 6 degrees.

913. INOPERATIVE COMPONENTS. A complete Category I ILS consists of the components specified in paragraph 910. When the localizer fails, an ILS approach is not authorized. When the glide slope becomes inoperative or is not available, the ILS reverts to a nonprecision approach system. In this case, obstacle clearance from paragraph 954 and the nonprecision minimums from paragraph 350 apply.
* When other components become inoperative, the ILS may continue in use with the landing minimums as prescribed in paragraph 350.

914.-919. RESERVED.

Section 2. ILS Category I Criteria

920. FEEDER ROUTES. The criteria for feeder routes are contained in chapter 2, section 2.

921. INITIAL APPROACH SEGMENT. The criteria for the initial approach segment are contained in chapter 2, section 3. *

922. INTERMEDIATE SEGMENT. Except as stated in this paragraph, the criteria for the intermediate segment are contained in Chapter 2, Section 4. The intermediate segment begins at the point where the initial approach course intercepts the localizer course. It extends along the inbound localizer course to the FAF for localizer approaches or the glide slope intercept point for ILS approaches. The minimum length of the intermediate segment depends on the angle at which the initial approach course intersects the localizer course, and is specified in Table 18. The MAXIMUM angle of intersection shall be 90 degrees unless a lead radial as specified in Paragraph 232.a. is provided and the length of the intermediate segment is increased in accordance with Paragraph 242.b. See Figure 75.

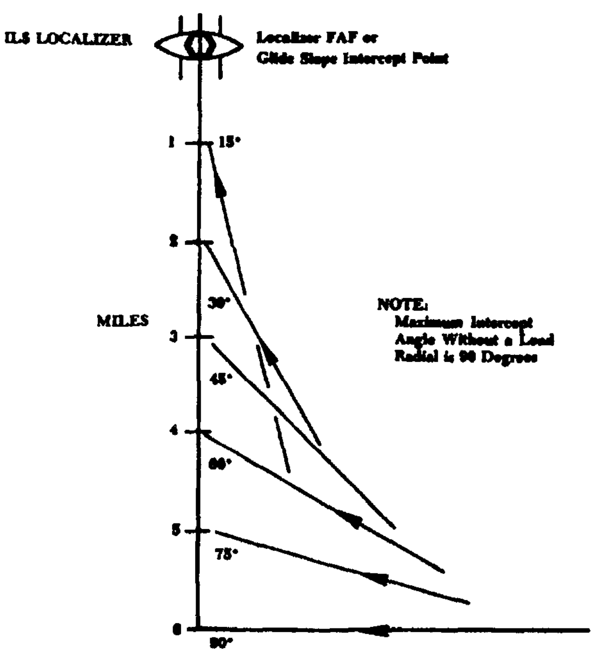


Figure 75. INTERMEDIATE SEGMENT VS. ANGLE OF INTERSECTION. ILS Category I. Par 922.

923. DESCENT GRADIENT. Even though the minimum length of the intermediate segment may be less than that specified in Chapter 2, Section 4, intermediate descent criteria specified in Paragraphs 242.d and 243.d shall be applied to at least 5 miles of flight track immediately prior to the glide slope intercept point.

Table 18. INTERSECTION ANGLE VS. LENGTH OF INTERMEDIATE SEGMENT.

Maximum Angle of Intersection (Degrees)	Minimum Length of Segment (Miles)
15	1
30	2
45	3
60	4
75	5
90-96	6

924. ALTITUDE SELECTION. Altitudes selected for the initial approach and intermediate approach segments shall be established and provide required obstacle clearance as specified in Chapter 2. In addition, the selected altitudes shall be limited as follows:

a. *Procedure Turn.* The procedure turn completion altitude shall NOT be lower than the glide slope interception altitude nor more than 500 feet above the glide slope interception altitude. The glide slope interception point shall be the outer marker whenever possible.

b. *High Altitude Teardrop Penetration Turn.* The penetration turn completion altitude shall NOT be lower than the glide slope interception altitude nor more than 4000 feet above the glide slope interception altitude. The glide slope interception point shall be the outer marker whenever possible.

c. *Other Initial Approaches.* The altitude at which the localizer course is intercepted shall NOT be less than the glide slope interception altitude.

d. *Intermediate Approach.* The altitude shall NOT be less than the glide slope interception altitude. The glide slope interception point shall be the outer marker whenever possible. When the glide slope is inoperative, the intermediate approach altitude shall provide at least 500 feet of obstacle clearance from the point of interception of the localizer course to the outer marker or other final approach fix. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet. See Paragraph 231.

925.-929. RESERVED.

* U.S. G.P.O.:1994-301-717:80569

SECTION 3. ILS CAT I FINAL APPROACH

930. FINAL APPROACH SEGMENT. The final approach segment shall begin at the point where the glide slope is intercepted, and descend to the authorized decision height (DH). Where possible, this point shall be coincidental with a designated FAF. At locations where it is not possible for the point of glide slope intercept to coincide with a designated FAF, the point of glide slope interception shall be located PRIOR to the FAF. Where a designated FAF cannot be provided, specific authorization by the approving authority is required.

a. Alignment. The final approach course is normally aligned with the runway centerline. Where a unique operational requirement indicates a need for an offset course, it may be approved, provided the course intersects the runway centerline at a point 1,100 to 1,200 feet toward the runway threshold from the DH point on the glide slope and the angular divergence of the course does NOT exceed 3°.

b. Area. The area considered for obstacle clearance in the final approach segment consists of a final approach area and transitional surfaces.

(1) Final Approach Area. The final approach area has the following dimensions:

(a) Length. The final approach area is 50,000 feet long measured outward along the final approach course from a point beginning 200 feet outward from the runway threshold. Where operationally required by other procedural considerations due to existing obstacles, the length may be increased as shown in figure 76. The final approach area used shall only be that portion of the area which is between the glide slope interception point and the point 200 feet from the threshold.

(b) Width. The final approach area is centered on the extended runway centerline except in those cases where an offset localizer is required, as provided in paragraph 930a, in which case the area is centered on the final approach course. The area has a width of 1,000 feet at the point 200 feet from the threshold and expands uniformly to a width of 16,000 feet at a point 50,000 feet from the point of beginning. This width further expands uniformly where greater length is required as in paragraph 930b(1)(a). See figure 76.

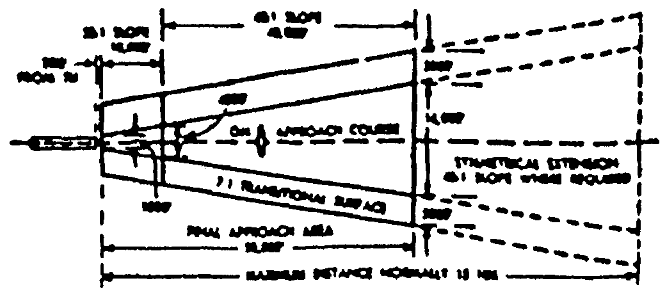


Figure 76. ILS CATEGORY I FINAL APPROACH AREA. Par 930.

The width either side of the centerline at a given distance "d" from the point of beginning can be found by using the formula "500+.15D=1/2W"; e.g.; 500+.15 X 50,000= 8,000, which is ½ width; therefore, the total width is 16,000 feet at the 50,000 foot point.

NOTE: Where glide slope interception occurs at a distance greater than 50,200 feet from the threshold, the final approach area and the final approach surface may be extended symmetrically to a maximum distance dictated by the usability of the glide slope.

931. FINAL APPROACH OBSTACLE CLEARANCE SURFACE (OCS). The final approach OCS is an inclined plane which originates at the runway THR elevation, 975 feet before ground point of intercept (GPI), and overlies the final approach area. The surface is divided into two sections: an inner 10,000 foot section and an outer 40,000 foot section. The slope of the surface changes at the 10,000 foot point. The exact gradient differs according to the angle at which the glide slope is established (see figure 77). Paragraphs 934 and 935 address application of the OCS.

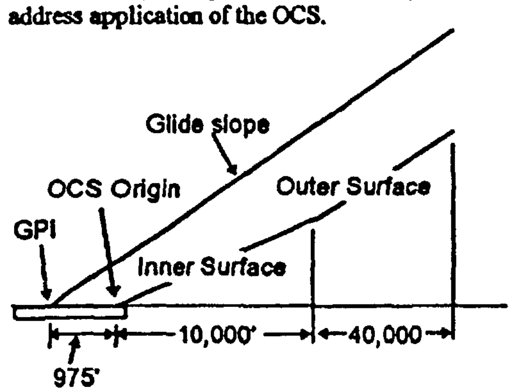


Figure 77. OBSTACLE CLEARANCE SURFACES. Par 931.

932. TRANSITIONAL SURFACES. Transitional surfaces for ILS Category I are inclined planes with a slope of 7:1 which extend outward and upward from the edge of the final approach area, starting at the height of the applicable final approach surface and extending for a lateral distance of 5,000 feet at the right angles to the final approach course (see figure 76).

933. DELETED

934. OBSTACLE CLEARANCE. No obstacle shall penetrate the applicable final approach OCS specified in paragraph 931 or the transitional surfaces specified in paragraph 932. Compare obstacle height to the appropriate OCS/transitional surface using the formulae below.

a. Inner OCS (OCS_I). Calculate the height of the OCS_I at any distance D less than 10,975 feet from GPI using the following formula:

$$OCS_I \text{ Height Above THR} = \left[\left(\tan(gs) - 0.02366\right) \times D\right] - 20$$

where: gs = glide slope angle
D = distance from GPI in feet

b. Outer OCS (OCS_O). Calculate the height of the OCS_O at any distance D equal to or greater than 10,975 feet from GPI using the following formula:

$$OCS_O \text{ Height Above THR} = \left[\left(\tan(gs) - 0.01866\right) \times D\right] - 75$$

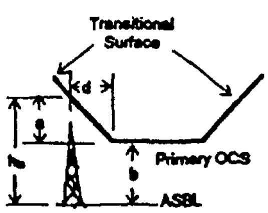
where: gs = glide slope angle
D = distance from GPI in feet

c. Transitional Surface. Calculate the height of the transitional surface (h_{ts}) at any distance (d) from the edge of the primary area measured perpendicular to the final approach course using the following formulae.

(1) $a = \dfrac{d}{7}$

(2) $h_{ts} = a + b$

Where a = amount of surface adjustment
b = OCS_I or OCS_O as appropriate



935. EFFECT OF OBSTACLES INSIDE THE DH. See paragraph 251 for the assessment of the visual portion of an ILS approach.

936. GLIDE SLOPE. In addition to the required obstacle clearance, the following shall apply to the selection of glide slope angle and antenna location:

a. Glide slope Angle. All new and relocated ILS facilities will be commissioned with a 3° glide slope angle. Existing facilities may continue in operation without change in the established glide slope angle. Angles greater than 3° or less than 2° shall not be established without approval of the Flight Standards Service, FAA, Washington, D.C., or appropriate military authority as necessary.

NOTE. Where PAR serves a runway that is also served by a non-radar precision instrument approach and/or a VGSI, the PAR, the non-radar precision instrument approach, and the VGSI glide slope angles and runway point of intercept (RPI) shall coincide. The PAR glide slope angle shall be within 0.20 of the non-radar precision instrument approach/VGSI glide slope angle and the RPI shall be within plus or minus 50 feet (30 feet for PAPI and PVGSI) of the non-radar precision approach RPI and/or VGSI runway reference point (RRP).

b. Glide slope Threshold Crossing Height (TCH). See paragraph 980 for TCH requirements. A height as low as 32 feet for military airports may be used at locations where special consideration of the glidepath angle and antenna location are required. Where the glide slope TCH exceeds 60 feet, consider relocating the landing threshold to ensure effective placement of the approach light system. See appendix 2 for a method of computing TCH.

937. RELOCATION OF GLIDE SLOPE. Where the OCS associated with a 3° glide slope is penetrated, and sufficient length of runway is available, the glide slope may be moved the required distance down the runway to ensure the OCS is clear. Where the glide slope threshold crossing height exceeds 60 feet, consider relocating the landing threshold to ensure effective placement of the approach light system. The minimum distance between the GPI and the runway threshold is 775 feet. (No minimum GPI distance need be applied to military locations provided the OCS is clear and TCH standards are met.)

938. DECISION HEIGHT (DH).

a. Minimum DH. For category I systems, the DH shall not be less than 200 feet above touchdown zone elevation (TDZE).

b. Adjustment of DH.

(1) Primary Surface Penetrations. When the OCS associated with a 3° glide slope is penetrated, and the approving authority will not approve an angle in excess of 3°, and the runway length does not permit a compensating adjustment, the DH shall be increased accordingly. See figure 78. Use the formulae below to determine the new DH.

(1) $$d = \frac{(OH - THRe) + 20}{\tan(gs) - 0.02366}$$

(2) $$HAT = (\tan(gs) * d) + (THRe - TDZE)$$

(3) $$DH = TDZE + HAT$$

where d = DH distance from GPI
OH = height of obstacle (MSL)
THRe = THR elevation
TDZE = Touchdown zone elevation
gs = glide slope angle

Application of this method need not require a DH that is more than 250 feet above the obstacle; however, the minimum HAT is 250 feet.

(2) Transitional Surface Penetrations. Where obstacles penetrate the transitional surface, and when deemed necessary, consider an adjustment in DH equal to the amount of penetration (see figure 79).

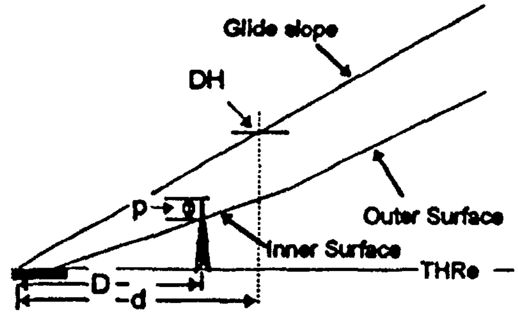


Figure 78. OCS PENETRATION. Par 938b(1).

939. RESERVED.

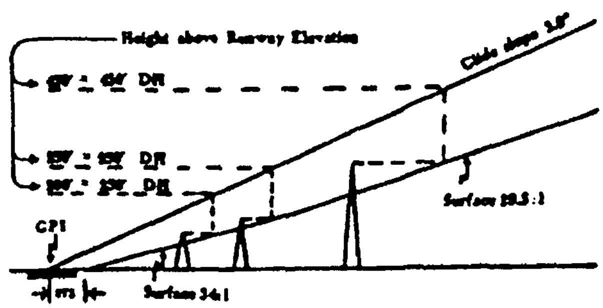


Figure 79. ADJUSTMENT OF DECISION HEIGHT. Par 938(b(2).

SECTION 4. ILS CAT I MISSED APPROACH

940. MISSED APPROACH SEGMENT. The missed approach segment begins at the MAP and ends at an appropriate point or fix where initial approach or en route obstacle clearance is provided. Missed approach procedures shall be based on PCG where possible.

941. MISSED APPROACH POINT (MAP). The MAP is a point on the FAC where the height of the glide slope equals the authorized DH.

942. STRAIGHT MISSED APPROACH. The straight missed approach area (maximum of 15° turn from FAC) starts at the MAP. The length of the area is 15 miles, measured along the missed approach course. The area has a width equal to that of the final approach area at the MAP and a width equal to that of the initial approach area at a point 15 miles from the MAP. The missed approach area is divided into 2 sections.

a. Section 1 starts at the MAP and is longitudinally centered on the missed approach course. It has the same width at the MAP as the final approach area. The total width increases to 1 mile at a point 1.5 miles from the MAP.

b. Section 2 starts at the end of section 1 and is centered on a continuation of the section 1 course. The width increases uniformly from 1 mile at the beginning to 12 miles at a point 13.5 miles from the beginning. A secondary area for reduction of obstacle clearance is identified within section 2. The secondary area is zero miles wide at the beginning and increases uniformly to 2 miles wide at the end of section 2. PCG is required to reduce obstacle clearance in the secondary areas (see figure 80).

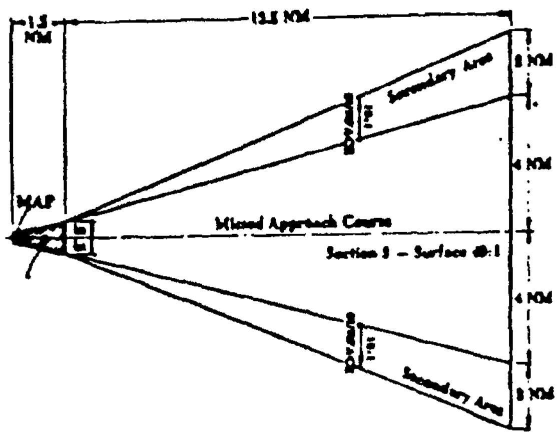


Figure 80. ILS STRAIGHT MISSED APPROACH AREA. Par 942.

943. TURNING MISSED APPROACH. Where turns of less than 15° are required in a missed approach procedure, the provisions of paragraphs 942a and b apply. Where turns of MORE than 15° are required, they shall be specified to commence at an altitude which is at least 400 feet above the elevation of the TDZ. Altitudes required prior to commencing a turn shall be specified in the published procedure. Such turns are assumed to commence at the point where section 2 begins. The flight track and obstacle clearance radii used shall be as specified in table 5, paragraph 275. The inner boundary line shall commence at the edge of section 1 opposite the MAP. The outer and inner boundary lines shall flare to the width of the initial approach area 13.5 miles from the beginning of section 2. Secondary areas for reduction of obstacle clearance are identified within section 2. The secondary areas begin after completion of the turn. They are zero miles wide at the beginning and increase uniformly to 2 miles wide at the end of section 2. PCG is required to reduce obstacle clearance in the secondary area. See figure 81

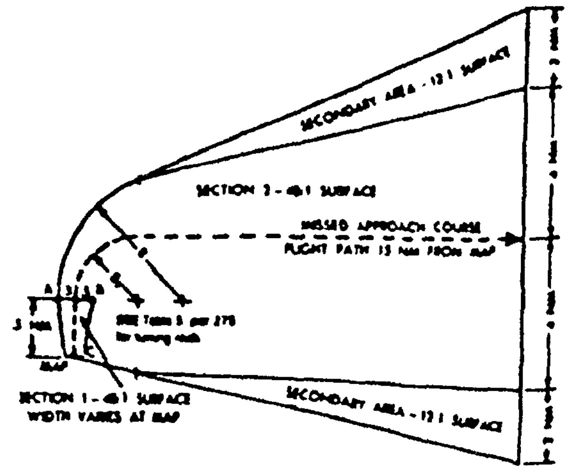


Figure 81. ILS TURNING MISSED APPROACH AREA. Par 943.

944. MISSED APPROACH OBSTACLE CLEARANCE.

a. Straight Missed Approach Area. No obstacle in section 1 or section 2 may penetrate a 40:1 surface which originates at the MAP at the height of the final approach obstacle clearance surface, but not more than 250 feet below the DH, and which overlies the entire missed approach area.

b. Turning Missed Approach Area. Section 1 obstacle clearance is the same as that for straight missed approaches. To determine the obstacle clearance requirements in section 2, the dividing line between sections 1 and 2 is identified as "A-B-C". The height of the missed approach surface over any obstacle in section 2 is determined by measuring the distance from the obstacle to the nearest point on line A-B-C and computing the height according to the 40:1 ratio, starting at the height of the missed approach surface at the end of section 1.

c. Secondary Areas. Where secondary areas are considered, no obstacle may penetrate a 12:1 surface which slopes outward and upward from the missed approach surface.

d. Discontinuance. Where the 40:1 surface reaches a height of 1,000 feet below the missed approach altitude (paragraph 270) further application of the surface is not required.

945. 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 1A. The portion in which the turn is made is section 2.

a. Straight Portion. Sections 1 and 1A correspond respectively to sections 1 and 2 of the normal straight missed approach area and are constructed as specified in paragraph 942 except that section 1A has no secondary areas. Obstacle clearance is provided as specified in paragraph 944b. The length of section 1A is determined as shown in figure 82 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 1A. Point C' is 9,000 feet from the end of section 1A.

b. Turning Portion. Section 2 is constructed as specified in paragraph 943 except that it begins at the end of section 1A 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 1A to which the turn is to be made. Then measure the distance from this obstacle to the nearest edge of the section 1A area. Using this distance as illustrated in figure 82, determine the height of the 40:1 slope at the edge of section 1A. 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 2 are the same as those specified in paragraph 944b except that section 2 is expanded to start at Point C if no fix exists at the end of section 1A or if no course guidance is provided in section 2.

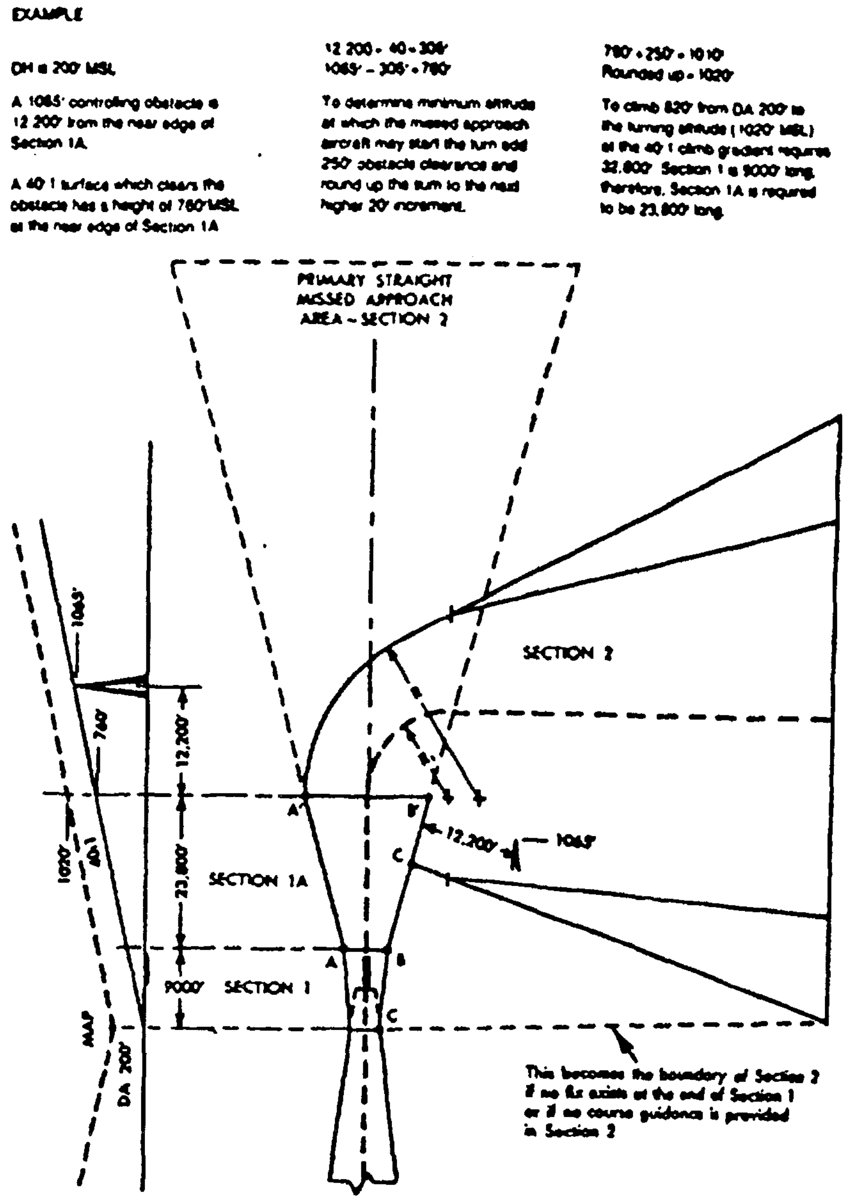


Figure 82. COMBINATION STRAIGHT AND TURNING MISSED APPROACH AREA. Par 945.

946. - 949. RESERVED.

SECTION 5. LOCALIZER AND LDA

950. FEEDER ROUTES, INTIAL APPROACH, AND INTERMEDIATE SEGMENTS. These criteria are contained in paragraphs 920, 921, 922, and 923.

951. USE OF LOCALIZER ONLY. Where no usable glide slope is available, a localizer-only (front or back course) approach may be approved, provided the approach is made on a LOC from a FAF 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 shall not be based on courses which exceed 6° in width and shall not be approved for offset LOC.

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

953. AREA. The final approach area and transitional surface dimensions are as specified in paragraph 930. However, only that portion of the final approach area which is between the FAF and the runway need be considered as the final approach segment for obstacle clearance purposes. The optimum length of the final approach segment is 5 miles. The MINIMUM length of the final approach segment shall be sufficient to provide adequate distance for an aircraft to make the required descent. The area shall be centered on the FAC and shall commence at the runway threshold. For LDA procedures the final approach area shall commence at the facility and extend to the FAF. The MAP for LDA procedures shall not be farther from the FAF than a point adjacent to the landing threshold perpendicular to the FAC.

954. OBSTACLE CLEARANCE. The MOC 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. The transitional surfaces in localizer-only type approaches begin at a height not less than 250 feet below the MDA.

955. DESCENT GRADIENT. The OPTIMUM gradient in the final approach segment is 318 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 400 feet per mile. When maximum straight-in descent gradient is exceeded, then a "circling only" procedure is authorized. When a stepdown fix is incorporated, descent gradient criteria must be met from FAF to SDF and SDF to FEP. See paragraphs 251, 252, and 288a.

956. MDA. Because no glide slope is associated with a localizer-only approach, the lowest altitude on final approach is specified as an MDA, not a DH. The MDA adjustments specified in paragraph 232 shall be considered.

957. MISSED APPROACH SEGMENT. The criteria for the missed approach segment are contained in paragraphs 942, 943, and 945. The MAP is on the FAC not farther from the FAF than the runway threshold (first usable portion of the landing area for circling approach). The missed approach surface shall commence over the MAP at the required height (see paragraph 274).

958.-959. RESERVED.

SECTION 6. ILS CATEGORY (CAT) II

960.-969. RESERVED.

SECTION 7. ILS CAT III

970.-979. RESERVED.

SECTION 8. GLIDE SLOPE THRESHOLD CROSSING HEIGHT REQUIREMENTS

980. CAT I THRESHOLD CROSSING HEIGHT (TCH) REQUIREMENTS.

a. Standard. Provided there is not a problem with obstacles penetrating the final approach obstacle clearance surfaces, the ILS glide slope should be located to provide a commissioned TCH which will result in a wheel crossing height (WCH) of 30 feet for the types of aircraft with the greatest glidepath-to-wheel height normally expected to use the runway (see table 18A).

b. Deviations From Standard. The TCH shall not be commissioned at a height which would result in a WCH of less than 20 feet or greater than 50 feet for the types of aircraft with the greatest glidepath-to-wheel height normally expected to use the runway. These limits shall not be exceeded unless formally approved by a flight procedures standards waiver as outlined in Order 8260.19C or by the appropriate military authority as necessary.

NOTE: 60 feet is the maximum TCH.

c. Displaced Threshold Considerations. The TCH over a displaced threshold can be as low as that which will result in a WCH of not less than 10 feet for the largest aircraft normally expected to use the runway provided the TCH over the beginning of the full strength runway pavement suitable for landing meets TCH requirements.

981. CAT II AND III TCH REQUIREMENTS.

a. Standard. The commissioned TCH shall be between 50 and 60 feet with the optimum being 55 feet.

b. Deviations from the Standard. Any deviation must be formally approved by a flight procedures standards waiver as outlined in Order 8260.19 or by the appropriate military authority as necessary.

c. Temporary Exemption Clause. Order 8240.47 may be applied to a published precision system where the TCH is within the allowable limits in table 18A. If the new flight inspection derived TCH is within 3 feet of the published TCH but not within the limits of table 18A, operations may continue without waiver action for up to 365 days from the date the order is applied.

(1) **If aircraft in height group 4** (see table 18A) have not been excluded from conducting CAT II or III operations on that runway, a TCH lower than 50 feet is not permitted unless the achieved ILS reference datum height (ARDH) has averaged 50 feet or higher.

(2) **After 365 days,** a flight procedures waiver must have been approved, the situation corrected, or CAT II and III operations canceled.

(3) ***Flight Standards Service*** or the appropriate military authority can authorize further deviation or immediately rescind this temporary exemption.

TABLE 18A

Representative Aircraft Type	**Approximate Cockpit or Glidepath to Wheel Height**	**Recommended TCH ± 5 Feet**	**Remarks**
HEIGHT GROUP 1 General aviation, Small commuters, Corporate turbojets, T-37, T-38, C-12, C-20, C-21, T-1, Fighter Jets	10 Feet or less	40 Feet	Many runways less than 6,000 feet long with reduced widths and/or restricted weight bearing which would normally prohibit landings by larger aircraft.
HEIGHT GROUP 2 F-28, CV-340/440/580, B-737, C-9, DC-9, DC-8, C-130, T-43, B-2, S-3	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	20 Feet	50 Feet	Primary runways not normally used by aircraft with ILS glidepath-to-wheel heights exceeding 20 feet.
HEIGHT GROUP 4 B-747/767, L-1011, DC-10, A-300, B-1, KC-10, E-4, C-5, VC-25	25 Feet	55 Feet	Most primary runways at major airports

Note 1: To determine the minimum allowable TCH, add 20 feet to the glidepath-to-wheel height.
Note 2: To determine the maximum allowable TCH, add 50 feet to the glidepath-to-wheel height (precision approaches not to exceed 60 ft.).

982.-989. RESERVED.

SECTION 9. SIMULTANEOUS ILS PROCEDURES

990. GENERAL. Simultaneous dual and triple ILS approach procedures using ILS installations with parallel courses may be authorized when the minimum standards in this section and section 1 are met.

991. SYSTEM COMPONENTS. Simultaneous ILS approach procedures require the following basic components.

a. **An ILS specified in section 1** of this chapter for each runway. Adjacent markers of the separate systems shall be separated sufficiently to preclude interference at altitudes intended for use.

b. **ATC approved radar** for monitoring simultaneous operations.

992. INOPERATIVE COMPONENTS. When any component specified in paragraph 991 becomes inoperative, simultaneous ILS approaches are not authorized on that runway.

993. FEEDER ROUTES. The criteria for feeder routes are contained in chapter 2, section 2.

994. INITIAL APPROACH SEGMENT. The criteria for the initial approach segment are contained in chapter 2, section 3. The initial approach shall be made from a facility or satisfactory radio fix by radar vector. Procedure and penetration turns shall not be authorized.

a. Altitude Selection. In addition to obstacle clearance requirements, the altitudes established for initial approach shall provide the following vertical separation between glide slope intercept altitudes.

(1) Dual. Simultaneous dual ILS approaches shall require at least 1,000 feet vertical separation between glide slope intercept altitudes for the two systems (see figure 96A).

(2) Triple. Simultaneous triple ILS approaches shall require at least 1,000 feet vertical separation between glide slope intercept altitudes for any combination of runways. No two runways share the same glide slope intercept altitude (see figure 96B).

b. Localizer Intercept Point. The localizer intercept point shall be established in accordance with paragraph 922. Intercept angles may not exceed 30°; 20° is optimum.

995. INTERMEDIATE APPROACH SEGMENT. Criteria for the intermediate segment are contained in paragraphs 241 and 242, except that simultaneous ILS procedures shall be constructed with a straight intermediate segment aligned with the FAC, and the minimum length shall be established in accordance with paragraph 922. The intermediate segment begins at the point where the initial approach intercepts the FAC. It extends along the inbound course to the GLIDE SLOPE intercept point.

996. FINAL APPROACH SEGMENT. Criteria for the final approach segment are contained in section 3 of this chapter.

997. FAC STANDARDS. The FAC's for simultaneous ILS approaches require the following:

a. Dual approaches shall have a minimum of 4,300 feet separation between parallel FAC's.

b. Triple approaches shall have a minimum of 5,000 feet separation between parallel FAC's. For triple parallel approach operations at airport elevations above 1,000 feet MSL, ASR with high resolution final monitor aids or high update radar with associated final monitor aids shall be required.

c. No Transgression Zone (NTZ). The NTZ shall be 2,000 feet wide equidistant between FAC's.

d. Normal Operating Zone (NOZ). The area between the FAC and the NTZ is half of the NOZ.

(1) The NOZ for dual simultaneous ILS approaches shall not be less than 1,150 feet in width each side of the FAC (see figure 97A).

(2) The NOZ for triple simultaneous ILS approaches shall not be less than 1,500 feet in width each side of the FAC (see figure 97B).

998. MISSED APPROACH SEGMENT. Except as stated in this paragraph, the criteria for missed approach are contained in section 4 of this chapter. A missed approach shall be established for each of the simultaneous systems. The minimum altitude specified for commencing a turn on a climb straight ahead for a missed approach shall not be less than 400 feet above the TDZE.

a. Dual. Missed approach courses shall diverge a minimum of 45°.

b. Triple. The missed approach for the center runway should continue straight ahead. A minimum of 45° divergence shall be provided between adjacent missed approach headings. At least one outside parallel shall have a turn height specified that is not greater than 500 feet above the TDZE for that runway.

999. RESERVED.

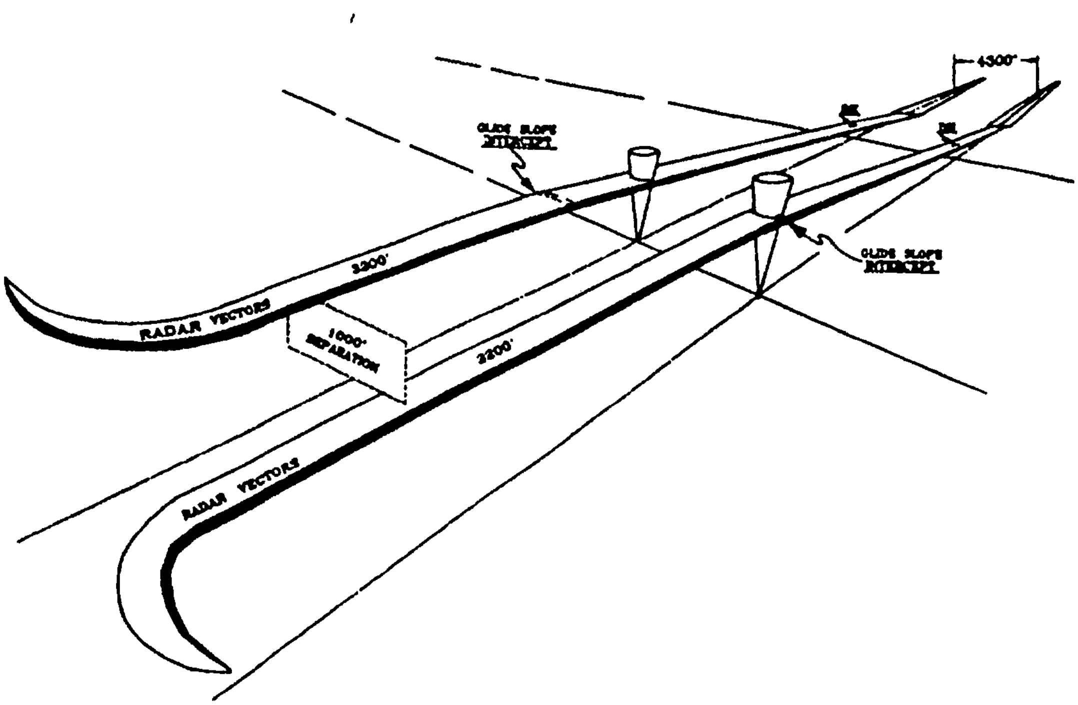


Figure 96A. INITIAL APPROACH SEGMENT, SIMULTANEOUS ILS. Par 994.

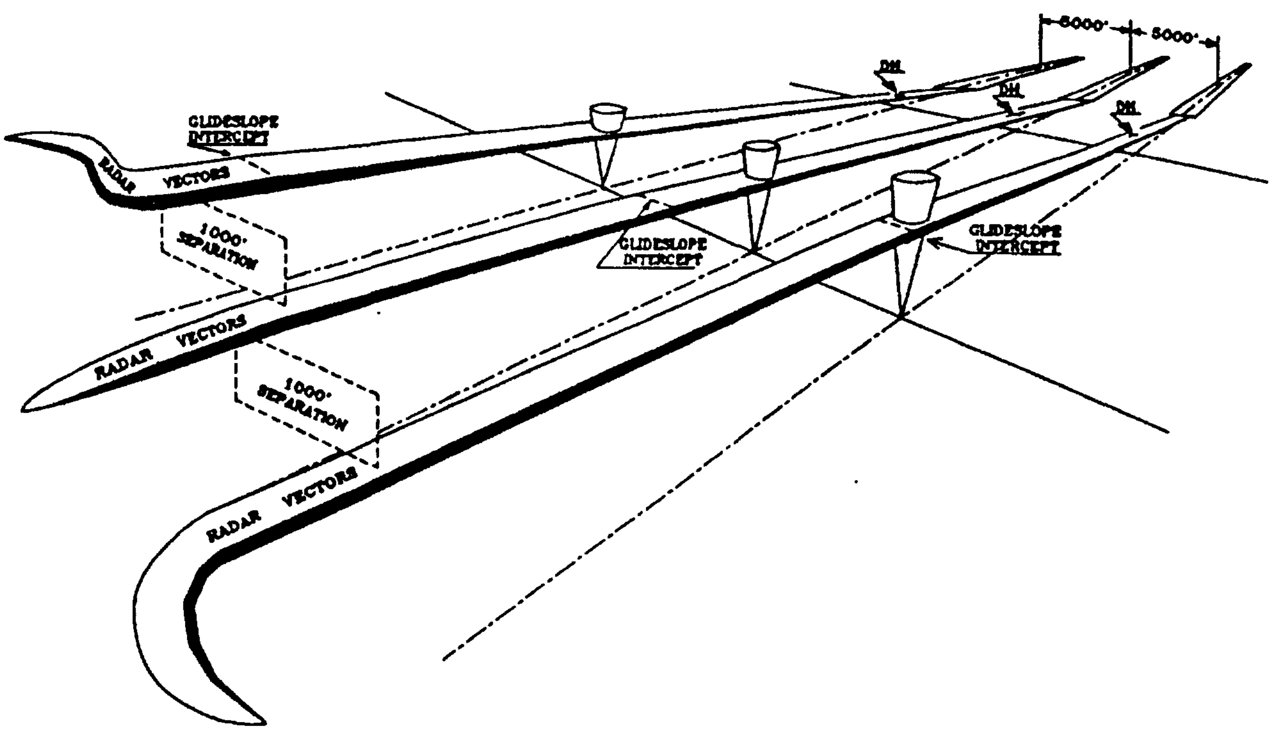


Figure 96B. INITIAL APPROACH SEGMENT FOR TRIPLE SUMULTANEOUS ILS. Par 994.

CHAPTER 10. RADAR PROCEDURES

1000. GENERAL. This chapter applies to approach procedures based on the use of ground and airborne radar. Four types of radar procedures are covered:

a. Precision Approach Radar (PAR). A radar display of azimuth, range, and glide slope information, which provides for precision approaches to a runway.

b. Airport Surveillance Radar. A radar installation with a display of azimuth and range, which provides a radar vectoring capability for final approach to an airport.

c. Simultaneous Radar Procedures. A radar or radars which serve parallel runways and provide for simultaneous approaches to authorized minimums.

d. Airborne Radar. A radar installation in an aircraft with a display of azimuth and range which provides a capability for an instrument approach when used with appropriate terrain, reflector, or transponder return.

1001. - 1009. RESERVED.

SECTION 1. PRECISION APPROACH RADAR (PAR)

1010. SYSTEM COMPONENTS. A PAR system consists of a PAR facility which meets the requirements for the operating agency.

1011. INOPERATIVE COMPONENTS. Failure of azimuth and range information renders the entire PAR inoperative. When the glide slope feature becomes inoperative, the PAR reverts to a non-precision approach system and non-precision minimums (paragraph 350) apply. In this case, obstacle clearance shall be as specified in paragraph 953 for localizer and LDA approaches.

1012. LOST COMMUNICATION PROCEDURES. The PAR procedure shall include instructions for the pilot to follow in the event of a loss of communications with the radar controller. Alternate lost communications procedures shall be established for use where multiple approaches are authorized.

1013. FEEDER ROUTES AND INITIAL APPROACH SEGMENTS. Navigational guidance for feeder routes and initial segments may be provided by surveillance radar, other navigation facilities, or a combination thereof. When radar is used as the primary means of navigation guidance, the criteria specified in section 4 of this chapter shall apply. When other navigational facilities are used as the primary means of navigational guidance, the criteria specified in chapter 2, sections 2 and 3, shall apply, as appropriate.

1014. INTERMEDIATE APPROACH SEGMENT. Navigational guidance in the intermediate segment may be provided by ASR, PAR, other navigation facilities, or combination thereof. Except as stated in this paragraph, the criteria for the intermediate segment are contained in chapter 2, section 4. The intermediate segment begins at the point where the initial approach course intercepts an extension of the FAC. This extension is the intermediate course. It extends along the inbound FAC to the point of interception of the GP. The minimum length of the intermediate segment depends on the angle at which the initial approach course intercepts the intermediate, and is specified in table 20. The MAXIMUM angle of interception shall be 90°.

Table 20. INTERMEDIATE SEGMENT ANGLE OF INTERCEPT VS. SEGMENT LENGTH.

Maximum Angle (Degrees)	Minimum Length (Miles)
15	1
30	2
45	3
60	4
75	5
90	6

NOTE: This table may be interpolated.

1015. DESCENT GRADIENT. Even though the minimum length of the intermediate segment may be less than that specified in chapter 2, section 4, intermediate descent criteria specified in paragraphs 242d and 243d shall be applied to at least 5 miles of flight track immediately prior to the glide slope intercept point.

1016. ALTITUDE SELECTION. Altitudes selected for the initial approach and intermediate approach segments provide required obstacle clearance as specified in chapter 2. In addition, the selected altitudes shall NOT be less than the glide slope interception altitude. Where PAR and ILS serve the same runway, the glide slope interception altitude should be the same for both, and the point of interception should be the OM wherever possible.

1017. - 1019. RESERVED.

SECTION 2. PAR FINAL APPROACH

1020. FINAL APPROACH SEGMENT. The final approach segment begins at the FAF. The FAF in PAR procedures is the point where interception of the glide slope occurs. The point of glide slope interception shall NOT be less than 3 miles from the landing threshold. When the glide slope is inoperative, the FAF is a point on the FAC within 5 miles of the landing threshold, but not less than the distance required by descent gradient criteria. The FAF for procedures without a glide slope should coincide with the FAF for PAR.

a. Alignment. The FAC shall be aligned with the runway centerline.

b. Area. The area considered for obstacle clearance in the final approach segment consists of a final approach area and transitional surfaces (see paragraph 1022). The final approach area has the following dimensions:

(1) Length. The final approach area is 50,000 feet long, measured outward along the FAC from a point beginning 200 feet outward from the runway threshold. Where operationally required by other procedural considerations due to existing obstacles, the length may be increased as shown in figure 98. The final approach area used shall only be that portion of the area which is between the glide slope interception point and the point 200 feet from the runway threshold.

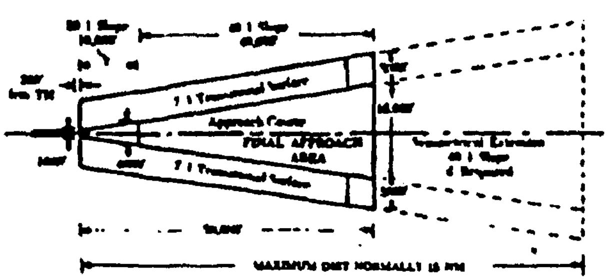


Figure 98. PAR FINAL APPROACH AREA. Par 1020b.

(2) Width. The final approach area is centered on the extended runway centerline. The area has a total width of 1,000 feet at the point 200 feet from the threshold and expands uniformly to a total width of 16,000 feet at a point 50,000 feet from the point of beginning. This width further expands uniformly where a greater length is required as in paragraph 1020b(1). See figure 98. The width either side of the centerline at a given distance "D" from the point of beginning can be found by using the formula 1/2W = 500 + D.15D. 500 + .15 x 50,000 = 8,000, which is ½ the width. Therefore, the total width is 16,000 feet at the 50,000 foot point.

NOTE: Where glide slope interception occurs at a distance greater than 50,200 feet from the threshold, the final approach area and the final approach surface may be extended symmetrically to a maximum distance dictated by the usability of the glide slope.

1021. FINAL APPROACH OCS. The final approach OCS is an inclined plane which originates at the runway THR elevation, 975 feet before GPI, and overlies the final approach area. The surface is divided into two sections: an inner 10,000 foot section and an outer 40,000 foot section. The slope of the surface changes at the 10,000 foot point. The exact gradient differs according to the angle at which the glide slope is established (see figure 98A). Paragraphs 1024 and 1025 address application of the OCS.

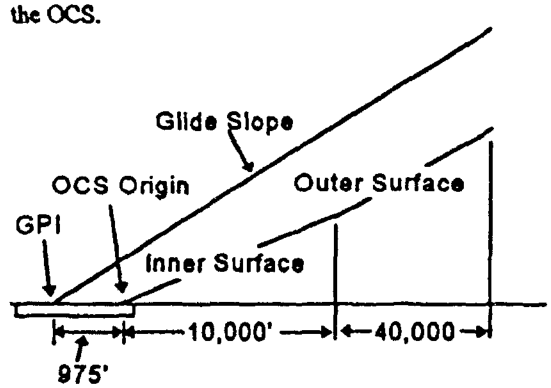


Figure 98A. OBSTACLE CLEARANCE SURFACES. Par 1021.

1022. TRANSITIONAL SURFACE. Transitional surfaces for PAR are inclined planes with a slope of 7:1 which extend outward and upward from the edges of the final approach area, starting at the height of the applicable final approach surface and extending for a lateral distance of 5,000 feet at right angles to the runway centerline. (see figure 98).

1023. DELETED.

1024. OBSTACLE CLEARANCE. No obstacle shall penetrate the applicable final approach OCS specified in paragraph 1021 or the transitional surfaces specified in paragraph 1022. Compare obstacle height to the appropriate OCS/transitional surface using the formulae below.

a. Inner OCS. Calculate the height of the inner OCS (OCS_I) at any distance D less than 10,975 feet from GPI using the following formula:

$$OCS_I \text{ Height Above THR } = \left[(\tan(gs) - 0.02366) \times D\right] - 20$$

where: gs = glide slope angle
D = distance from GPI in feet

b. Outer OCS. Calculate the height of the outer slope (OCS_O) at any distance D equal to or greater than 10,975 feet from GPI using the following formula:

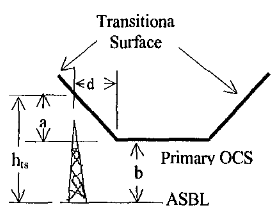
$$OCS_O \text{ Height Above THR } = \left[(\tan(gs) - 0.01866) \times D\right] - 75$$

where: gs = glide slope angle
D = distance from GPI in feet

c. Transitional Surface. Calculate the height of the transitional surface (h_{ts}) at any distance (d) from the edge of the primary area measured perpendicular to the final approach course using the following formula.

(1) $a = \frac{d}{7}$

(2) $h_{ts} = a + b$



Where a = amount of surface adjustment
d = distance from edge of primary
b = OCS_I or OCS_O as appropriate

1025. EFFECT OF OBSTACLES INSIDE THE DH. See paragraph 251 for the assessment of the visual portion of a PAR approach.

1026. GLIDE SLOPE. In addition to the required obstacle clearance, the following shall apply to the selection of the glide slope angle and antenna location.

a. Glide Slope Angle. The optimum glide slope angle is 3°. Angles less than 2° or more than 3° shall not be established without the authorization of the approving authority. The PAR glide slope angle shall be within 0.20 of the non-radar precision instrument approach/VGSI glide slope angle and the RPI shall be within plus or minus 50 feet (30 feet for PAPI and PVGSI) of the non-radar precision approach RPI and/or VGSI runway reference point (RRP).

b. Glide Slope Threshold Crossing Height (TCH). See paragraph 980 for TCH requirements. A height as low as 32 fee for military airports may be used at locations where special consideration of the glidepath angle and antenna location are required. Where the glide slope TCH exceeds 60 feet, consider relocating the landing threshold to ensure effective placement of the approach light system. See appendix 2 for a method of computing TCH.

1027. RELOCATION OF GLIDE SLOPE. Where the OCS associated with a 3° glide slope is penetrated, and sufficient length of runway is available, the glide slope may be moved the required distance down the runway to ensure the OCS is clear. Where the glide slope threshold crossing height exceeds 60 feet, consider relocating the landing threshold to ensure effective placement of the approach light system. The minimum distance between the GPI and the runway threshold is 775 feet. (No minimum GPI distance need be applied to military locations provided the OCS is clear and TCH standards are met.)

1028. Height above Touchdown (HAT). The HAT value associated with the DA shall not be less than 200 feet for civil operations and 100 feet for military operations.

1029. RESERVED.

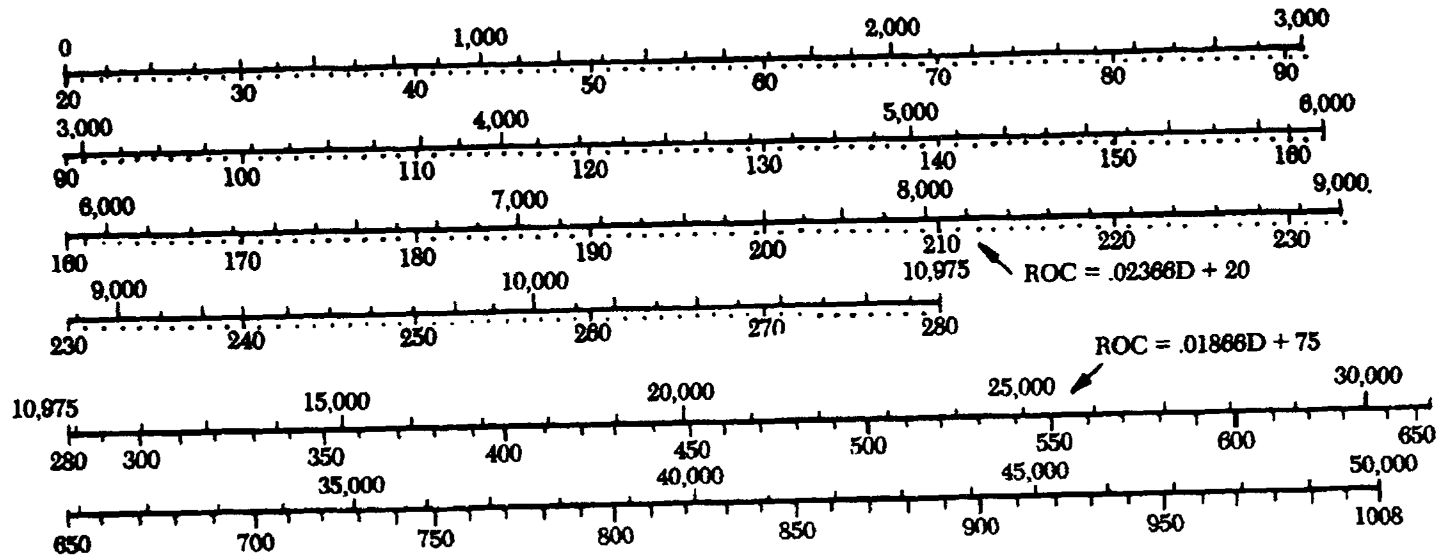
SECTION 3. PAR MISSED APPROACH

1030. MISSED APPROACH SEGMENT. The MAP begins at the missed approach point and ends at an appropriate point or fix where initial approach or en route obstacle clearance is provided. Missed approach procedures shall be based on positive course guidance where possible.

1031. MISSED APPROACH POINT (MAP). The MAP is a point on the final approach course where the height of the glide slope is equal to the authorized DH.

1032. STRAIGHT MISSED APPROACH. The straight missed approach area (maximum of 15° turn from FAC) starts at the MAP. The length of the area is 15 miles measured along the missed approach course. The area has a width equal to that of the final approach area at the MAP and a width equal to that of the initial approach area at a point 15 miles from the MAP. The missed approach area is divided into 2 sections.

Section 1 starts at the MAP and is longitudinally centered on the missed approach course. It has the same width at the MAP as the final approach area.



The lowest glide slope that will provide the required obstacle clearance (ROC) over a critical obstacle is found by the formula:

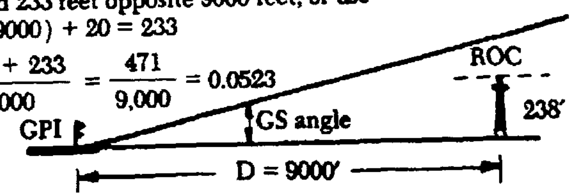
$$\text{Tan of GS angle} = \frac{\text{Obstacle height + ROC}}{\text{GPI to obstacle Distance}}$$

EXAMPLE:

Controlling obstacle is 238 feet above runway elevation and 9000 feet from the GPI. Find the minimum GS angle

From the nomograph find 233 feet opposite 9000 feet, or use the formula $(0.02366 \times 9000) + 20 = 233$

$$\text{Tan of GS angle} = \frac{238 + 233}{9000} = \frac{471}{9{,}000} = 0.0523$$



Arc Tan 0.0523 = 3.0 degrees

NOTE: A method with an example of criteria application (Paragraphs 1021 through 1025) is included in Appendix 2.

Figure 99. PAR OBSTACLE CLEARANCE NOMOGRAPH. Par 1024

b. Section 2 starts at the end of Section 1 and is centered on a continuation of the Section 1 course. The width increases uniformly from 1 mile at the beginning to 12 miles at a point 13.5 miles from the beginning. A secondary area for reduction of obstacle clearance is identified within Section 2. The secondary area is zero miles wide at the beginning and increases uniformly to 2 miles wide at the end of Section 2. Positive course guidance is required to reduce obstacle clearance in the secondary area. See Figure 100.

1033. TURNING MISSED APPROACH. Where turns of more than 15 degrees are required in a missed approach procedure, they shall begin at an altitude which is at least 400 feet above the elevation of the touchdown zone. Such turns are assumed to begin at the point where Section 2 begins. The flight track and obstacle clearance radii used shall be as specified in Table 5, paragraph 275. To determine the length of Section 1:

a. Add 400 feet to touchdown zone elevation.

b. Round to next higher 100 foot increment.

c. Subtract the decision height value from the result of steps a & b.

d. Divide the result by 152 to obtain the required length of Section 1 in nautical miles.

e. Minimum length of Section 1 shall be 1.5 NM.

The width at the end of Section 1 is determined by symmetrically extending Section 1 to the required length. The inner boundary of Section 2 shall begin at the edge of Section 1 opposite the MAP. The outer and inner boundary lines shall flare to the width of the initial approach area at 15 NM from the MAP measured along the flight path. Secondary areas for reduction of obstacle clearance are identified within 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 2 miles wide at the end of Section 2. Positive course guidance is required to reduce obstacle clearance in the secondary areas. See Figure 101.

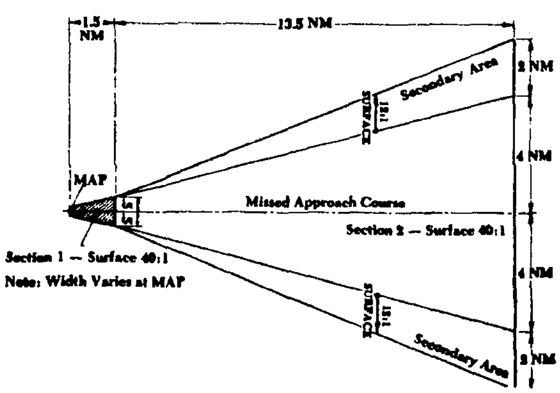


Figure 100. PAR STRAIGHT MISSED APPROACH AREA. Par 1032.b.

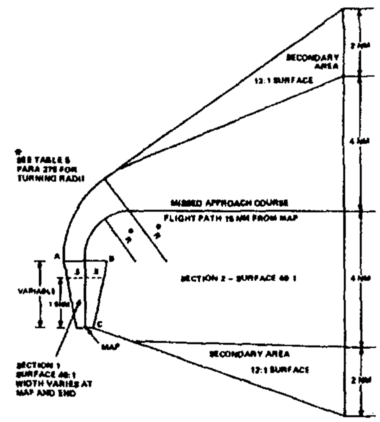


Figure 101. PAR TURNING MISSED APPROACH AREA. Par 1033

1034. MISSED APPROACH OBSTACLE CLEARANCE.

a. Straight Missed Approach Area. No obstacle in Section 1 or Section 2 may penetrate a 40:1 surface which originates at the MAP at the height of the final approach surface, but not more than 250 feet below the DH, and which overlies the entire missed approach area.

b. Turning Missed Approach Area. Section 1 obstacle clearance is the same as that for straight missed approaches. To determine the obstacle clearance requirements in Section 2, the dividing line between Section 1 and 2 is identified as "A-B-C". The height of the missed approach surface over any obstacle in Section 2 is determined by measuring the distance from the obstacle to the nearest point on line A-B-C, and computing the height according to the 40:1 ratio, starting at the height of the missed approach surface at the end of Section 1.

c. Secondary Areas. Where secondary areas are considered, no obstacle may penetrate a 12:1 surface which slopes outward and upward from the missed approach surface.

d. Discontinuance. 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.

1035. 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 1A. The portion in which the turn is made is Section 2.

a. Straight Portion. Sections 1 and 1A correspond respectively to Sections 1 and 2 of the normal straight missed approach area and are constructed as specified in Paragraph 1032 except that Section 1A has no secondary areas. Obstacle clearance is provided as specified in Paragraph 1034.b. The length of Section 1A is determined as shown in Figure 102 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 1A. Point C' is 9000 feet from the end of Section 1A (see Figure 102).

b. Turning Portion. Section 2 is constructed as specified in Paragraph 1033 except that it begins at the end of Section 1A 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 1A to which the turn is to be made. Then measure the distance from this obstacle to the nearest edge of the Section 1A area. Using this distance as illustrated in Figure 102 determine the height of the 40:1 slope at the edge of Section 1A. 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 2 are the same as those specified in Paragraph 1034.b except that Section 2 is expanded to start at Point C if no fix exists at the end of Section 1A or if no course guidance is provided in Section 2 (see Figure 102).

1036. – 1039. RESERVED.

Section 4. Airport Surveillance Radar (ASR)

1040. GENERAL. This section applies to approach procedures based on the use of ASR. ASR may be used to provide primary navigation guidance within the operational coverage of the radar. ASR approaches may be established where the coverage and alignment tolerances specified in the U.S. Standard Flight Inspection Manual can be met and the airport is not more than 20 miles from the radar antenna.

1041. INITIAL APPROACH SEGMENT. The initial approach segment begins at the position the aircraft is in when radar contact is established, and ends at the intermediate fix. Radar guidance may be used in pre-established patterns or may be provided by diverse vectors issued by the radar controller.

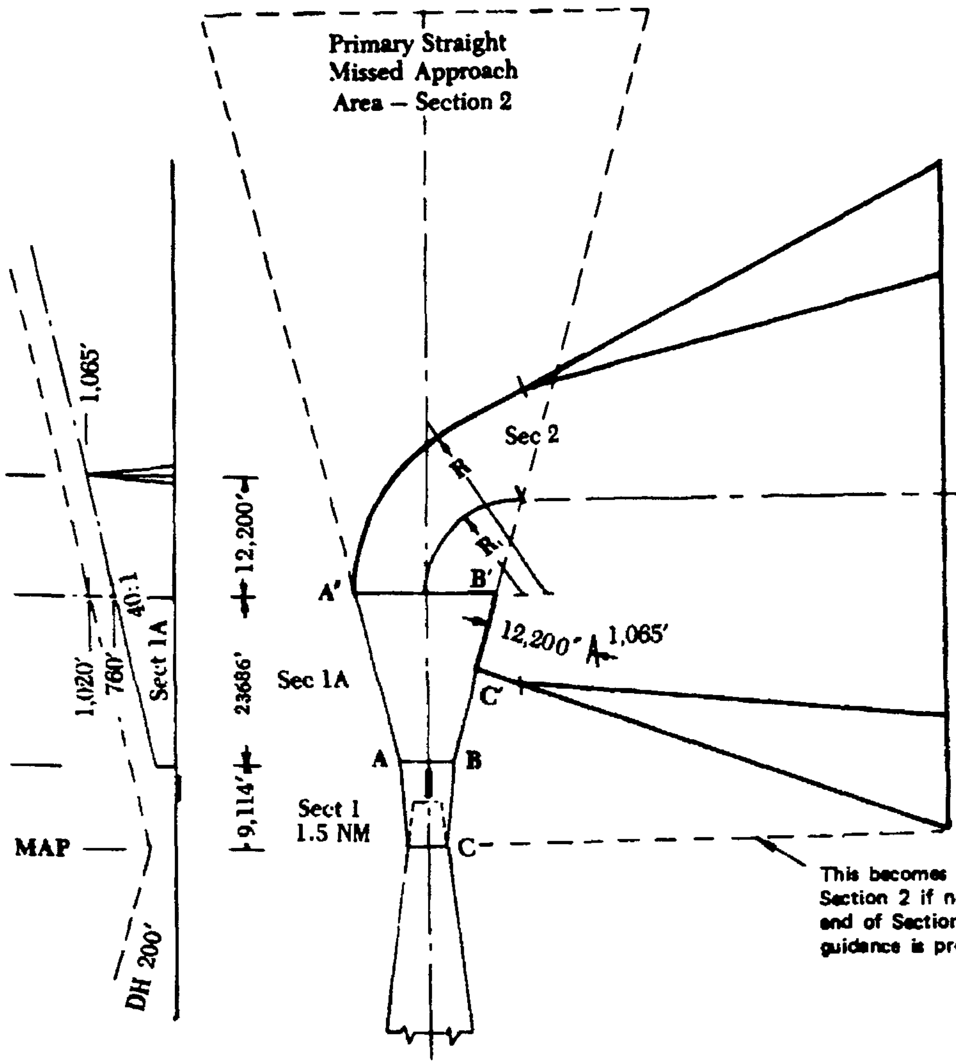
a. Radar Patterns. Radar patterns shall begin at an established fix or point which permits positive radar identification.

(1) Alignment. The initial approach course, or courses, shall be selected to coincide with aircraft maneuvering capability and to satisfy air traffic flow requirements. The angle at which the initial approach course joins the intermediate course shall not exceed 90 degrees.

(2) Area. The area considered for obstacle clearance is 3 miles (5 miles at distances greater than 40 miles from the radar antenna) either side of the designated pattern course. There is no secondary area. The area has no specific maximum or minimum length. However, the initial approach must be long enough to permit the altitude loss required by the procedure at the authorized descent gradient.

NOTE: Air Route Surveillance Radar (ARSR) may be used to provide course guidance up to and including the intermediate fix or point.

(3) Obstacle Clearance. A minimum of 1000 feet of clearance shall be provided over all obstacles in the initial approach area. Clearance over a prominent obstacle which is displayed as a permanent echo on the radar scope may be discontinued after the aircraft has been observed to pass the obstacle. Allowance for precipitous terrain should be made as specified in Paragraph 323. The altitudes selected by application of the obstacle clearance criteria specified in this paragraph may be rounded to the nearest 100 feet. See Paragraph 1043.



EXAMPLE:

DH is 200' MSL.

A 1065' controlling obstacle is 12200' from the near edge of Sec. 1A.

A 40:1 surface which clears the obstacle has a height of 760' MSL at the near edge of Section 1A.

12200' ÷ 40'=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 40:1 climb gradient requires 32800'. Sec. 1 is 9114' long; therefore, Section 1A is required to be 23686' long.

Figure 102. COMBINATION STRAIGHT AND TURNING MISSED APPROACH AREA. Par 1035.

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after the aircraft has been observed to pass the obstacle. Allowance for precipitous terrain should be made as specified in Paragraph 323. The altitudes selected by application of the obstacle clearance criteria specified in this paragraph may be rounded to the nearest 100 feet. See Paragraph 1043.

(4) Descent Gradients. The OPTIMUM descent gradient in the initial approach is 250 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 feet per mile. The OPTIMUM descent gradient for high altitude penetrations is 800 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 1000 feet per mile.

b. Diverse Vectors. Navigation guidance of an aircraft by diverse vectors issued by the radar controller may commence upon positive radar identification.

(1) Alignment. Diverse vectors issued by the controller are selected to coincide with aircraft maneuvering capability and to satisfy air traffic flow requirements.

(2) Area. The area considered for obstacle clearance shall be the entire area within the operational coverage of the radar. This area may be sub-divided to gain relief from obstacles which are clear of the area in which flight is to be conducted. There is no prescribed limit on the size, shape, or orientation of these sub-divisions; however, they shall be designed to emphasize simplicity and safety in radar air traffic control applications.

(3) Obstacle Clearance. A minimum of 1000 feet of clearance shall be provided over all obstacles within the operational coverage of the radar or within the appropriate subdivision where subdivisions have been established. Altitudes established for use shall also provide 1000 feet of clearance over all obstacles outside of the subdivision within 3 miles of the subdivision boundary (5 miles at distances greater than 40 miles from the antenna). Clearance over a prominent obstacle which is displayed as a permanent echo on the radar scope may be discontinued after the aircraft has been observed to pass the obstacle. Allowance for precipitous terrain should be made as specified in Paragraph 323. The altitudes selected by application of the obstacle clearance criteria specified in this paragraph may be rounded to the nearest 100 feet. See Paragraph 1043.

(4) Descent Gradient. The OPTIMUM descent gradient in the initial approach is 250 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 500 feet per mile. The OPTIMUM descent gradient for high altitude penetrations is 800 feet per mile. Where a higher descent gradient is necessary, the MAXIMUM permissible gradient is 1000 feet per mile.

1042. INTERMEDIATE APPROACH SEGMENT. The intermediate segment begins at the radar fix where the initial approach course intersects an extension of the final approach course. This extension is the intermediate course, and the point of intersection is the intermediate fix. The intermediate segment extends along the intermediate course inbound to the point where final approach descent commences. This point is the final approach fix.

a. Alignment. The intermediate course is an extension of the final approach course.

b. Area. The width of the intermediate segment is 3 miles either side of the course at the intermediate fix. It tapers to the width of the final approach area at the final approach fix. There are no secondary areas. The length of the intermediate segment shall not exceed 15 miles. The minimum length of the intermediate segment depends on the angle at which the initial approach course intercepts the intermediate course, and is specified in the table below. The MAXIMUM angle of interception shall be 90 degrees.

c. Obstacle Clearance. A minimum of 500 feet of clearance shall be provided over all obstacles in

Table 22. INTERCEPTION ANGLE VS. LENGTH OF INTERMEDIATE SEGMENT.

Maximum Angle of Interception (Degrees)	Minimum Length of Segment (Miles)
15	1
30	2
45	3
60	4
75	5
90	6

NOTE This Table may be interpolated. See Figure 75.

the intermediate area. Allowance for precipitous terrain should be made as specified in Paragraph 323. Clearance over a prominent obstacle which is displayed as a permanent echo on the radar scope may be discontinued after the aircraft has been observed to pass the obstacle. The altitudes selected by the application of the obstacle clearance criteria specified in this paragraph may be rounded to the nearest 100 feet. See Paragraph 1043.

d. Descent Gradient. Because the intermediate segment is used to prepare the aircraft speed and configuration for entry into the final approach segment, the descent gradient should be as flat as possible. The OPTIMUM descent gradient should not exceed 150 feet per mile. The MAXIMUM descent gradient is 300 feet per mile. When the length of the intermediate segment is less than specified in Paragraph 242, intermediate descent criteria shall be applied to at least 5 miles of flight track immediately prior to the FAF.

1043. ALTITUDE SELECTION. Altitudes selected for the initial and intermediate approach segments shall be established in 100 foot increments. For example, 1149 feet may become 1100 feet; and 1150 feet shall become 1200 feet.

1044. FINAL APPROACH SEGMENT. The final approach begins at the final approach fix, which is a radar fix and ends at the runway or missed approach point, whichever is encountered last.

a. Alignment. The final approach course shall be aligned on the extended runway centerline for straight-in approach and to the center of the airport for circling approach. When an operational advantage can be achieved, the final approach course for circling may be aligned to any portion of the usable landing surface.

b. Area. The area considered for obstacle clearance begins at the final approach fix and ends at the runway or missed approach point, whichever is encountered last, and is centered on the final approach course. The minimum length of the final approach area shall be 3 miles. The maximum length should not exceed 6 miles. See Figure 103. The width of the primary area (Wp) is based on a formula which provides 2 miles of width at the radar antenna, increasing to 6 miles of width at a distance (D) of 20 miles from the radar antenna. The formula is $1/2Wp = 0.1D + 1$ mile. There are no secondary areas. See Figure 104.

c. Obstacle Clearance.

(1) Straight-In. A minimum of 250 feet of clearance shall be provided over all obstacles in the final approach area, except that where a prominent obstacle which is displayed as a permanent echo on the radar scopes exists it need not be considered for obstacle clearance after the aircraft is observed to have passed the obstacle. Allowance for precipitous terrain as specified in Paragraph 323 should be made.

(2) Circling. In addition to the minimum requirements specified in Paragraph 1044.c.(1) obstacle clearance in the circling area shall be as prescribed in Chapter 2, Section 6.

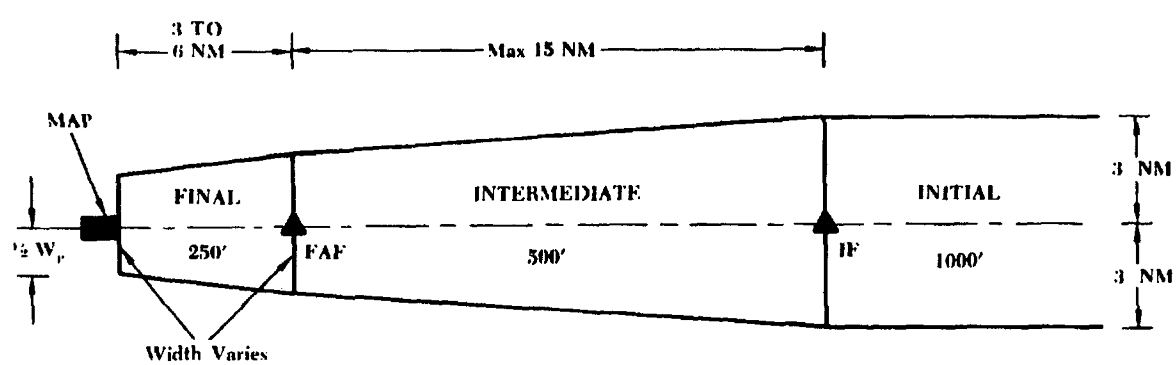
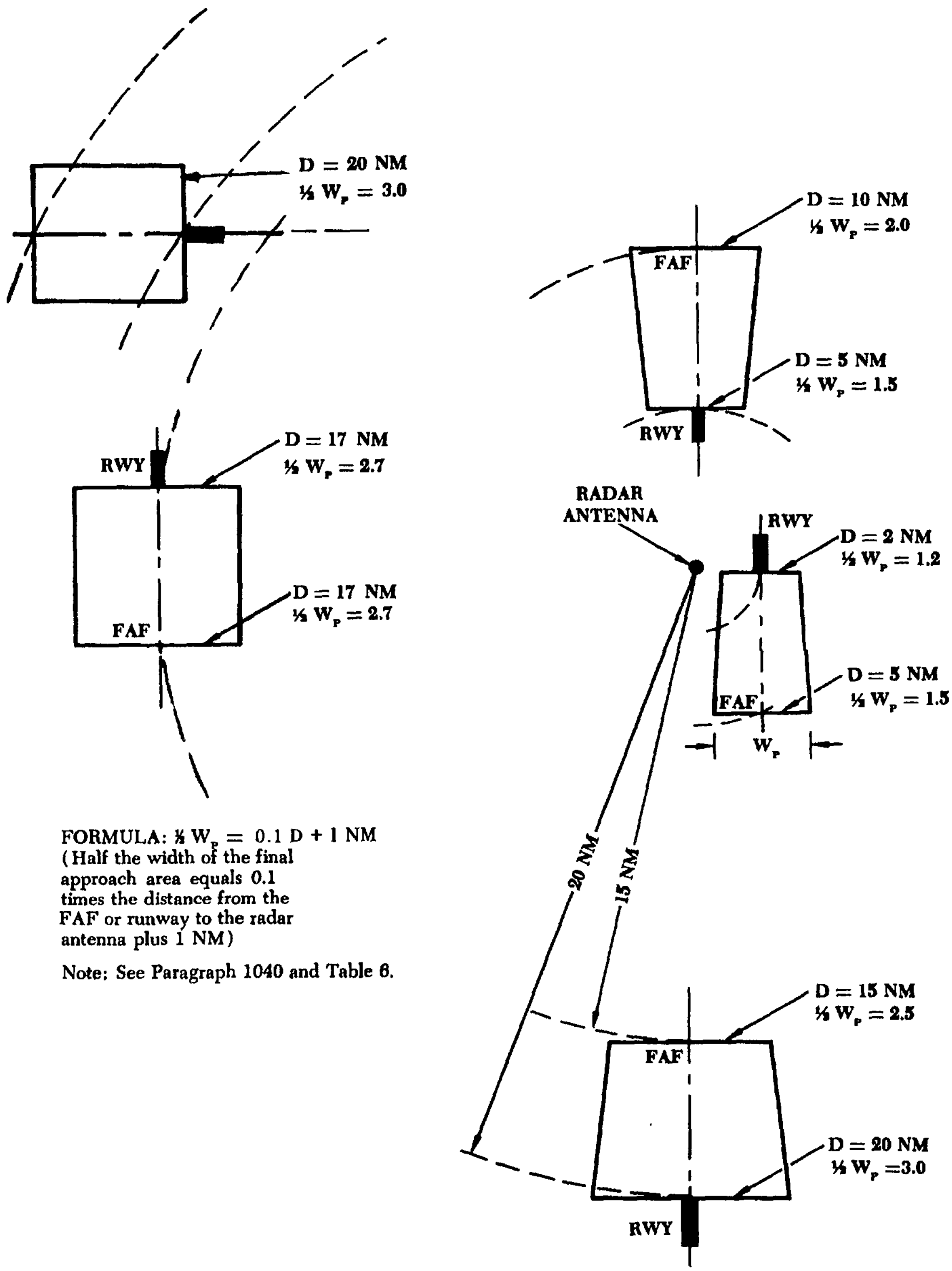


Figure 103. TYPICAL ASR APPROACH SEGMENTS. Par 1044.b.



FORMULA: ½ W_p = 0.1 D + 1 NM
(Half the width of the final approach area equals 0.1 times the distance from the FAF or runway to the radar antenna plus 1 NM)

Note: See Paragraph 1040 and Table 6.

Figure 104. EXAMPLES OF ASR FINAL APPROACH AREA DIMENSIONS. Par 1044.b.

1044.d. DESCENT GRADIENT. The OPTIMUM descent gradient is 300 feet per mile. The MAXIMUM descent gradient is 400 feet per mile.

(1) **Straight-In Approach.** The descent gradient shall be computed using the distance from the FAF to the runway threshold and the difference between the altitude over the FAF and TDZ elevation.

(2) **Circling Approach.** The descent gradient shall be computed using the distance from the FAF to the MAP and the difference between the altitude over the FAF and MDA.

1045. DEVIATION FROM ESTABLISHED RADAR PATTERNS. Whenever it is necessary to deviate from established radar patterns, obstacle clearance prescribed in Paragraph 1041.b. for diverse vectors shall be provided by approved radar vectoring charts.

1046. RADAR MONITOR. The use of ASR to monitor aircraft flying a published procedure based on another navigation system is encouraged to increase accuracy and expedite air traffic flow. However, no reduction in obstacle clearance may be made as a result of such monitoring. This does not preclude establishment of radar fixes in such published procedures for the purpose of permitting descent to a lower altitude.

1047. LOST COMMUNICATION PROCEDURES. The ASR procedure shall include instructions for the pilot to follow in the event of loss of communications with the radar controller. Alternate lost communication procedures shall be established for use where multiple approaches are authorized.

1048. MISSED APPROACH SEGMENT. The criteria for the missed approach segment are contained in Chapter 2, Section 7. The missed approach point is on the final approach course not farther from the final approach fix than the runway threshold (first usable portion of the landing area for circling approach). The missed approach surface shall commence over the MAP at the required height. See Paragraph 274.

1049. RESERVED.

Section 5. Simultaneous PAR Procedures

1050. GENERAL. Where facilities and equipment are available to support the requirement, PAR approach procedures to parallel runways may be established. The criteria specified in Chapter 9, Section 9, for simultaneous ILS procedures shall be used as a guideline in developing such procedures.

1051.-1059. RESERVED.

Section 6. Airborne Radar Procedures

1060. GENERAL. Airborne radar procedures will be developed and published for military use at a later date.

1061.-1099. RESERVED.

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 approach Category A aircraft with special maneuvering characteristics. The intent, therefore, is to provide relief from those portions of other TERPS chapters which 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. HAL. Height above landing area elevation.

b. HAS Height Above the Surface. 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). 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 utilizing VHF/UHF DF may be developed in accordance with the appropriate chapters of this documents. Criteria for RNAV, ARA, and MLS with high glide path angle or selectable glide path angle capability will be developed at a later date. *

1105. PROCEDURE IDENTIFICATION. Helicopter only procedures shall bear an identification which includes the term "COPTER," the type of facility providing final approach course guidance, and a numerical identification of the final approach course, e.g., COPTER VOR 090, COPTER NDB 270, COPTER PAR 327, COPTER ASR 327, etc. If the procedure includes an arc final approach, the word "ARC" will be used, and will be followed by a sequential number, e.g., COPTER VORTAC ARC 1, COPTER VOR/DME ARC 2, COPTER TACAN ARC 3, etc.

NOTE: *Where separate procedures at the same location use the same type of facility and same final approach course such procedures will be differentiated by adding an alphabetical suffix.*

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.

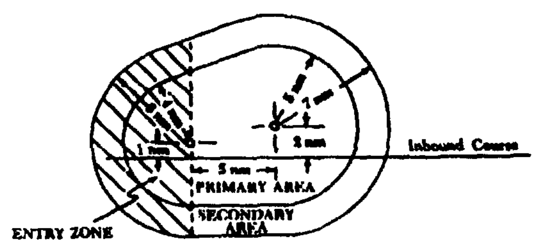


Figure 105. HELICOPTER PROCEDURE TURN AREA. Par 1112.

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. Paragraph 242 is changed as follows:

a. Alignment. The provisions of paragraph 242a apply with the exception that the intermediate course shall 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 2 miles. The minimum length is 1 mile and the recommended maximum is 5 miles. A distance greater than 5 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 4 miles or more than 30 miles from the navigation facility shall not be used.

a. Area.

(1) **Length.** The OPTIMUM length of the intermediate approach segment is 2 miles. The minimum length is 1 mile and the recommended maximum is 5 miles. A distance greater than 5 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.

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 5 miles from the fix or from the facility. This produces an intermediate segment 5 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 5 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 shall be aligned as indicated in paragraphs 1152 and 1159. For nonprecision procedures final approach course alignment shall 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 paragraph 275 apply with the exception that when applying missed approach criteria shown in figures 19 through 24, and table 5, 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 shall 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 shall 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. Chapter 3, section 2, is changed as follows:

a. In paragraph 320 "runway environment" is understood also to mean "landing area environment."

b. In paragraph 321 reference to 40:1 is changed to 20:1.

c. Paragraph 322 does not apply.

d. Paragraphs 324, 938 and 1028 apply except that a DH of 100 feet may be approved without approach lights; the tables in paragraph 350 do not apply, and table 29 in paragraph 1167 governs the establishment of the DH.

1127. VISIBILITY. Chapter 3, section 3, is changed as follows:

* *a. Nonprecision Approaches.*

(1) **Approach to Runway.** The minimum visibility may be 1/2 the computed straight-in CAT A fixed-wing value from tables 6, 9, or 10, as applicable, but not less than 1/4 mile/1,200 RVR.

(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. Paragraphs 330 and 331 do not apply.

b. Precision Approaches.

(1) **Approach to Runway.** The minimum visibility may be 1/2 the computed straight-in CAT A fixed-wing values specified in tables 9 and 10, but not less than 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. Paragraphs 330 and 331 do 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 shall be 1 mile. No credit for lights will be authorized unless an approved visual lights guidance system is provided. See also paragraph 344. Alternate minimums are not authorized. Table 25 does not apply.

EXAMPLE

MDA is 360' MSL based on obstacles in the approach area. A 1098' MSL controlling obstacle is 1 mile (6076') from the near edge of Section 1.

A 20:1 surface which clears the obstacle has a height of 794' MSL at the near edge of Section 1.

6076 Divided by 20 Equals 304 1098 Minus 304 Equals 794.

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.

794' Plus 250' Equals 1044' rounded up Equals 1060' MSL.

To climb 700' from MDA 360' MSL to the turning altitude (1060' MSL) at the 20:1 climb gradient requires 14,000'. This is the minimum length of Section 1.

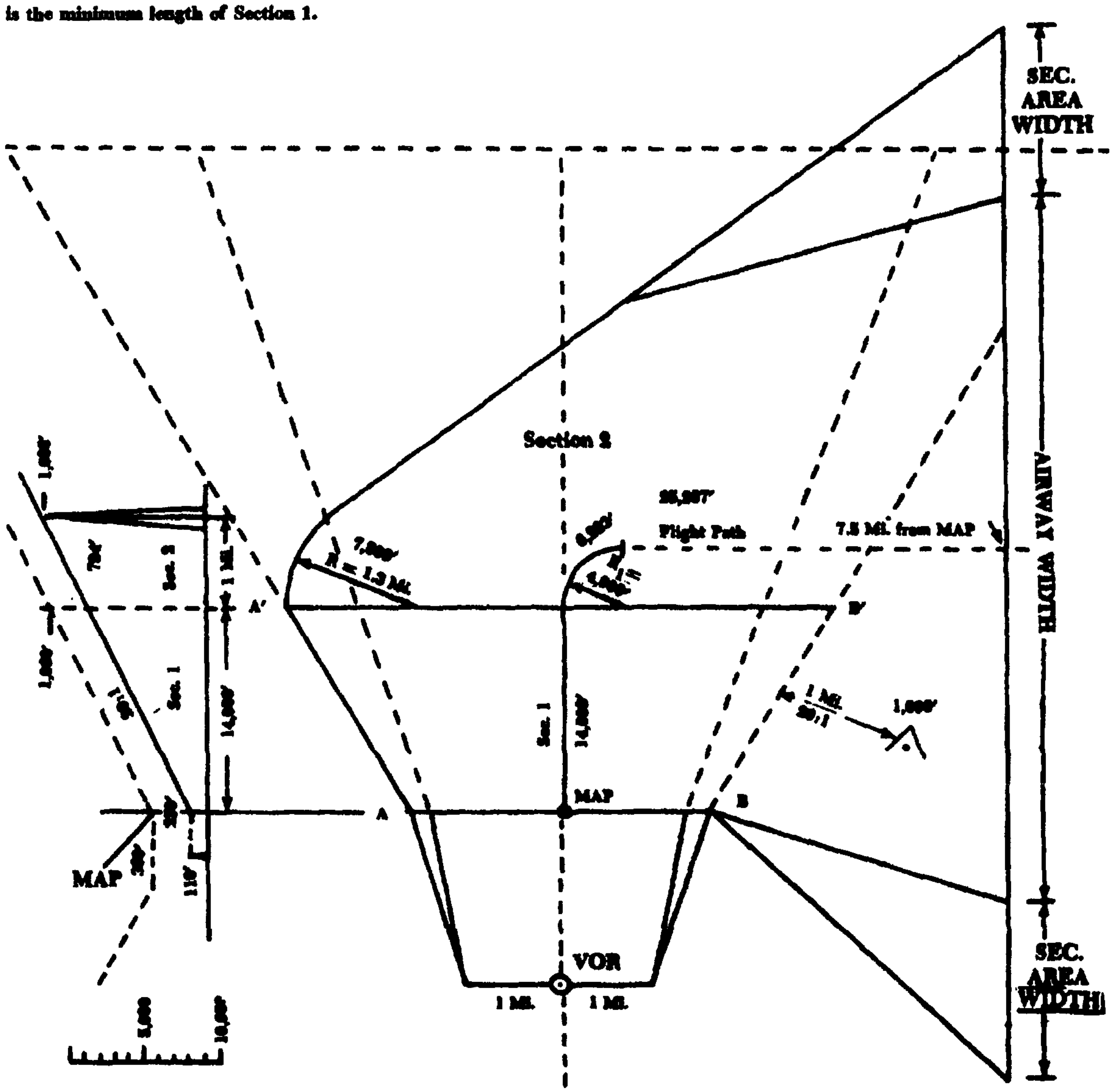


Figure 106. COMBINATION MISSED APPROACH AREA. Paragraph 1122.

* **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 paragraph 342 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 ft.	601-800 ft.	More than 800 ft.
Visibility Minimum (Mi)	1/2	3/4	1

*   *

1129. TAKEOFF MINIMUMS. Paragraph 370 does not apply. Helicopter takeoff minimums will be in accordance with the appropriate Federal Aviation Regulations and Military Regulations.

Section 4. On-Heliport VOR (No FAF)

1130. GENERAL. Paragraph 400 does not apply. These criteria apply to procedures based on a VOR 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.

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 the 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 5 miles. This may be extended if an operational requirement exists. The primary area is 2 miles wide at the facility and expands uniformly to 4 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 5 miles from the facility. See figure 107.

c. Obstacle Clearance. Paragraph 413c(1) applies.

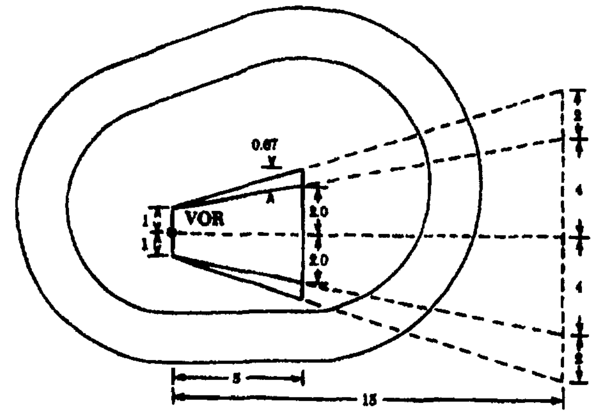


Figure 107. FINAL APPROACH PRIMARY AND SECONDARY AREA. On-Heliport VOR, No FAF, Par 1132b. See also Figure 105.

d. Procedure Turn Altitude. The procedure turn completion altitude shall 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 chapter 3.

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 (MILES)

Magnitude of Turn Over the 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.

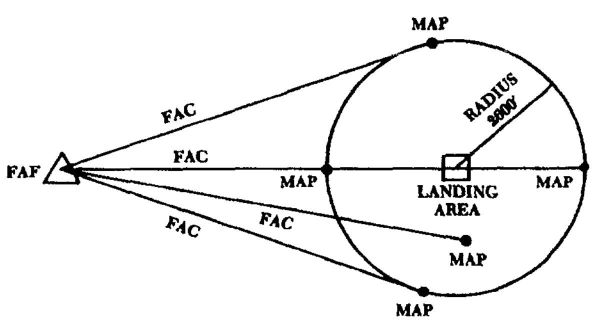


Figure 108. MISSED APPROACH POINTS. Off-Heliport VOR with FAF. Par. 1135.

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.

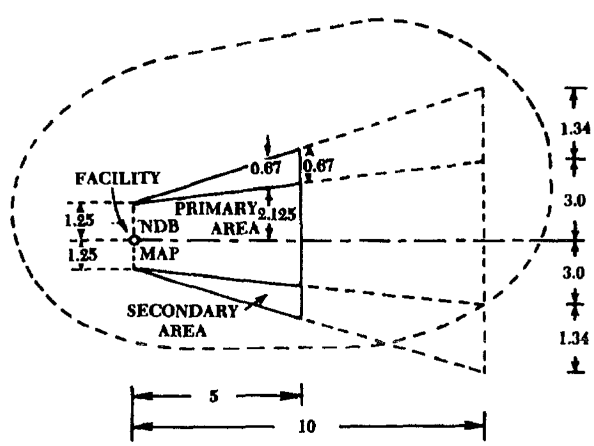


Figure 109. FINAL APPROACH PRIMARY AND SECONDARY AREAS. On-Heliport NDB. No FAF. Paragraph 1140.

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.

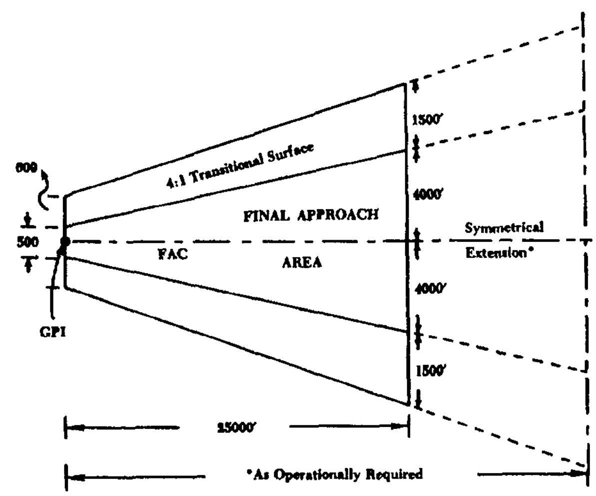


Figure 110. PAR FINAL APPROACH AREA.
Par 1159 and 1160

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 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.

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.

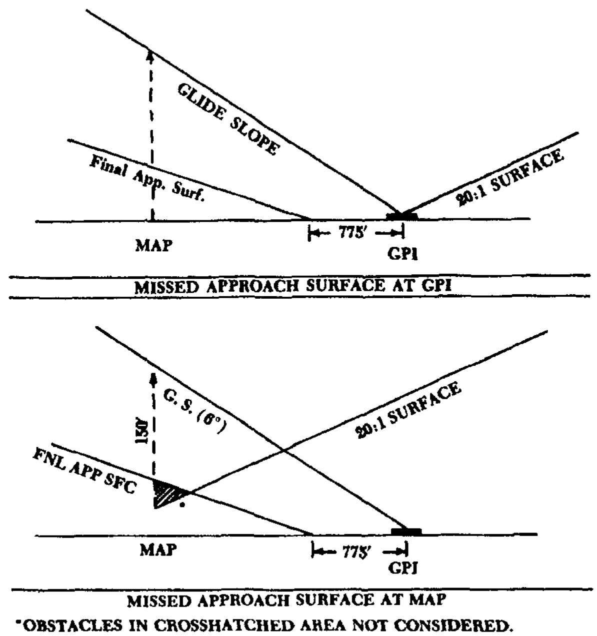


Figure 112. MISSED APPROACH SURFACE OPTIONS (Par 1168)

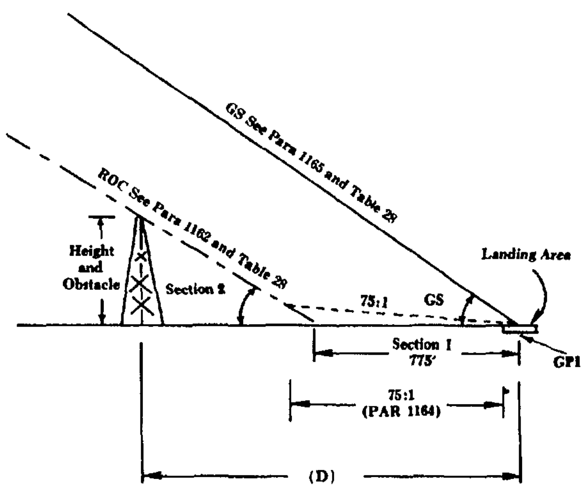


Figure 111. FINAL APPROACH AREA SURFACE AND OBSTACLE CLEARANCE. Paragraphs 1162 and 1164.

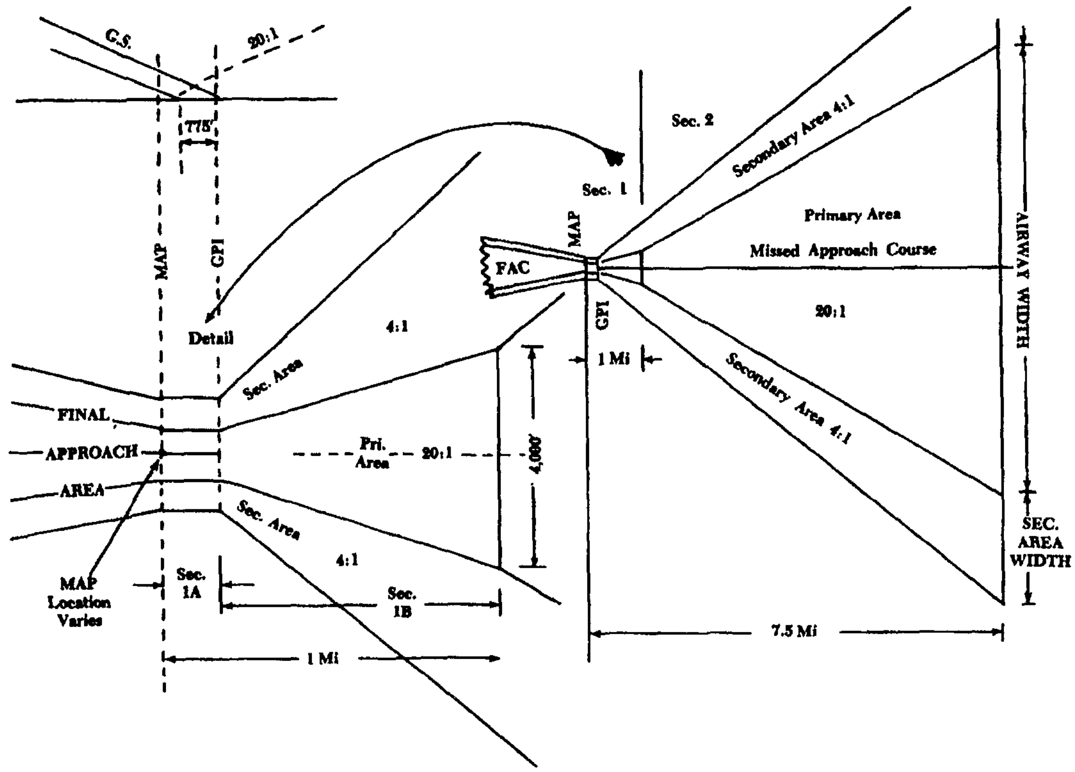


Figure 113. STRAIGHT MISSED APPROACH.

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

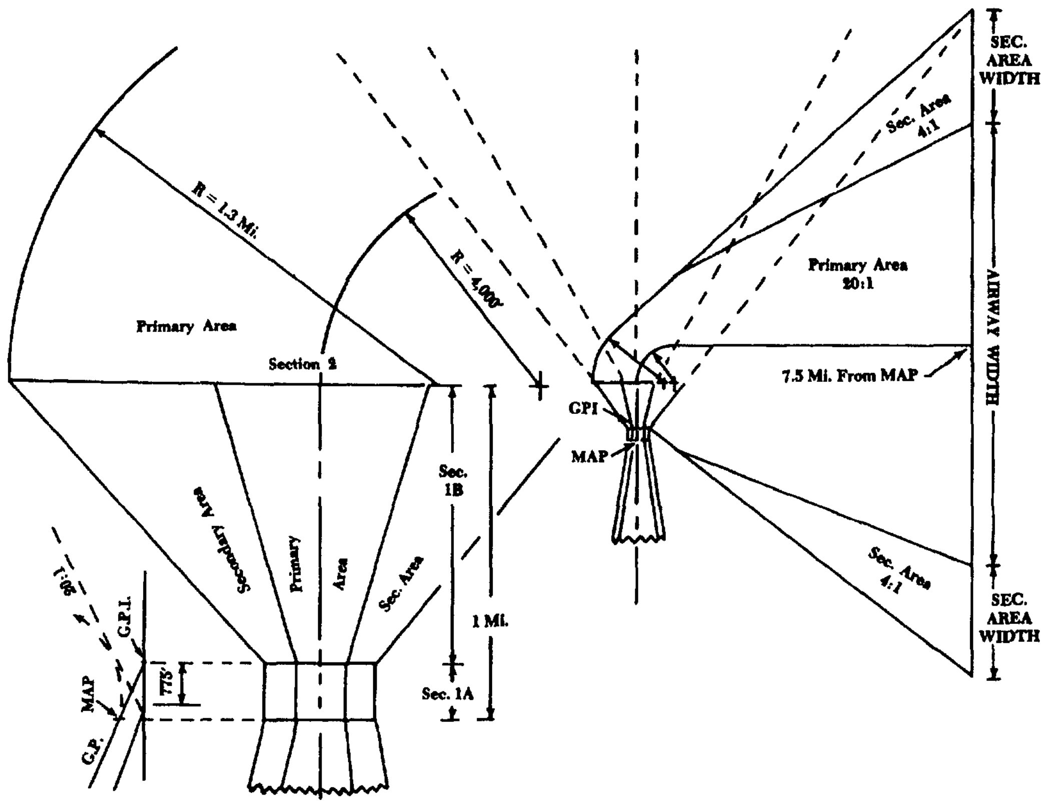


Figure 114. TURNING MISSED APPROACH AREA.
Par 1170.

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.

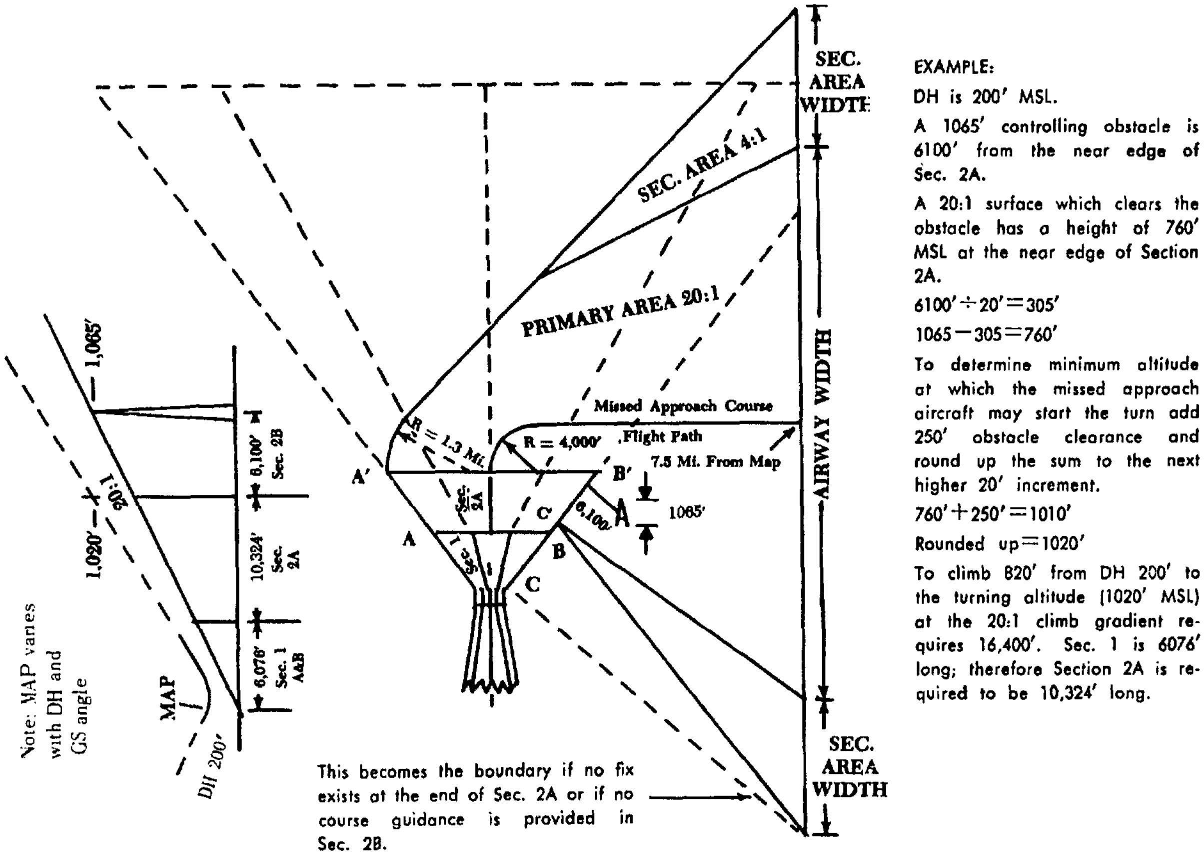


Figure 115. COMBINATION STRAIGHT AND TURNING MISSED APPROACH. Paragraph 1171.

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 12. DEPARTURE PROCEDURES

1200. GENERAL. These criteria specify the obstacle clearance requirements to be applied to diverse departures, departure routes, and standard instrument departures (SIDs). Obstacle identification surfaces (OIS) of 40:1 are used. A climb gradient of 200 feet per NM will provide at least 48 feet per NM of clearance above objects which do not penetrate the OIS. Objects which penetrate the OIS are obstacles and shall be considered in the departure procedure by specifying a flight path which will safely avoid the obstacle(s) or by specifying a climb gradient greater than 200 feet per NM that will provide 48 feet of required obstacle clearance (ROC) for each NM of the flight path. Takeoff ceiling and visibility minimums shall be established for those departures specifying a climb gradient.

1201. APPLICATION. Diverse departure criteria (paragraph 1202) shall be applied to all runways authorized by the approving authority for instrument departures. Application of diverse departure criteria may result in the need to develop specific departure routes to avoid obstacles (paragraph 1203).

1202. DIVERSE DEPARTURES. At many airports, a prescribed departure route is not required for ATC purposes nor as the only suitable route to avoid obstacles. In spite of this, there may be obstacles in the vicinity of the airport that should be considered in determining that restrictions to departures are to be prescribed in a given sector(s). The areas and surfaces described herein are to be used to identify such obstacles. Sectors shall be described by bearings and distance from the airport reference point which diverge at least 15° either side of the controlling obstacle. Departure restrictions shall be published as described in paragraph 1207a.

a. Zone 1.

(1) Area. The area begins at the departure end of the runway (DER) and has a beginning width of 1000 feet (±500 feet from centerline). The area splays 15° on each side of the extended runway centerline for a distance of 2 NM from the DER. See Figure 116A.

(2) Obstacle Identification Surface. A 40:1 OIS overlies Zone 1. It begins no higher than 35 feet above the elevation of the DER and rises in the direction of departure.

b. Zone 2.

(1) Area. Zone 2 extends radially from a point on the runway centerline located 2000 feet from the start end of the runway. It is centered on the extended takeoff surface centerline and excludes Zone 1. It extends the distance necessary for the 40:1 OIS to reach the minimum altitude authorized for en route operations. See Figure 116B.

2. Obstacle Identification Surface. A 40:1 OIS overlies Zone 2 and has a beginning height equal to the height of the OIS at the end of Zone 1. Distance measurements to an obstacle shall be made

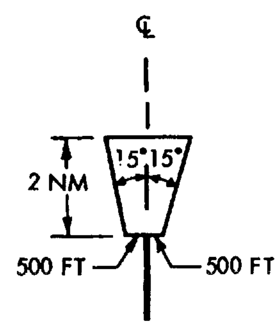


Figure 116A. ZONE 1 DIVERSE DEPARTURE.

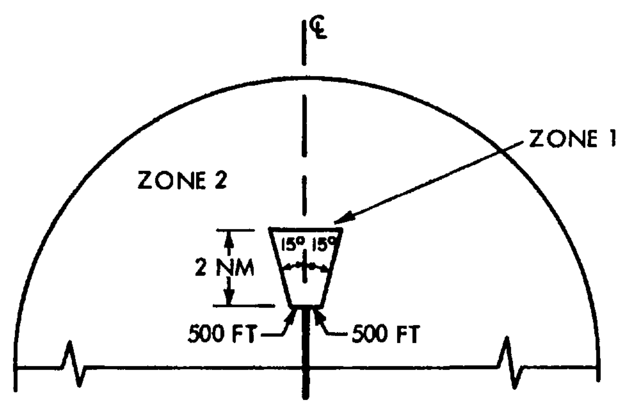


Figure 116B. ZONE 2 DIVERSE DEPARTURE.

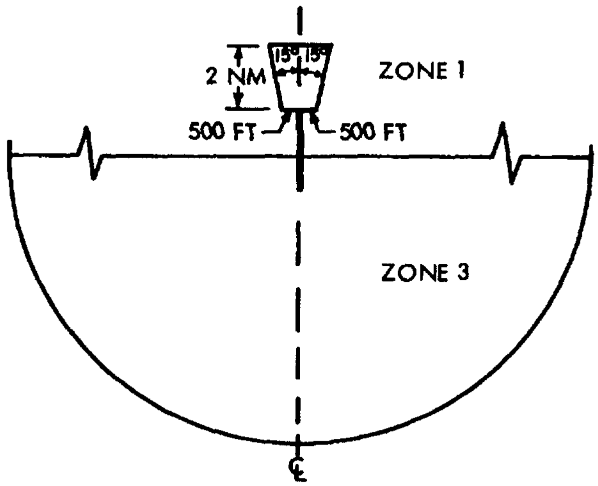


Figure 116C. ZONE 3 DIVERSE DEPARTURE.

from the runway edge or edge of Zone 1, whichever is the shorter distance.

c. Zone 3.

(1) **Area.** Zone 3 covers the area in the direction opposite to the takeoff, beginning 2000 feet from the start end of the runway. It provides clearance for 180° turn departures and extends the distance necessary for the 40:1 OIS to reach the minimum altitude authorized for en route operations. See Figure 116C.

(2) **Obstacle Identification Surface.** A 40:1 OIS overlies Zone 3 and begins 400 feet above airport elevation along the runway edge and rises therefrom.

1203. DEPARTURE ROUTES. There are three basic types of departure routes: straight, turning, and combination straight and turning. Departure routes shall be based on positive course guidance acquired within 10 NM from the DER on straight departures and within 5 NM after completion of turns on departures requiring turns. Surveillance radar, when available, may be used to provide positive course guidance.

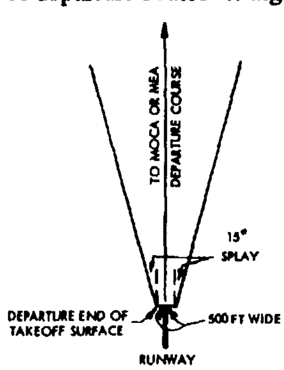


Figure 116D. STRAIGHT DEPARTURE AREA WITHOUT COURSE GUIDANCE.

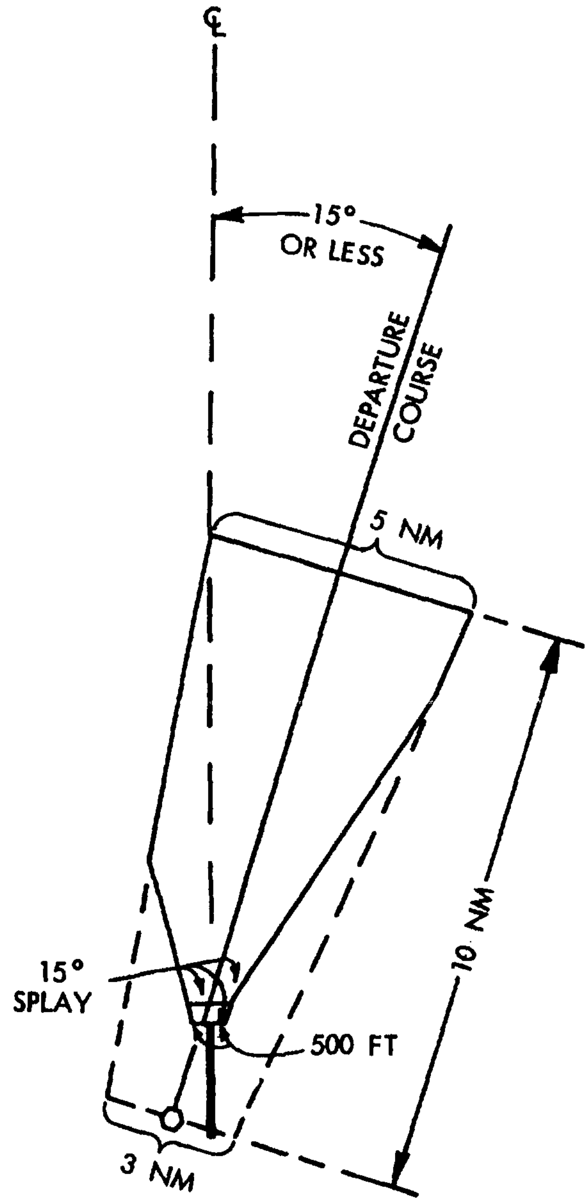


Figure 116E. STRAIGHT DEPARTURE WITH COURSE GUIDANCE FROM ON AIRFIELD FACILITY.

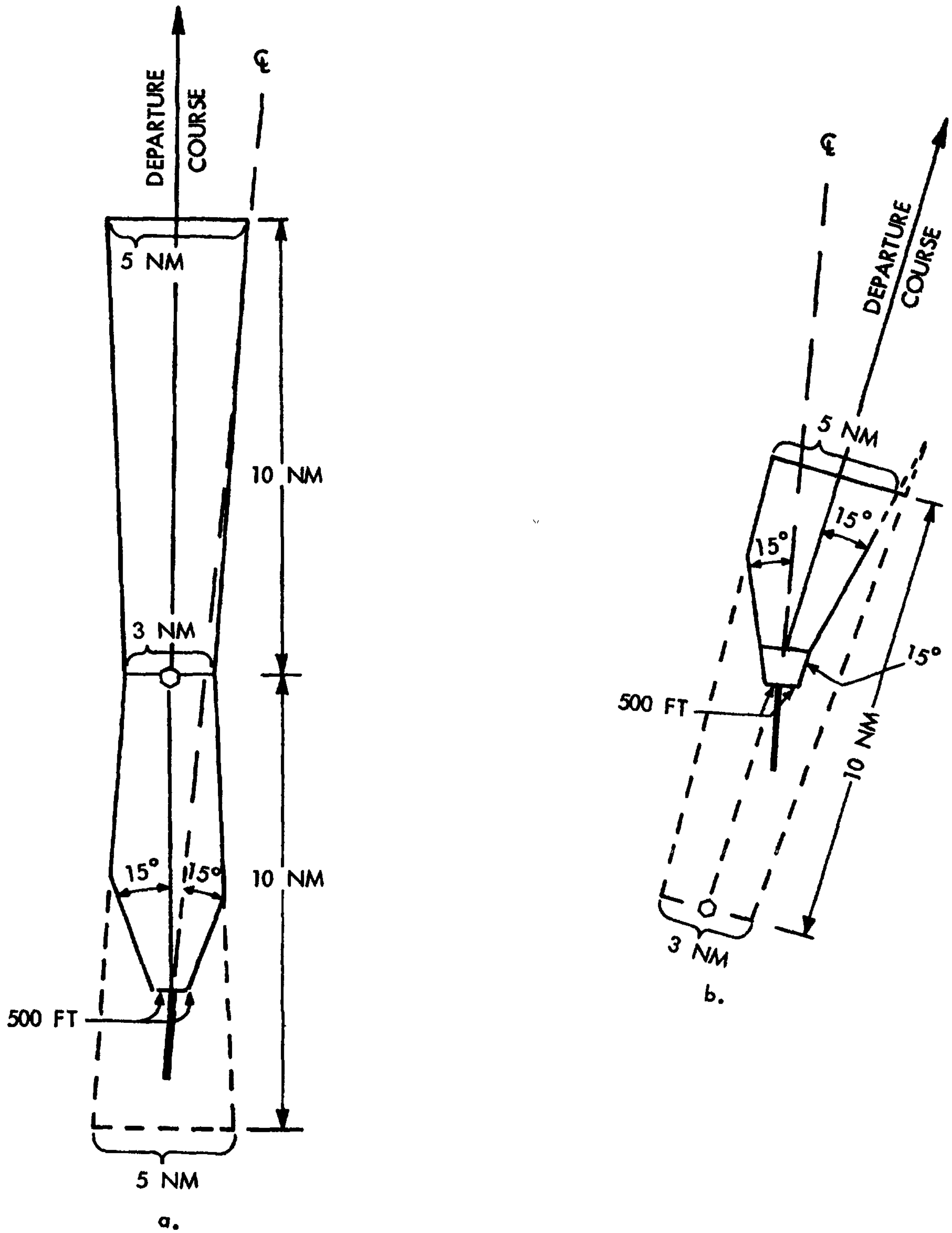


Figure 116F. STRAIGHT DEPARTURE WITH COURSE GUIDANCE FROM ON AIRFIELD FACILITY.

a. Straight Departures. A straight departure is one in which the initial departure course is within 15° of the alignment of the takeoff surface. Additionally, the departure course must intersect the runway centerline extended within 2 NM from the DER or the departure course must lie within 500 feet laterally of the runway centerline at the DER. See Figures 116D, 116E, 116F, 116G, and 116H. When the initial departure course is to a facility, a maneuvering segment is provided under the provisions of paragraph 1203a(1)(b).

(1) **Area.** The area begins at the departure end of the runway. It is based on the departure course

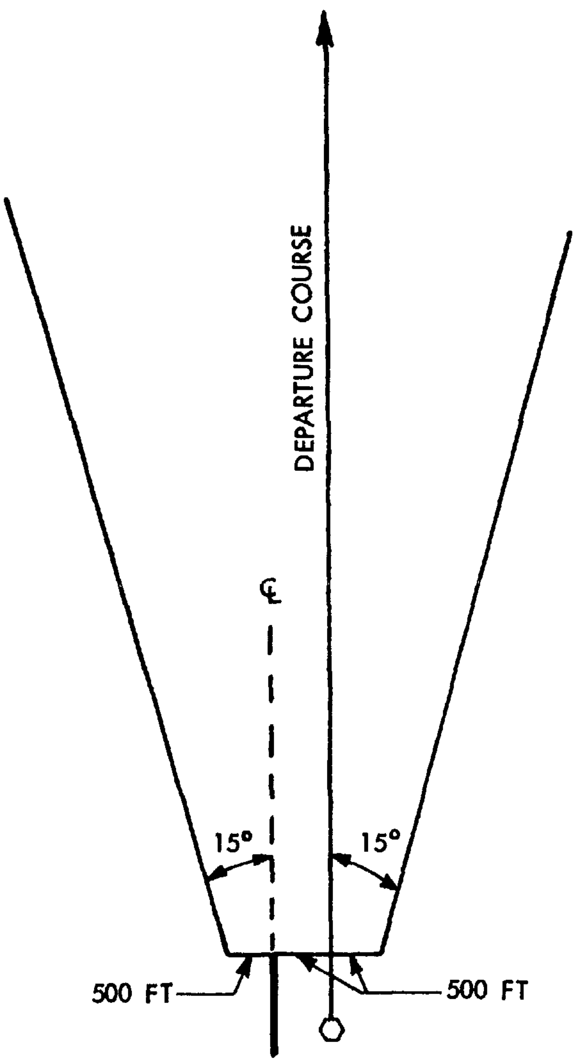


Figure 116G. STRAIGHT DEPARTURE WITH OFFSET DEPARTURE COURSE.

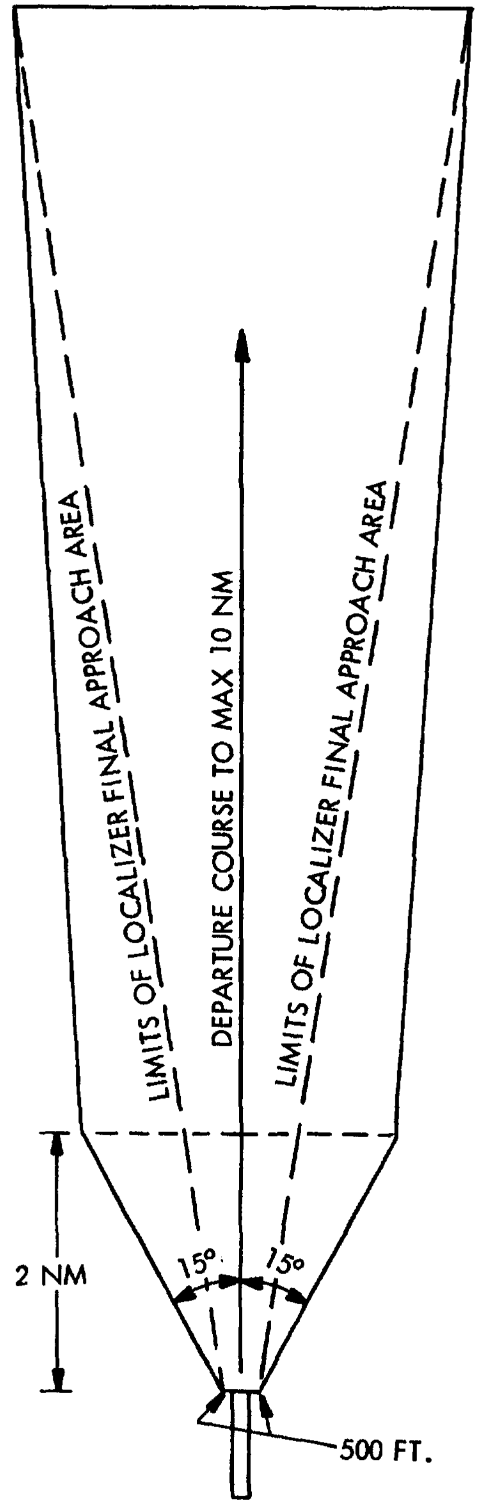


Figure 116H. DEPARTURE AREA WHEN LOCALIZER IS USED FOR COURSE GUIDANCE.

and has a minimum beginning width of 1000 feet (± 500 feet from centerline). The edge of the area shall be no less than 500 feet from the centerline of the runway and the departure course. For example, if the departure course lies 500 feet from the centerline, the beginning width of the area shall be no less than 1500 feet. See Figure 116G. The area splays 15° on each side of the departure course and/or runway centerline extended (whichever protects the greater area) to the point where the boundaries intercept the area associated with the navaid providing course guidance.

(a) When course guidance is provided by a localizer, the area specified in paragraph 1202a(1) shall be used for the first 2 NM of the departure. This area shall be joined to the localizer final approach area stated in paragraph 930b by lines drawn from the extremities of the area at 2 NM from the departure threshold to the width of the localizer area at 10 NM. See Figure 116H. (At certain airports, localizers, although installed, may not be available for use as a departure navaid.)

(b) The area associated with the navaid (other than a localizer) providing course guidance shall have the following dimensions. It shall be 3 NM (± 1 1/2 NM) wide at the facility, it shall have a maximum length of 10 NM and shall splay to a width of 5 NM[1] (± 2 1/2 NM) at 10 NM from the facility. If additional distance is required, the area may be joined from its extremities to the primary en route area using 4.5°[2] of splay until primary en route width is reached.

NOTE 1: 6 NM (± 3 NM) for NDB
NOTE 2: 5° for NDB

(i) If a turn of 15° or less is required over the facility, the inbound and outbound areas outer boundaries shall be joined by an arc of 1 1/2 NM radius.

(ii) If a turn of more than 15° but less than 30° is required over the facility, the turning departure area outer boundary radius (Table 31) shall be applied to join the two areas. The outbound area outer boundary shall be applied to join the two areas. The outbound area outer boundary shall be constructed by a line tangent to the arc and drawn to the edge of the outbound area at 10 NM from the facility. See Figure 116I.

(iii) If a turn of 30° or more is required over the facility, the area shall be extended a distance of 1 NM beyond the facility aligned with the inbound track at a width of 3 NM (± 1 1/2 NM) and the turning departure area outer boundary radius (Table 31) shall be applied to join the extension to the area associated with the outbound track. The outbound area outer boundary shall be constructed by a line tangent to the arc and drawn to the edge of the outbound area at 10 NM from the facility. See Figure 116J.

(2) Obstacle Identification Surface. A 40:1 OIS overlies the straight departure area and rises in the direction of departure. The OIS begins at the DER at an elevation no higher than 35 feet above the elevation of the DER.

b. Turning Departures. If the initial departure course does not meet the criteria specified in paragraph 1203a, a turning departure shall be constructed.

Table 31. Departure Turn Radii

TURN ALTITUDE	FLIGHT TRACK RADIUS NM (R_1)		OUTER BOUNDARY RADIUS NM (R)	
	CATs A & B	OTHERS	CATs A & B	OTHERS*
S.L. to 1000' MSL	1.0	2.5	2.0	5.5
1001' to 3500' MSL	1.2	2.7	2.4	5.9
3501' to 6000' MSL	1.3	2.9	2.6	6.3
6001' to 8500' MSL	1.4	3.1	2.8	6.7
Above 8500' MSL	1.6	3.4	3.2	7.3

**These turn radii will accommodate speeds up to 350 KIAS with 30° angle of bank. Outer boundary radius may be reduced 1/2 NM for operational advantage. Procedure must be annotated with airspeed restriction of 250 KIAS.*

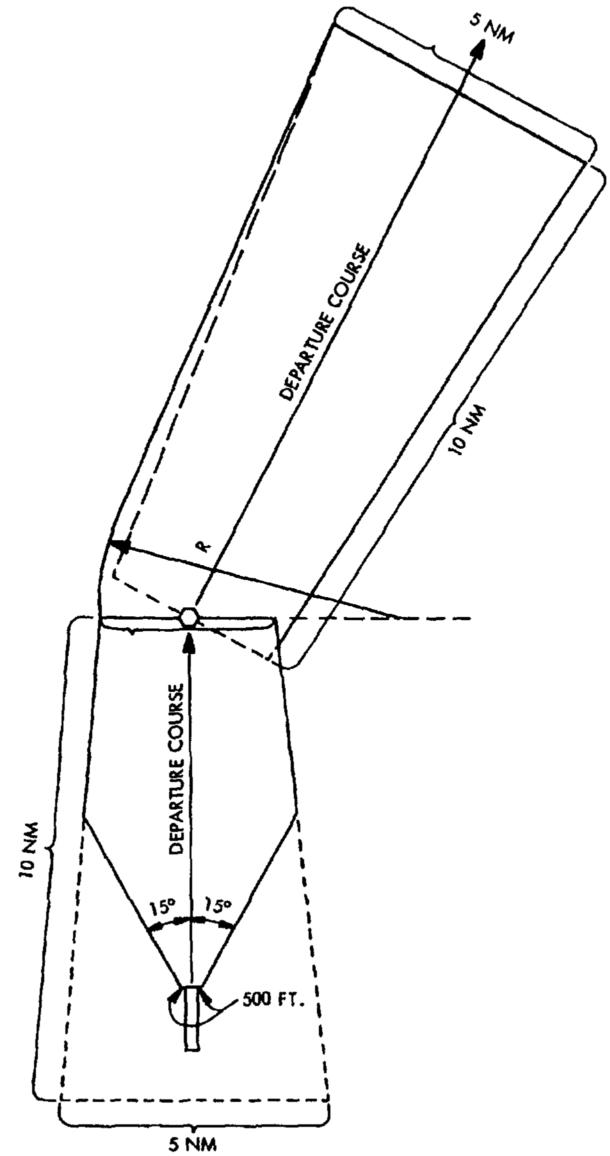


Figure 116I. TURN OF MORE THAN 15° BUT LESS THAN 30° OVER FACILITY.

A turning departure is one in which the aircraft climbs straight ahead on the heading of the takeoff surface until reaching 400 feet above the airport elevation (within 2 NM) and then immediately begins a turn to intercept a departure course. Positive course guidance is required within 5 NM after completion of the turn. See Figure 116K.

(1) **Area.** The turning departure area is divided into Sections 1 and 2.

(a) Section 1 is identical to the 15° splay area specified in paragraph 1203a(1). It terminates 2 NM from the beginning of the 15° splay area.

(b) Section 2 starts at the end of Section 1. The flight track and outer boundary radii shall be determined from Table 31. The outer boundary line shall splay 15° from the departure course beginning at the point abeam the point where the turn is completed. The inner boundary line shall begin at the runway edge 2000 feet from the start end of the takeoff surface on the side in the direction of the turn (Point D).

It terminates at the same distance abeam the departure course as the outer boundary does at the end of the departure. The splay of Section 2 terminates when the width reaches that of the primary en route structure. Thereafter, en route criteria apply.

(2) Obstacle Identification Surface.

(a) Section 1. A 40:1 OIS overlies Section 1 and is identical to the 40:1 specified in paragraph 1203a(2).

(b) Section 2. The dividing lines between Sections 1 and 2 are identified as "AB, BC, CD." A 40:1 OIS overlies Section 2 and has an initial height equal to the terminating height of Section 1 at any point along the dividing line and rises in the direction of the departure course. The height of the OIS at any point in Section 2 is determined by measuring the straight line distance from this point to the nearest point on the "AB, BC, CD" dividing line.

c. *Combination Straight and Turning Departure.* If a straight climb to a height which is more than 400 feet above the elevation of the DER is necessary prior to beginning the departure turn, a combination straight and turning departure area must be applied. Whenever possible, the point at which the turn commences shall be identified by a fix or by the intersection of the initial dead reckoning departure course with a radial or bearing which provides positive course guidance. When a fix, radial or bearing is not available, the turn may be specified to commence at an altitude based on a climb gradient of 200 feet per NM. For example, a turn 1000 feet above DER elevation shall be assumed to commence 5 NM from the end of

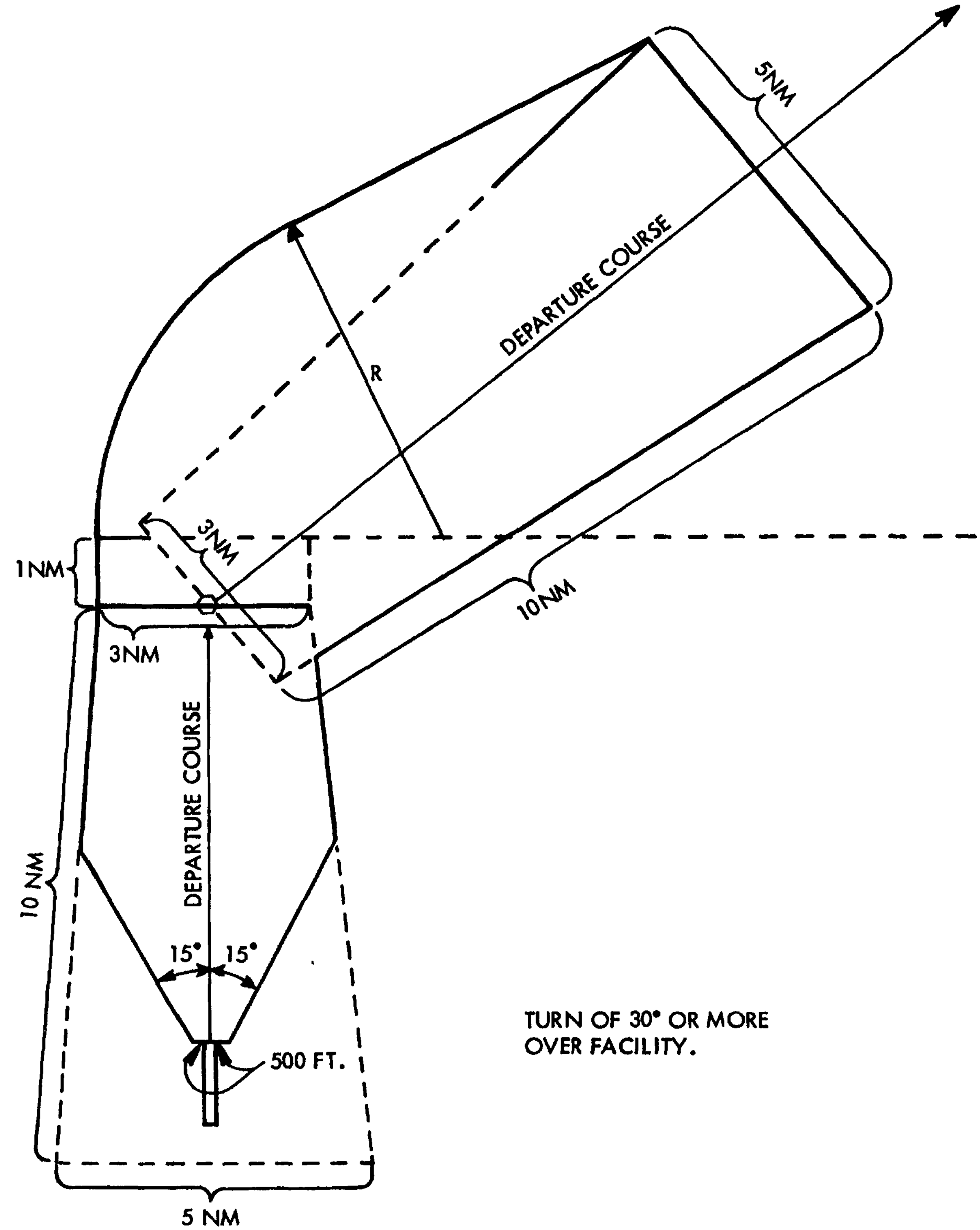


Figure 116J. TURN OF 30° OR MORE OVER FACILITY.

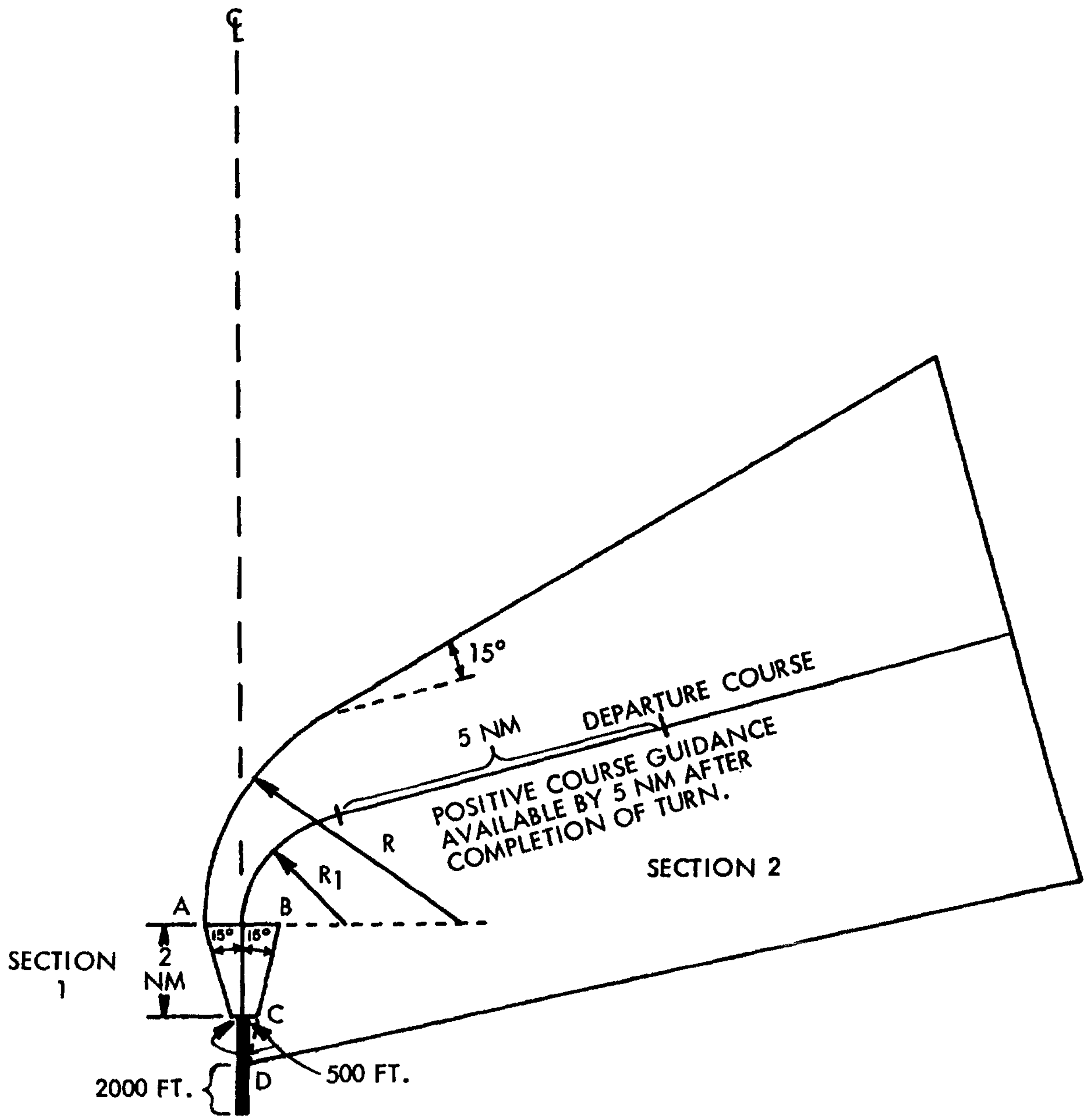


Figure 116K. TURNING DEPARTURE.

runway. Positive course guidance is required within 5 NM after completion of the turn.

(1) **Area.** The combination straight and turning departure is divided into Sections 1 and 2. See Figure 116L.

(a) Section 1 is identical to the straight departure area except that it extends to the point at which the turn begins.

(b) Section 2 starts at the end of Section 1. The flight track and outer boundary radii shall be determined from Table 31. The outer boundary radius shall be drawn beginning a distance past the plotted position of the turning point equal to the fix error, along track accuracy, or abeam plotted position; whichever is further from the end of the departure runway. The inner boundary line shall begin at the edge of the 15° splay area at a distance prior to the plotted position of the turning point equal to the fix

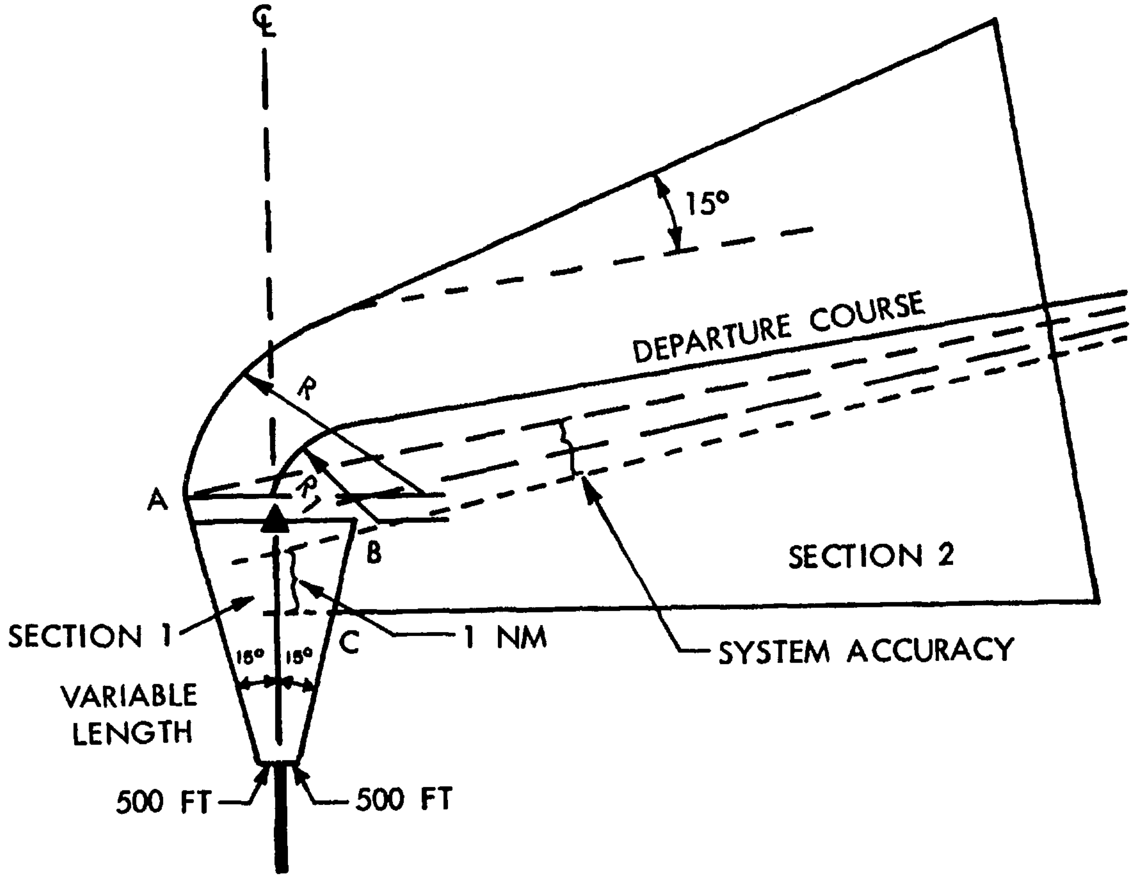


Figure 116L. COMBINATION STRAIGHT AND TURNING DEPARTURE.

error or along track accuracy plot plus 1 NM. Where the turn is specified to commence at an altitude, the outer boundary radius begins at the end of Section 1, and the inner boundary line begins at the edge of the 15° splay area abeam the DER. The outer boundary line shall splay 15 degrees from the departure course beginning at the point abeam the point where the turn is completed. The inner boundary line is drawn from the point of beginning to a point which is the same distance abeam the departure course as the outer boundary is at the end of the departure.

(c) Where a turn is required to intercept a radial/bearing to proceed to or from a facility, alternate area construction is necessary. See Figure 116M. The appropriate flight track radius will join the radial/bearing and the runway centerline extended. The arc will be drawn from a point on the bisector of the angle between the runway centerline extended and the plotted position of the radial/bearing. Section 1 ends at the point of tangency of the extended centerline and the arc. The inner boundary begins at the near edge of Section 1 at a point 1 NM prior to the end of that section. The outer boundary begins at the intersection of the extended 15° splay line of Section 1 and the plotted position of the radial/bearing. The splay of Section 2 terminates when the width reaches that of the primary en route structure. Thereafter, en route width criteria apply.

(2) Obstacle Identification Surface.

(a) Section 1. A 40:1 OIS overlies the straight departure area. It begins no higher than 35 feet above the elevation of the DER and rises in the direction of departure.

(b) Section 2. The dividing lines between Sections 1 and 2 are identified as "AB, BC." A 40:1 OIS overlies Section 2. It has the same height as the Section 1 OIS at the dividing line AB and rises in the direction of the departure course.

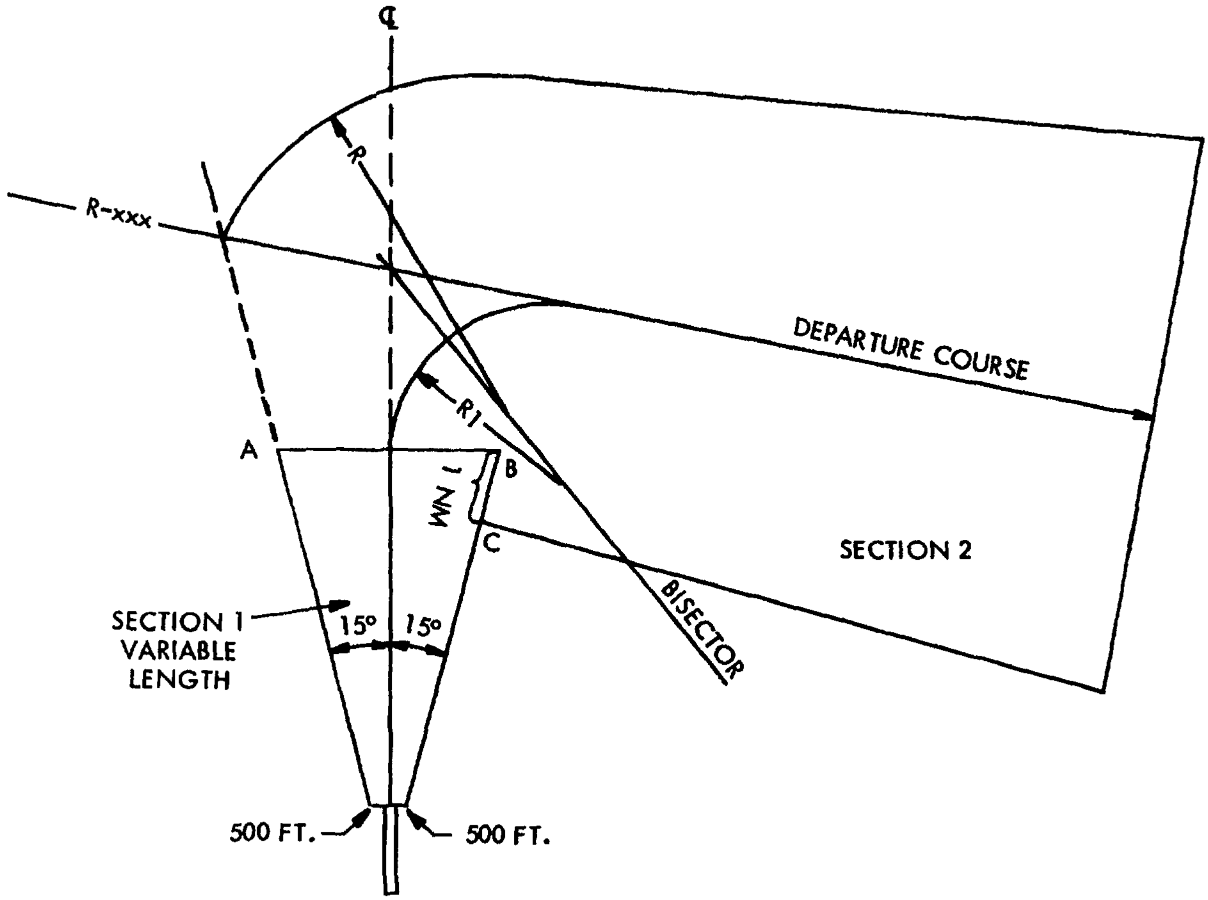


Figure 116M. COMBINATION STRAIGHT AND TURNING DEPARTURE (TO INTERCEPT RADIAL OR BEARING).

1204. EARLY TURNS. Some obstacles, because of location and height (causing excessively high climb gradients), may require a turn as soon as practicable after takeoff (less than 400 feet above airport elevation). Where this condition exists, Zones 1, 2, and 3 of paragraph 1202 (see Figures 116A, 116B, and 116C) shall be used with the following exceptions. The Zone 2 OIS begins at an elevation 50 feet above the elevation of the airport and the Zone 3 OIS (if utilized) begins 200 feet above the elevation of the airport. Measurements in Zones 2 and 3 shall be made to the obstacle from the runway edge. Early turns, when developed, shall be subject to the conditions of paragraph 1207c.

1205. CLIMB GRADIENTS. Climb gradients shall include 48 feet per NM required obstacle clearance. When precipitous terrain is a factor, consideration shall be given to increasing the obstacle clearance (see paragraph 323a). Gradients shall be specified to an altitude or fix at which a gradient of more than 200 feet per NM is no longer required.

a. Diverse Departures. In cases where departure routes are not required to avoid obstacles, but obstacles exist in a sector(s) such as a mountain range, the required gradient shall be computed from the origin of the Zone 2 or 3 OIS (as applicable) direct to the obstacle. The altitude to which the climb gradient must be maintained is based on the obstacle plus ROC requiring the highest altitude in that sector.

b. Departure Routes. Climb gradients shall be computed from the elevation of the OIS at the DER along the shortest possible flight path within the obstacle clearance area to the obstacle.

c. Early Turns. When an early turn is required toward an obstacle in either Zone 2 or 3, the gradient

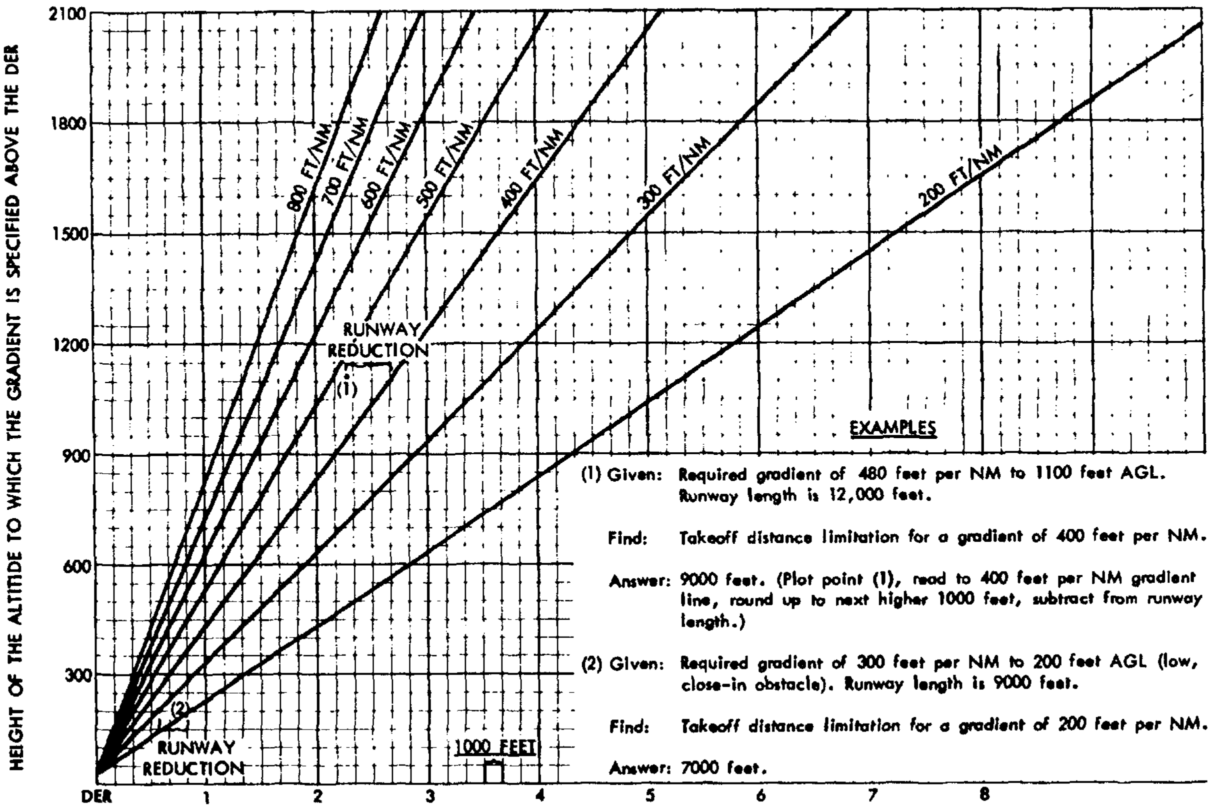


Figure 116N. DISTANCE FROM DER (NM) & RUNWAY REDUCTION (1000'S OF FEET).

will be computed from the origin of the Zone 2 or 3 OIS (as applicable) direct to the obstacle.

d. Climb gradients to 200 feet above DER or less shall not be specified. These gradients would normally be caused by low, close-in obstacles. The provisions of paragraph 1205e should be applied and/or a note published stating that the obstacle(s) exist and should be considered by the pilot.

e. When a climb gradient in excess of 400 feet per NM would be required, a reduction in that gradient for aircraft which use less than the full length of the runway shall be provided. A chart is available to reduce the computed gradient. See Figure 116N.

f. When a climb gradient is specified, it shall be parenthetically stated in climb rate expressed in feet per minute for average ground speeds of 150K, 200K, and additionally at elevations above 5,000 feet MSL at 250K. Example: climb gradient is 300 feet per NM to 3,000 feet MSL (750 feet per minute at 150K, 1,000 feet per minute at 200K).

1206. END OF DEPARTURE. The departure area terminates at a point where the 40:1 OIS, measured along the flight track, reaches the minimum altitude authorized for en route operations or radar vectoring, whichever is applicable.

1207. PUBLISHED INFORMATION. The minimum information to be published for departure procedures is specified as follows:

a. Diverse Departures. Departure restrictions shall be expressed as sectors to be avoided or sectors in which climb gradients and/or minimum altitudes are specified to enable an aircraft to safely overfly an obstacle. When more than one sector is involved, the climb gradient selected shall be the highest in any sector that may be expected to be overflown. The altitude to which the gradient is specified must permit the aircraft to continue at 200 feet per NM minimum through that sector, a succeeding sector, or to an en route altitude. A fix may also be designated to mark the point at which a climb gradient in excess of 200 feet per NM is no longer required.

b. Departure Routes. A departure route must specify all courses, points, fixes, and altitudes required in the procedure. When obstacles must be overflown, minimum crossing altitudes and climb gradient information shall be provided for all departures requiring a climb gradient greater than 200 feet per NM. The altitude or fix at which a climb gradient in excess of 200 feet per NM is no longer required shall also be specified.

c. Early Turns. The early turn shall be expressed as a turn to a heading or to intercept a course as soon as practicable. When obstacles exist in Zone 1, a minimum ceiling value of 400 feet and a visibility value of at least one mile shall be published. In the event an early turn must be made toward an obstacle within 6 NM of the departure runway, and if no positive course guidance is available, a suitable climb gradient shall be published.

d. The resultant takeoff distance limitation when the provisions of paragraph 1205e are applied.

e. Ceiling and visibility minimums imposed in accordance with paragraph 1208.

f. When departures are limited to Categories A and B aircraft, the procedure shall be clearly annotated.

1208. REQUIRED CEILING AND VISIBILITY MINIMUMS. Procedures requiring a climb gradient in excess of 200 feet per NM shall also specify a ceiling and visibility to be used as an alternative for aircraft incapable of achieving the gradient. The ceiling value shall be the 100-foot increment above the controlling obstacle or above the altitude required over a specified point from which a 40:1 gradient will clear the obstacle. Ceilings of 200 feet or less shall not be specified. The visibility value shall be at least one mile.

1209.–1299. 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 (see also Figures 44 and 45).

1412. INTERMEDIATE APPROACH SEGMENT. Criteria for the intermediate approach segment are contained in Chapter 2, Section 4. See Figures 44 and 45.

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 centerline, 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 which 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. *

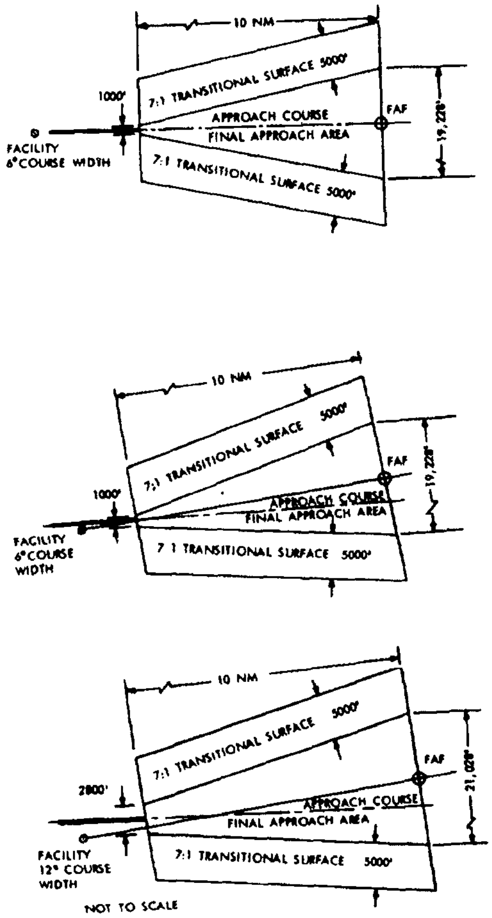


Figure 14-1. FINAL APPROACH AREAS WITH FAF.

c. *Transitional Surfaces.* Transitional surfaces are inclined planes with a slope of 7:1 which 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 1413a(2), 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 513d.

f. *Use of Fixes.* Criteria for the use of radio fixes are contained in Chapter 2, Section 2.

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 which 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.

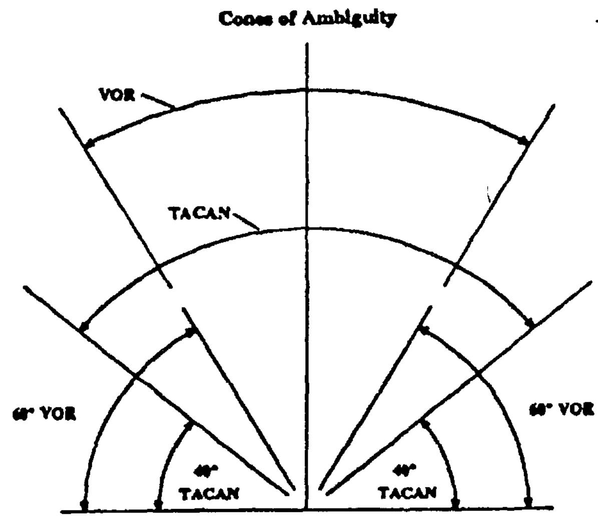


Figure 15-1. CONES OF AMBIGUITY.
Par 1502.

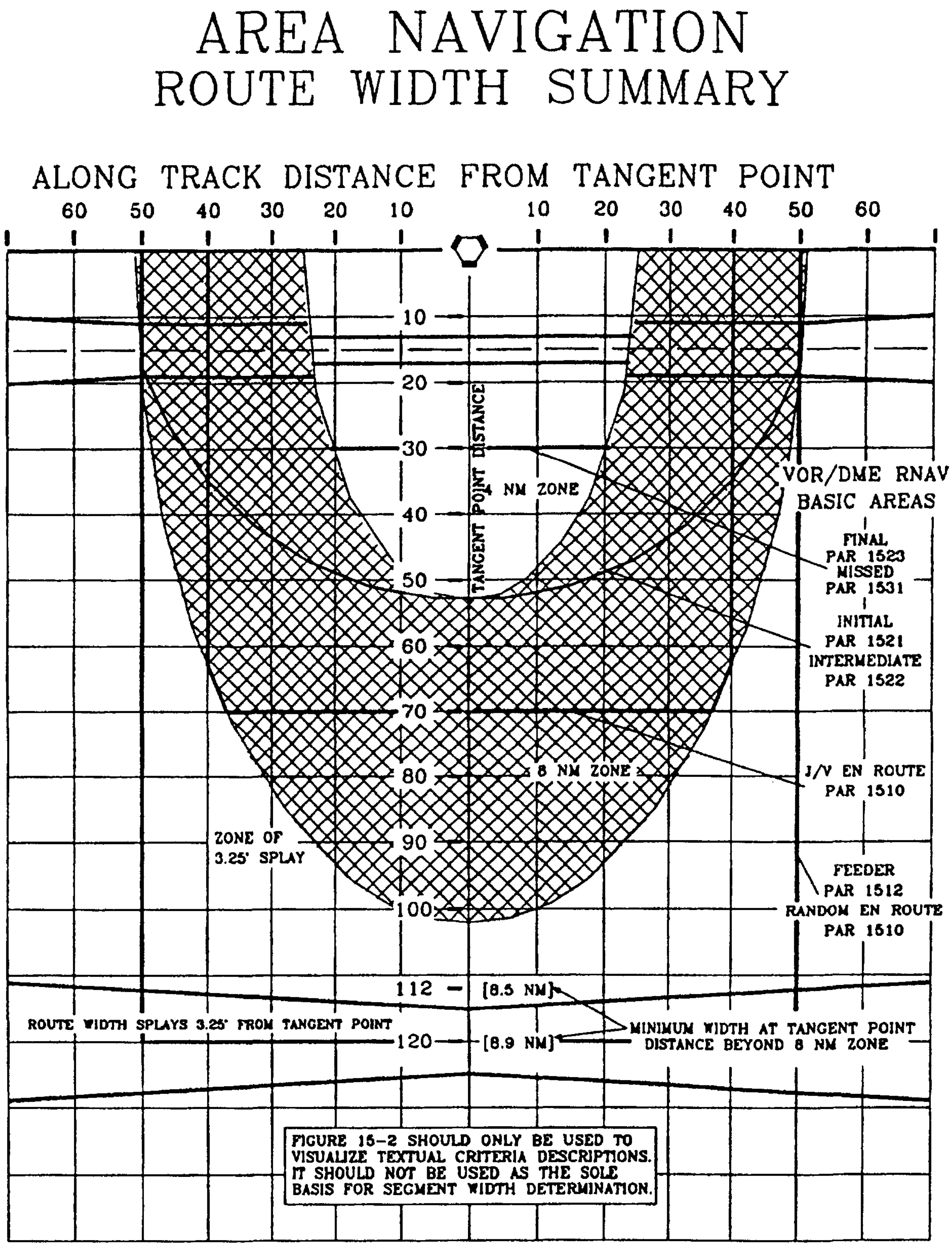


Figure 15-2. Par 1502.

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.

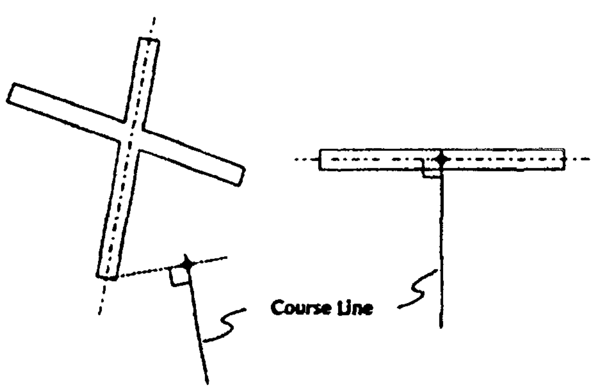


Figure 15-3. LOCATION OF APT WP.
Par 1506.

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 ± 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).

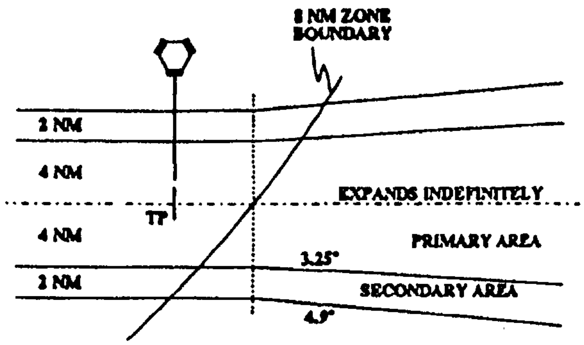


Figure 15-4. VOR/DME BASIC AREA.
Par 1510a(1)

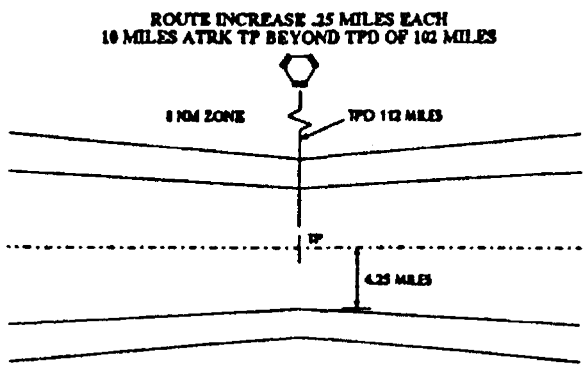


Figure 15-5. VOR/DME BASIC AREA.
Par 1510a(1) and b(1).

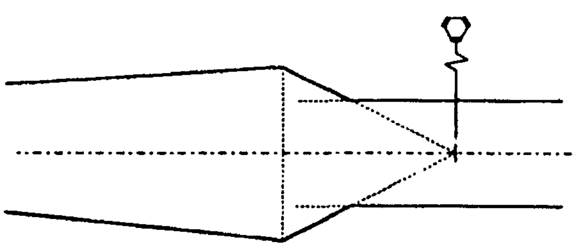


Figure 15-6. UNEQUAL JOINING ROUTE SEGMENTS. Par 1510a(1)(a).

(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).

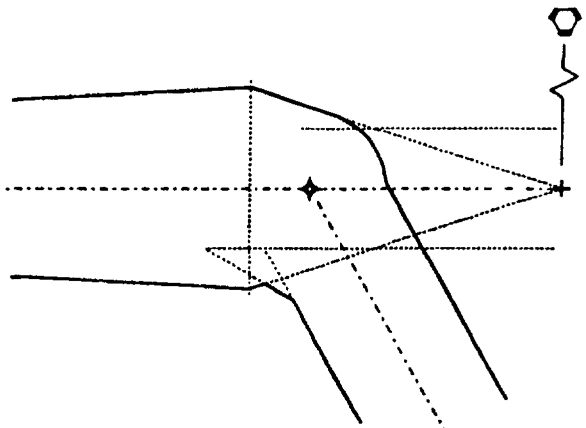


Figure 15-7. UNEQUAL JOINING ROUTE SEGMENTS WITH A TURN.
Par 1510a(1)(b).

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.

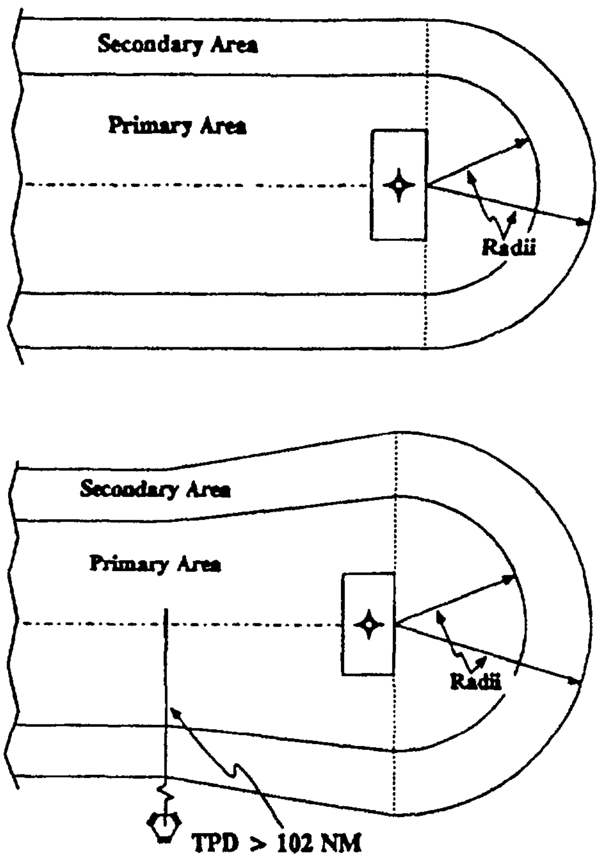
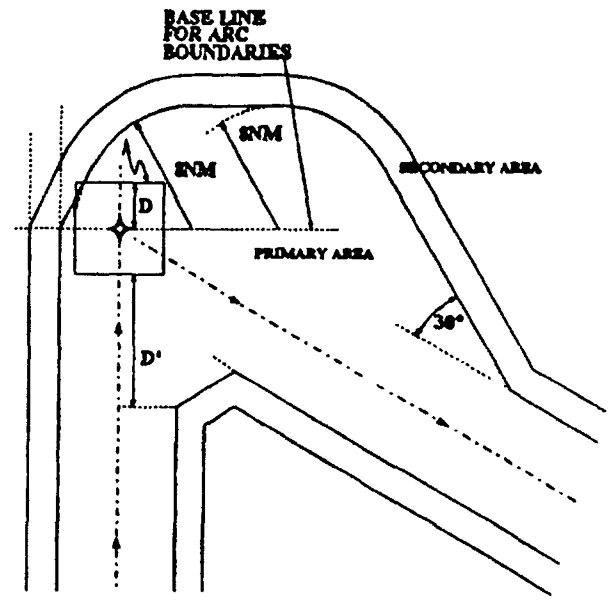


Figure 15-8. TERMINATION POINTS. Par 1510a(3) and 1510b(3).

(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.



D - 3NM FROM LINE A; HOWEVER, BASELINE IS NOT PRIOR TO PLOTTED POSITION OF FIX.
D' - IAW PARAGRAPHS 1510c(2)(b) 1, 2, AND 3

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.

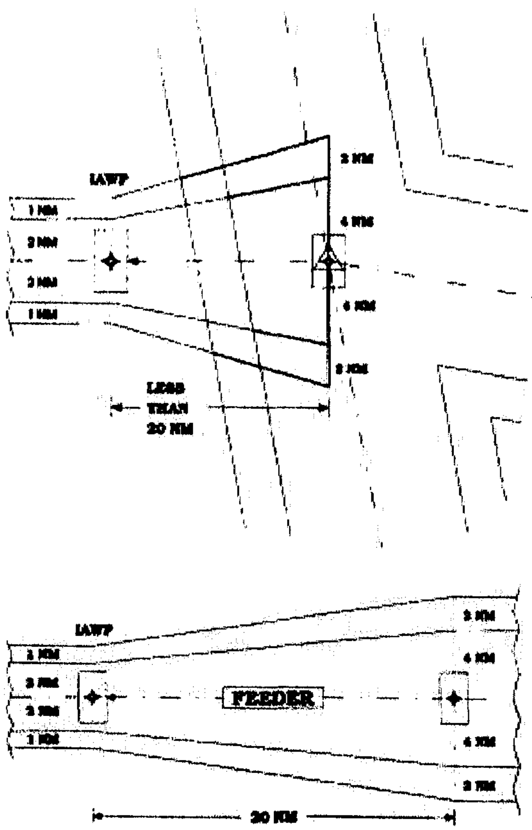


Figure 15-10. FEEDER ROUTES CONNECTING NON-VOR/DME BASIC AREAS. Par 1512b(1)(b).

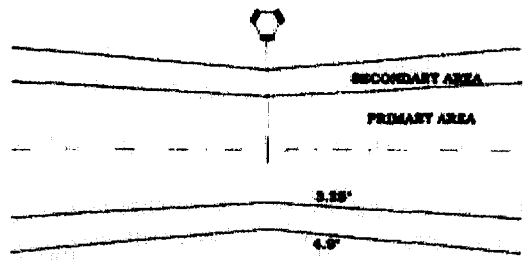


Figure 15-11. VOR/DME SECONDARY AREAS SPLAY 4.9°. Par 1512b(2)(a).

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.

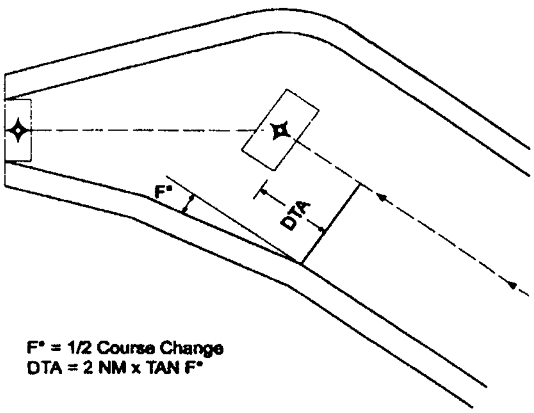


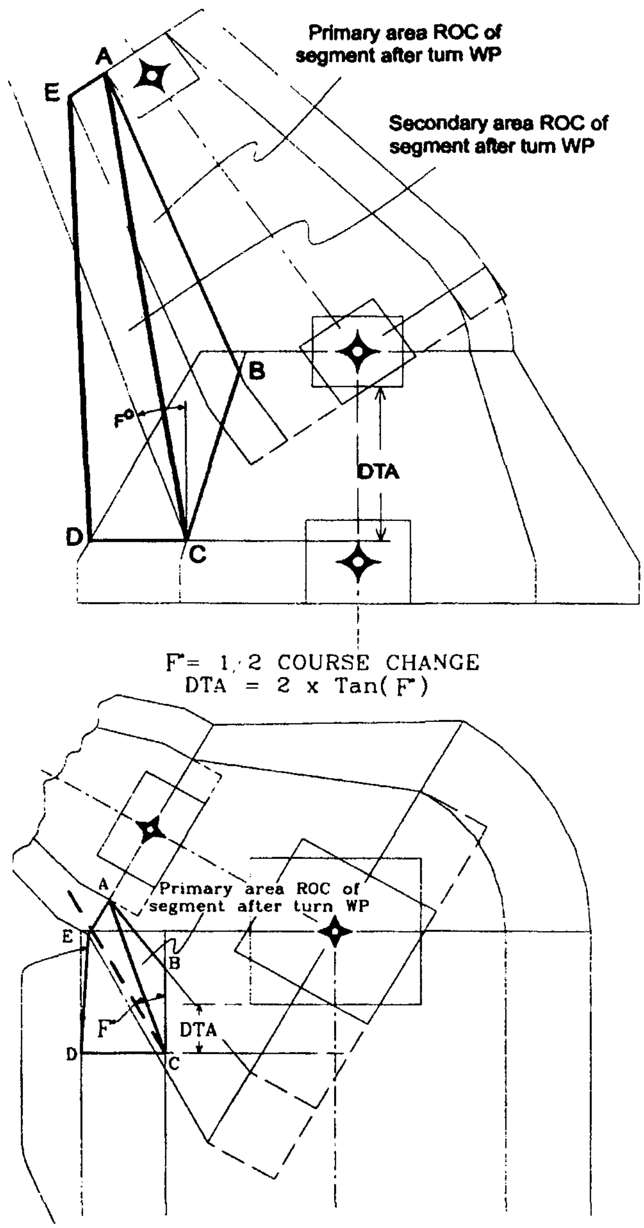
Figure 15-12. TURN ANTICIPATION SPLAY. Par 1520.

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°.



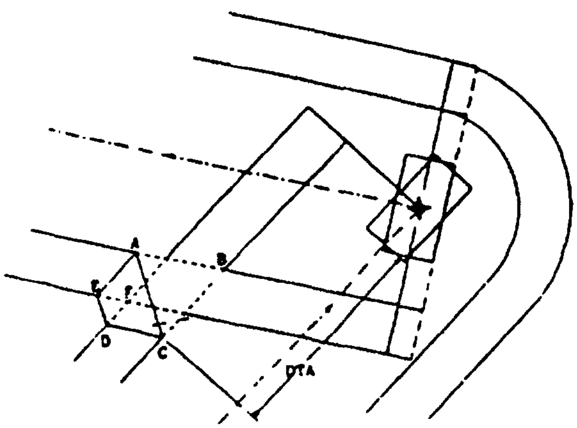
NOTE: Secondary area boundary line for expanded area Enclosed areas A, B, C are primary areas using ROC of segment following turn WP Enclosed areas A, C, D, E are secondary areas using ROC of segment following turn WP. Obstacle slope in these areas are perpendicular to lines AC

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.

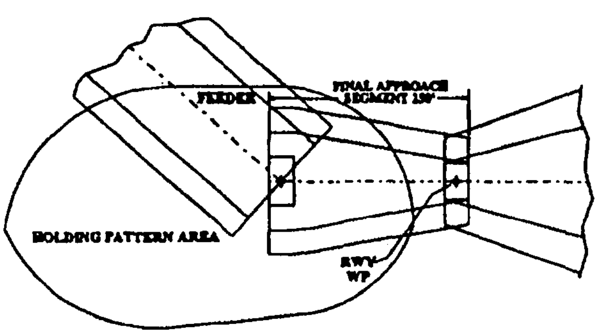


Figure 15-15. HOLDING PATTERN AND FINAL APPROACH, AND ASSOCIATED ROC. Par 1521b.

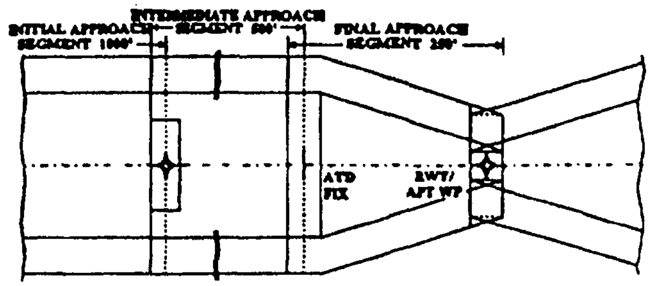


Figure 15-16. INITIAL, INTERMEDIATE, FINAL APPROACH, AND ASSOCIATED ROC. Par 1521, 1523.

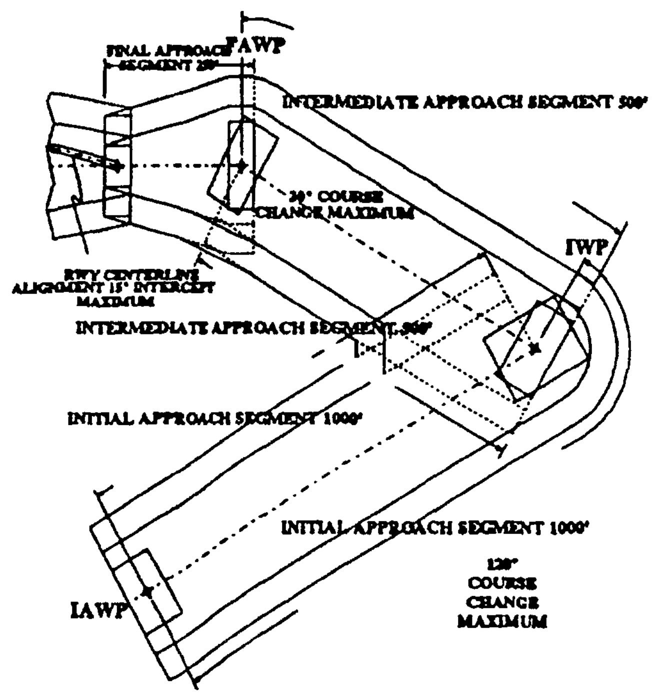


Figure 15-17. INITIAL, INTERMEDIATE, FINAL APPROACH, AND ASSOCIATED ROC. Par 1521, 1522.

(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.

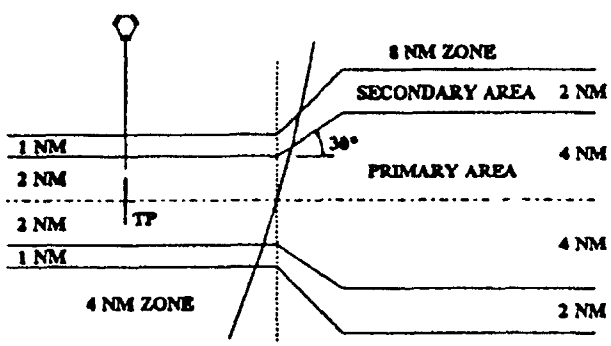


Figure 15-18. VOR/DME BASIC AREA. Par 1521c(2)(a)1.

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).

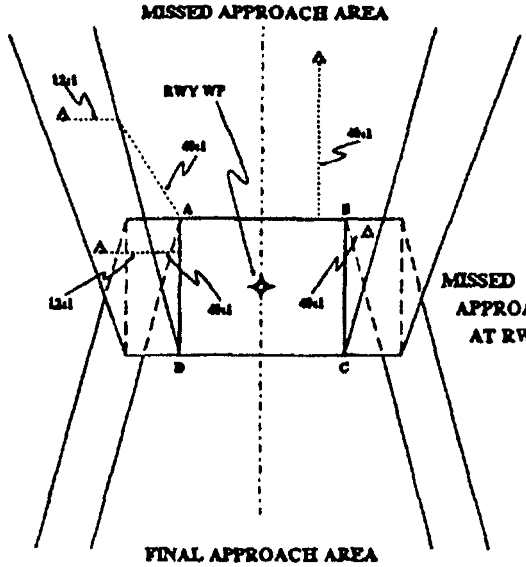


Figure 15-20. STRAIGHT MISSED APPROACH AT THE RWY WP. Par 1533a(1).

(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 6 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 1 mile at the MAP to a width of 2 miles at the end of the 15-mile area. The splay of these areas begins at the earliest point the MAP can be received.

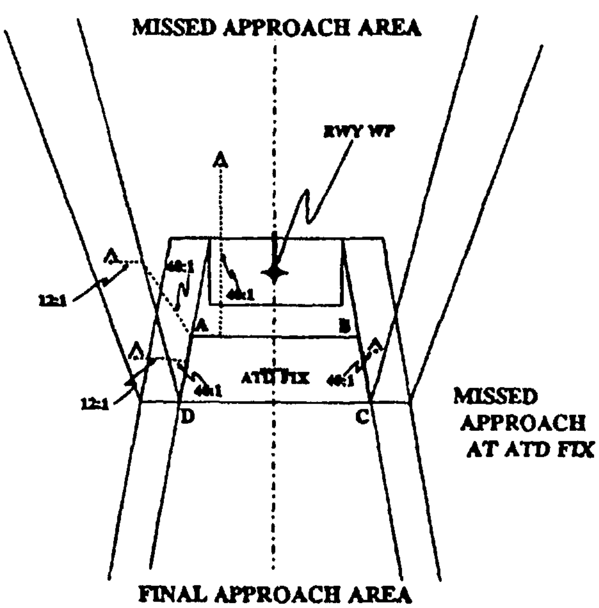


Figure 15-21. STRAIGHT MISSED APPROACH AT AN ATD FIX. Par 1533a(2).

(4) **When a turn of 15° 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 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° 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 323 from the MDA

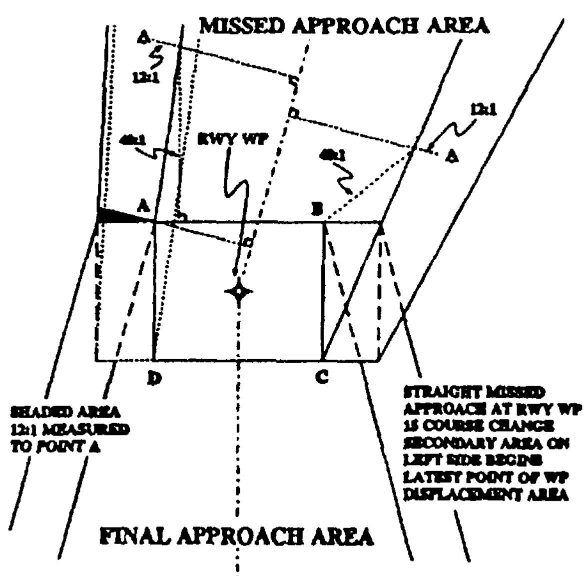


Figure 15-22. CONSTRUCTION OF STRAIGHT MISSED APPROACH WHEN TURNS ≤ 15° CAUSE OUTSIDE BOUNDARY TO CROSS INSIDE MAP FIX DISPLACEMENT TOLERANCE AT RWY WP. Par 1533a(4).

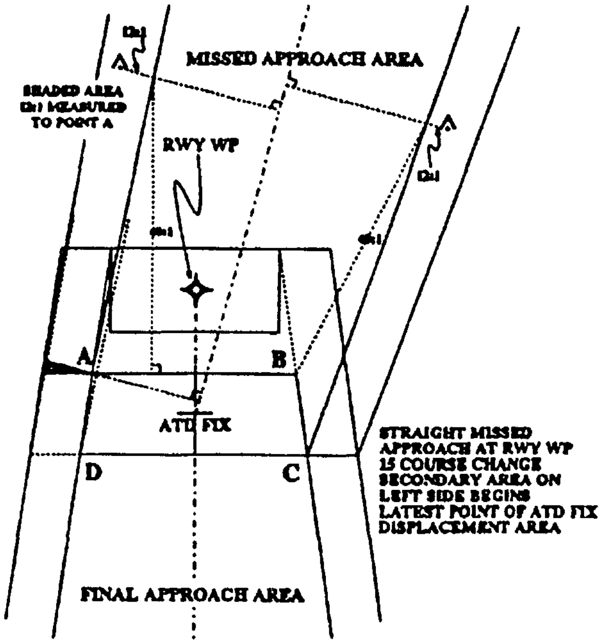


Figure 15-23. CONSTRUCTION OF STRAIGHT MISSED APPROACH WHEN TURNS ≤ 15° CAUSE OUTSIDE BOUNDARY TO CROSS INSIDE MAP FIX DISPLACEMENT TOLERANCE AT AN ATD FIX. Par 1533a(4).

1534. TURNING MISSED APPROACH. Turning missed approach criteria apply whenever the missed approach course differs by more than 15° 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° 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°, connects to the corner of the WP or fix displacement area at the nonturn 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 of 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 323.

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 15-33 (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.

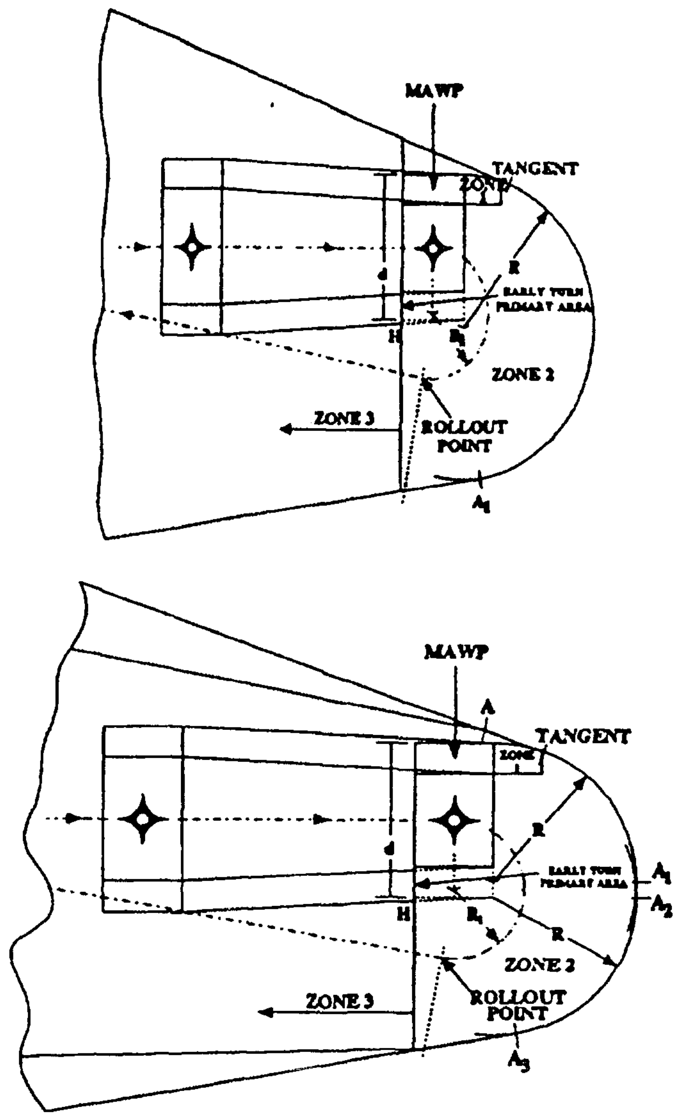


Figure 15-24. WIDE AND NARROW MISSED APPROACH METHODOLOGY.
Par 1534a(1) and (2)

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

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

(c) A turn anticipation area shall 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° or less, point C_1 connects to point J. See figure 15-31. For turns of more than 90°, 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 base line 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 base line extension of line G-D-C separates sections 2 and 3. When point C_1 is established prior to the base line, C_1 connects to point C (see figure 15-33).

2 When C_1 is established beyond the base line, 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° 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°. 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 MDA less adjustments in paragraph 323a, b, and c, plus a 40:1 rise in section 1 as measured from line A-B to end of section 1.

1536. CLEARANCE LIMIT. The missed approach procedure shall specify an appropriate fix as a clearance limit. The fix shall be suitable for holding. For VOR/DME systems, the clearance limit WP's shall meet terminal fix displacement tolerance criteria from table 15-1. For non-VOR/DME systems, clearance limit WP's shall 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 except that table 6A criteria relating minimum visibility to a distance from the station shall be applied as a variation of XTRK fix displacement tolerance of the plotted position of the MAP shown in table 15-5. XTRK values in table 15-2 shall be applied for VOR/DME. An XTRK value of 0.6 NM shall be applied for non-VOR/DME.

1541.-1599. RESERVED.

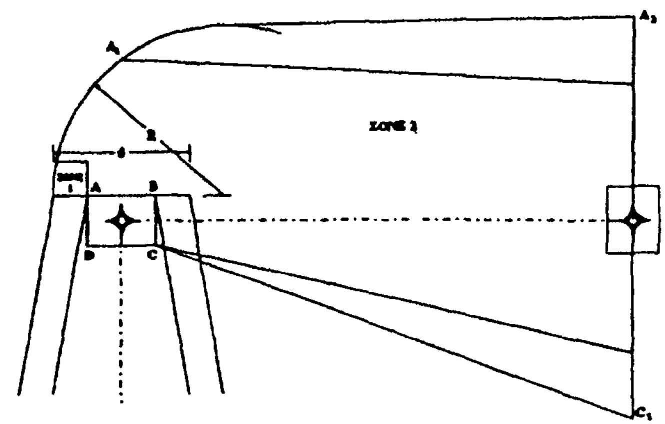


Figure 15-25. RNAV TURNING MISSED APPROACH, 90° OR LESS.
Par 1534a(2)(b).

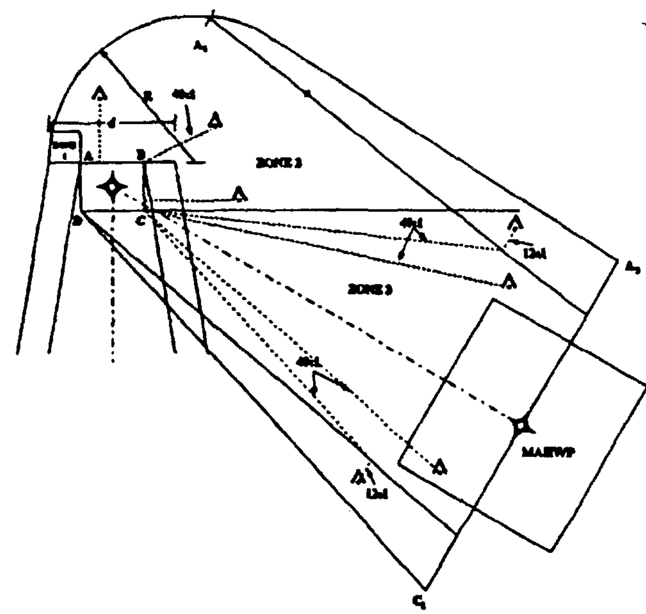


Figure 15-26. RNAV TURNING MISSED APPROACH, MORE THAN 90° UP TO 120°.
Par 1534a(2)(b).

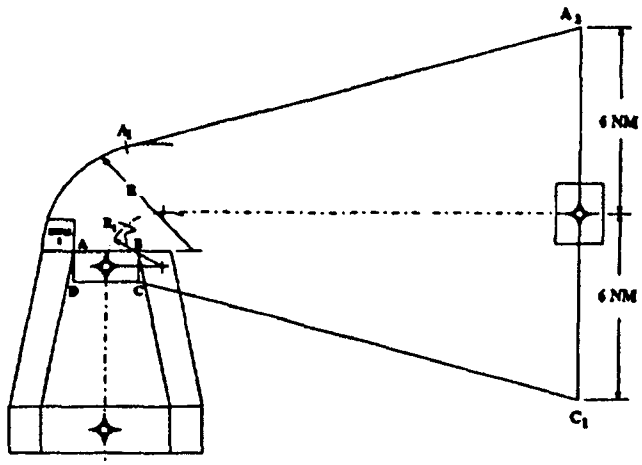
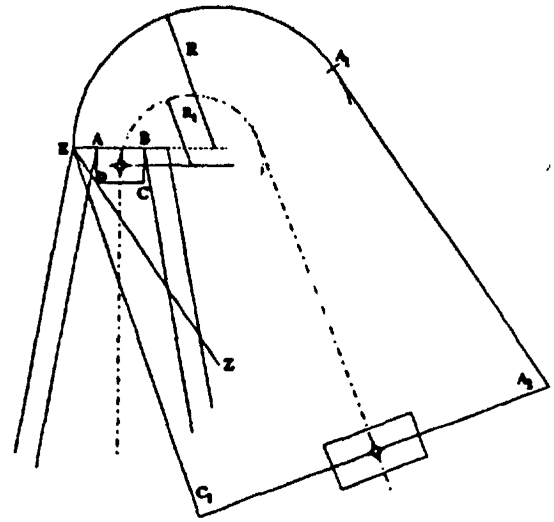


Figure 15-27. DIRECT TURNING MISSED APPROACH, ≤ 90° TIE-BACK POINT C_1 TO POINT C. Par 1534a(2)(b).



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).

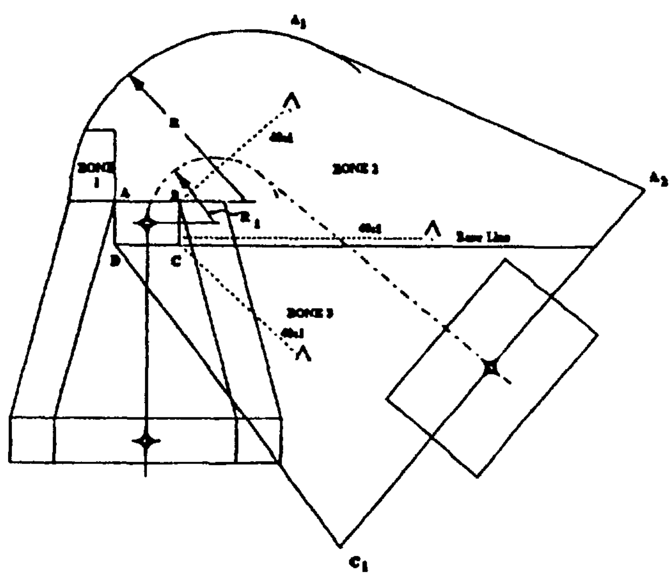
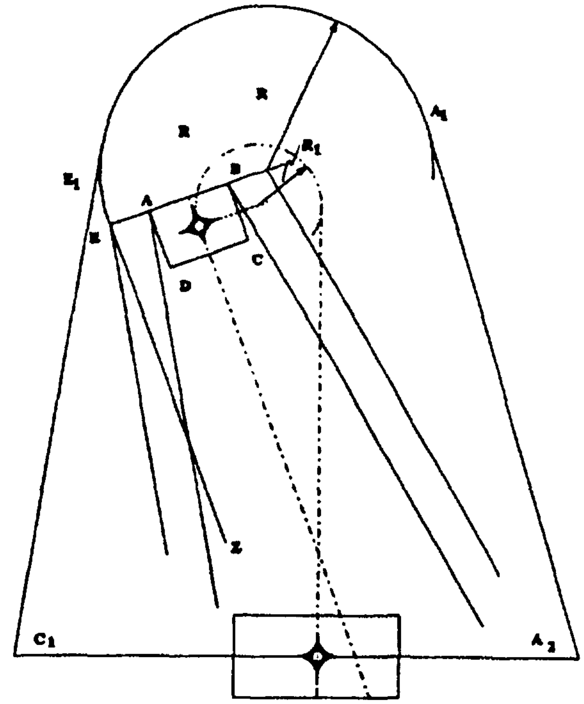


Figure 15-28. DIRECT TURNING MISSED APPROACH, > 90° TIE-BACK POINT C_1 TO POINT D. Par 1534a(2)(b).



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).

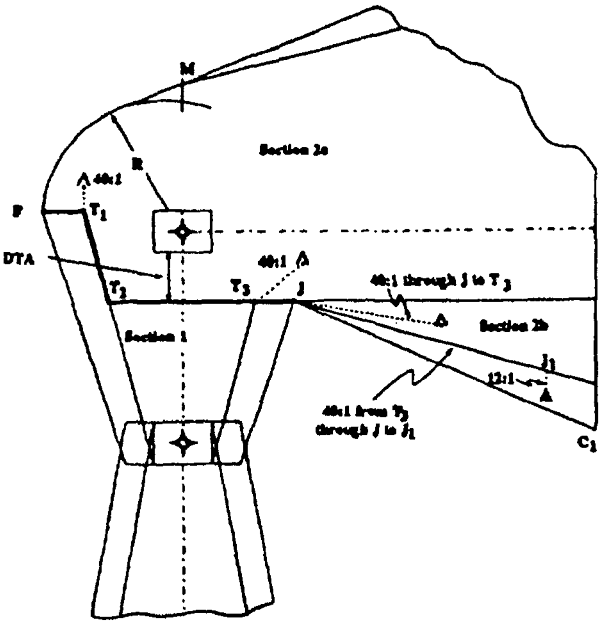


Figure 15-31. RNAV COMBINATION STRAIGHT AND TURNING MISSED APPROACH 90° TURN OR LESS. Par 1535a(2) and 1535b(1)(b).

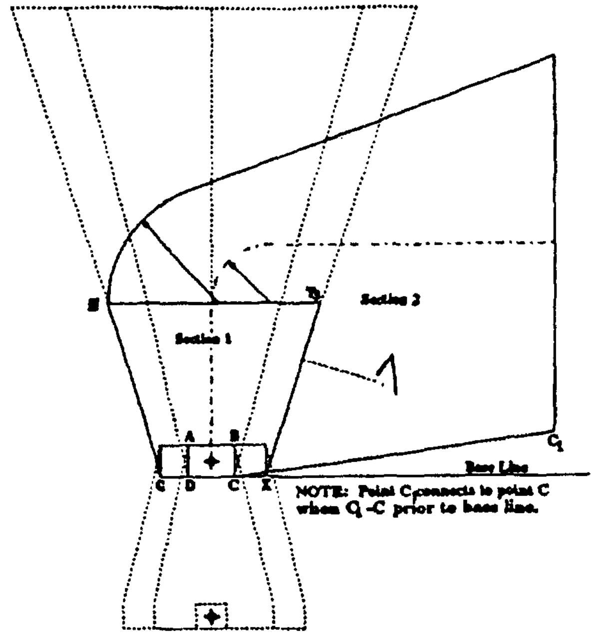


Figure 15-33. CLIMB TO ALTITUDE, STRAIGHT AND TURNING MISSED APPROACH, C_1 PRIOR TO BASE LINE. Par 1535a(3).

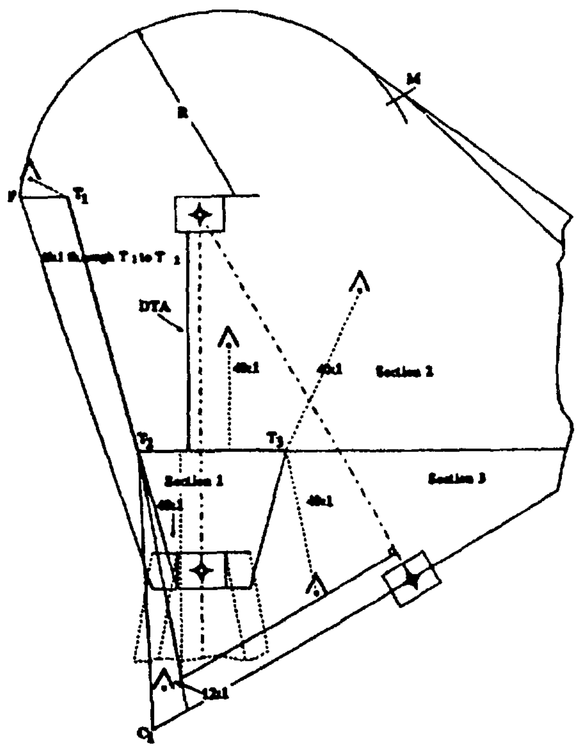


Figure 15-32. RNAV COMBINATION STRAIGHT AND TURNING MISSED APPROACH MORE THAN 90° UP TO 120°. Par 1535a(2)and b(3).

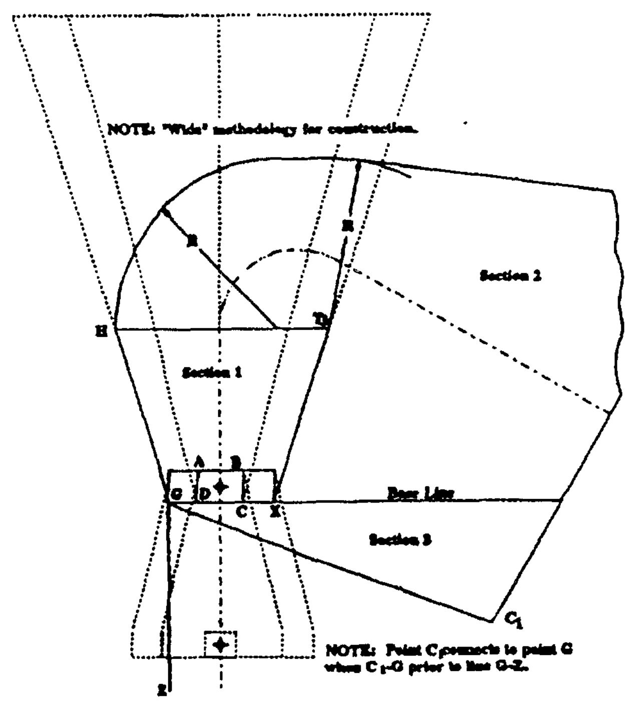


Figure 15-34. CLIMB TO ALTITUDE, STRAIGHT AND TURNING MISSED APPROACH > 90°. Par 1535a(3).

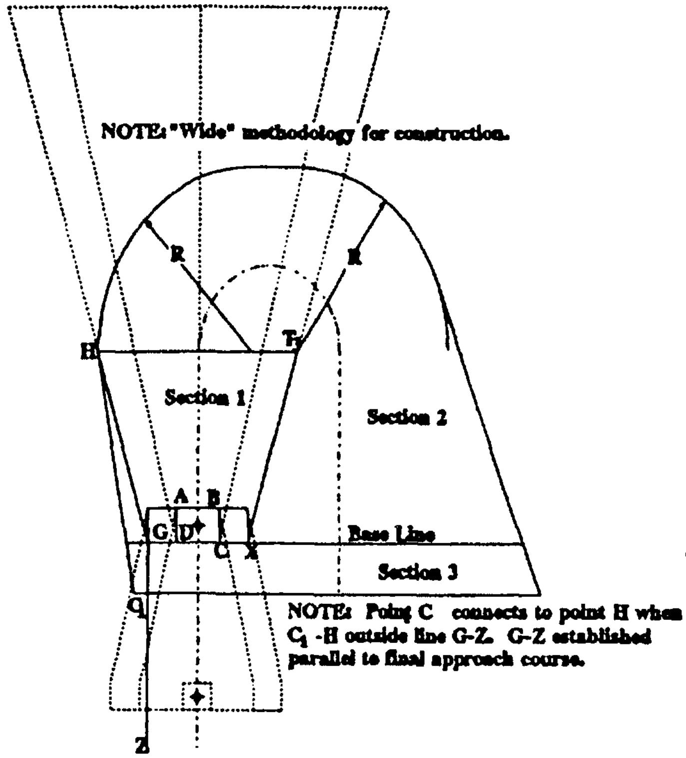


Figure 15-35. CLIMB TO ALTITUDE, STRAIGHT AND TURNING MISSED APPROACH > 90°. Par 1535a(3).

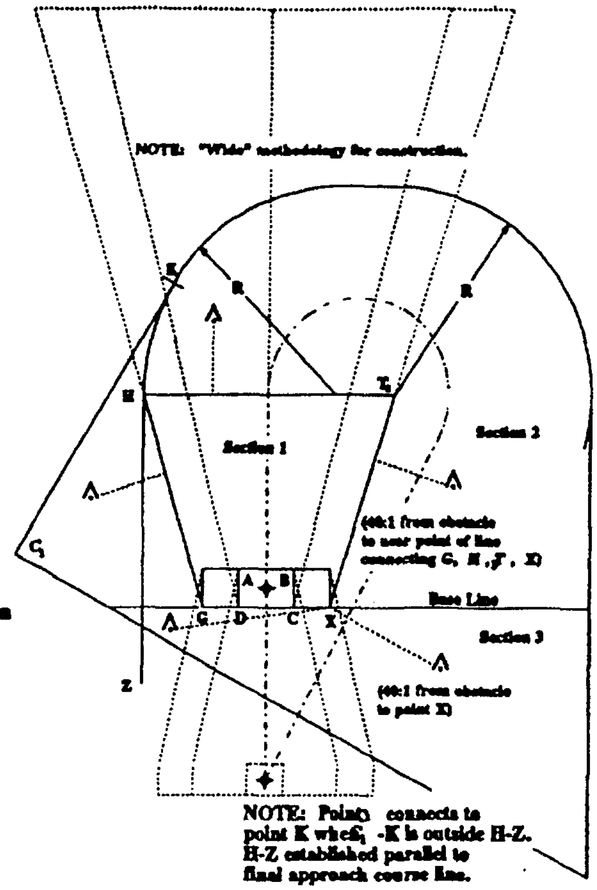


Figure 15-36. CLIMB TO ALTITUDE, STRAIGHT AND TURNING MISSED APPROACH > 180°. Par 1535a(3).

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		1 3	1 7	2 2	2 8	3 4	3 5
	ATRK		0 6	0 6	0 7	0 8	0 9	0 9
10	XTRK	1 2	1 3	1.7	2 2	2 8	3 4	
	ATRK	0 8	0.8	0.9	0 9	1 0	1 1	
20	XTRK	1 2	1 4	1 8	2 3	2 8		
	ATRK	1 3	1 3	1.3	1 4	1 4		
30	XTRK	1 2	1 4	1.8	2 3	2 9		
	ATRK	1 8	1 8	1 9	1 9	2 0		
40	XTRK	1 3	1 5	1 8	2 3			
	ATRK	2.4	2.4	2 4	2 4			
50	XTRK	1 3	1 5					
	ATRK	2 9	3.0					
53	XTRK	1 3						
	ATRK	3 1						

Table may be interpolated -- or use next higher value.
XTRK/ATRK values are ±

J/V En Route (0–70) and Random En Route (0–120)

		0	10	20	30	40	50
0	XTRK		1 3	1 7	2 2	2 8	3 4
	ATRK		0 6	0 6	0 7	0 8	0 9
10	XTRK	1 2	1 3	1 7	2 2	2 8	3 4
	ATRK	0 8	0 6	0 8	0 9	1 0	1 1
20	XTRK	1 2	1 4	1 8	2 3	2 8	3 4
	ATRK	1 3	1 3	1 3	1 4	1 4	1 5
30	XTRK	1 2	1 4	1.8	2 3	2 9	3 5
	ATRK	1 8	1 8	1 9	1 9	2 0	2 0
40	XTRK	1 3	1 5	1 8	2 3	2 9	3 5
	ATRK	2 4	2 4	2 4	2 4	2 5	2 5
50	XTRK	1 3	1 5	1 9	2 4	2 9	3 5
	ATRK	2 9	3 0	3 0	3 0	3 0	3 1
60	XTRK	1 4	1 6	1 9	2 4	3 0	3 6
	ATRK	3 5	3 5	3 5	3 6	3 6	3 6
70	XTRK	1 4	1 6	2 0	2 5	3 0	3 6
	ATRK	4 1	4 1	4 1	4 1	4 2	4 2
80	XTRK	1 5	1 7	2.1	2 5	3 1	3 6
	ATRK	4 6	4 7	4 7	4 7	4 7	4 8
90	XTRK	1 6	1 8	2.1	2 6	3 1	3 7
	ATRK	5 2	5 2	5 3	5 3	5 3	5 3
100	XTRK	1 7	1 8	2 2	2 6	3 2	3 7
	ATRK	5 8	5 8	5 8	5 9	5 9	5 9
110	XTRK	1 7	1 9	2 2	2 7	3 2	3 8
	ATRK	6 4	6 4	6 4	6 4	6 5	6 5
120	XTRK	1 8	2 0	2 3	2 8	3 3	3 8
	ATRK	6 9	7 0	7 0	7 0	7 0	7 1

J/V En Route

Random En Route

Table application per segment

Segment	Table 15-1 J/V En Route	Table 15-1 Random En Route	Table 15-1 Terminal
En Route	X		
Feeder		X	
Feeder S/D		X	
IAWP			X
Initial S/D			X
IWP			X
Intermediate S/D			X
MA/Holding			X

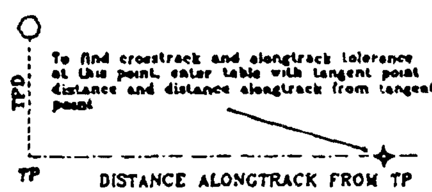


Table 15-2. FINAL/MISSED AREA FIX DISPLACEMENT TOLERANCE.

FIX DISTANCE ALONGTRACK FROM TANGENT POINT

TANGENT POINT DISTANCE (TPD) FINAL/MISSED

TPD		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	

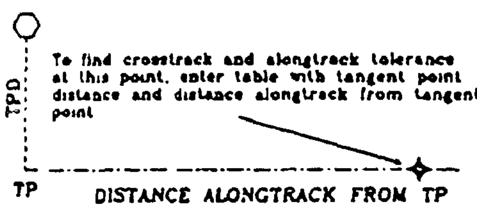


Table 15-3. NON-VOR/DME FIX DISPLACEMENT TOLERANCE.

	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		
	En Route	Terminal	Approach
Segment:			
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

CHAPTER 17. ENROUTE CRITERIA

1700.-1709. RESERVED.

Section 1. VHF Obstacle Clearance Areas

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

1711. PRIMARY AREAS.

a. Basic Area. The primary enroute 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.

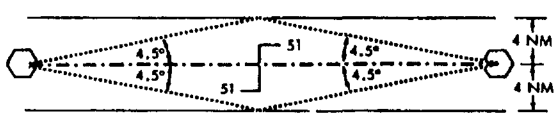


Figure 17-1 PRIMARY OBSTACLE CLEARANCE AREA
Par 1711 a.

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.

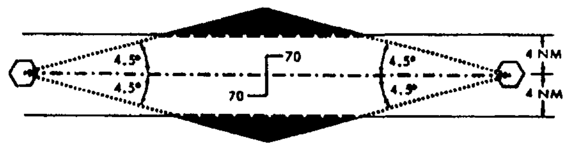


Figure 17-2. PRIMARY OBSTACLE CLEARANCE AREA.
Application of System Accuracy. Par 1711 b.

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.

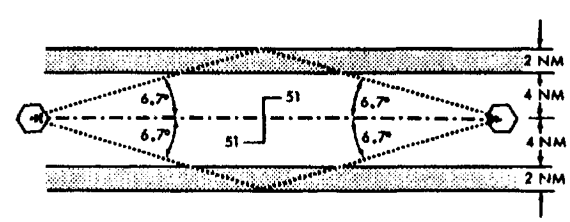


Figure 17-3. SECONDARY OBSTACLE CLEARANCE AREAS.
Par 1712.a.

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.

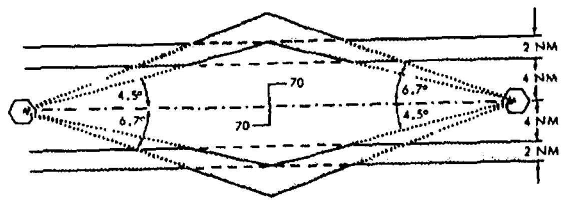


Figure 17-4 SECONDARY OBSTACLE CLEARANCE AREAS. Application of System Accuracy Lines. Par 1712 b

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 enroute 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 supplements 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 10,000 feet MSL (FAR 91.70), some conditions do not require the application of turning area airspace criteria.

(1) The graph in Figure 17-5 may be used to determine if the turning area should be plotted for airways/routes below 10,000 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 10,000 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 above 10,000 feet MSL up to but not including 18,000 feet MSL the primary area radius is 6 NM and the secondary area radius is 8 NM. Above 18,000 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 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 1713.e. above applies.

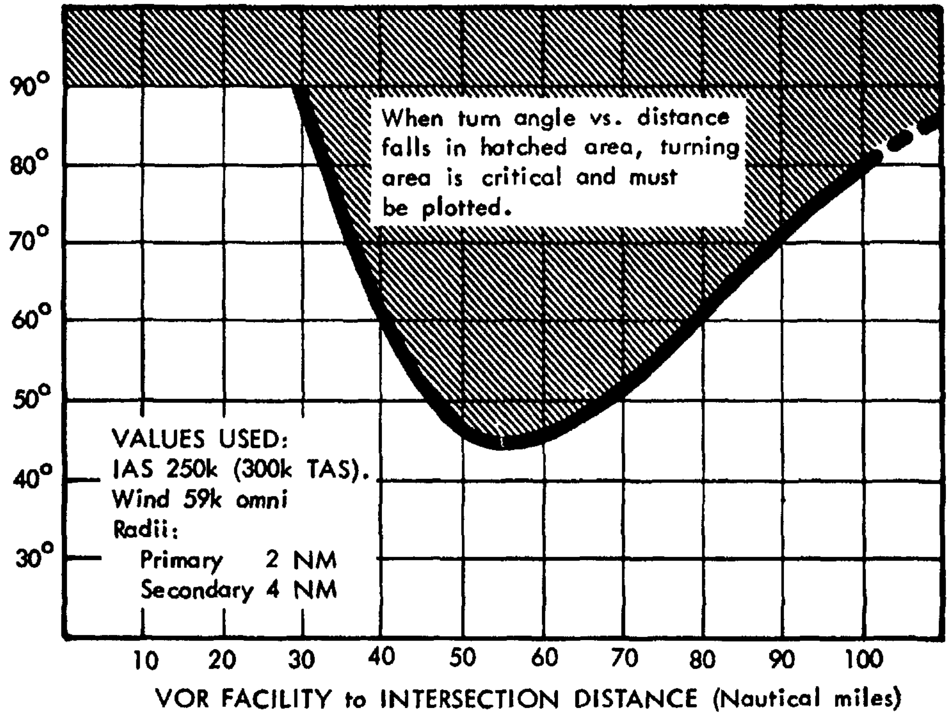


Figure 17-5 TURN ANGLE VS DISTANCE Par 1713 b (1) and (2)

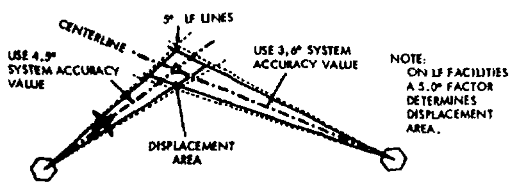


Figure 17-6 FIX DISPLACEMENT Par 1713 e

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."

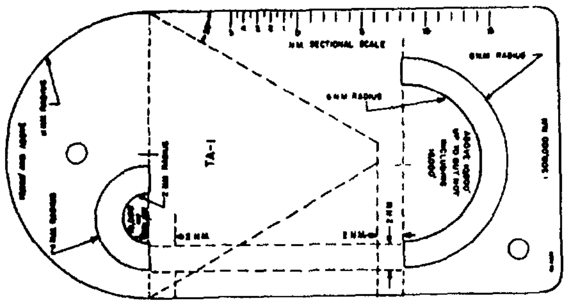


Figure 17-7. TURNING AREA TEMPLATE. Par 1715.

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.

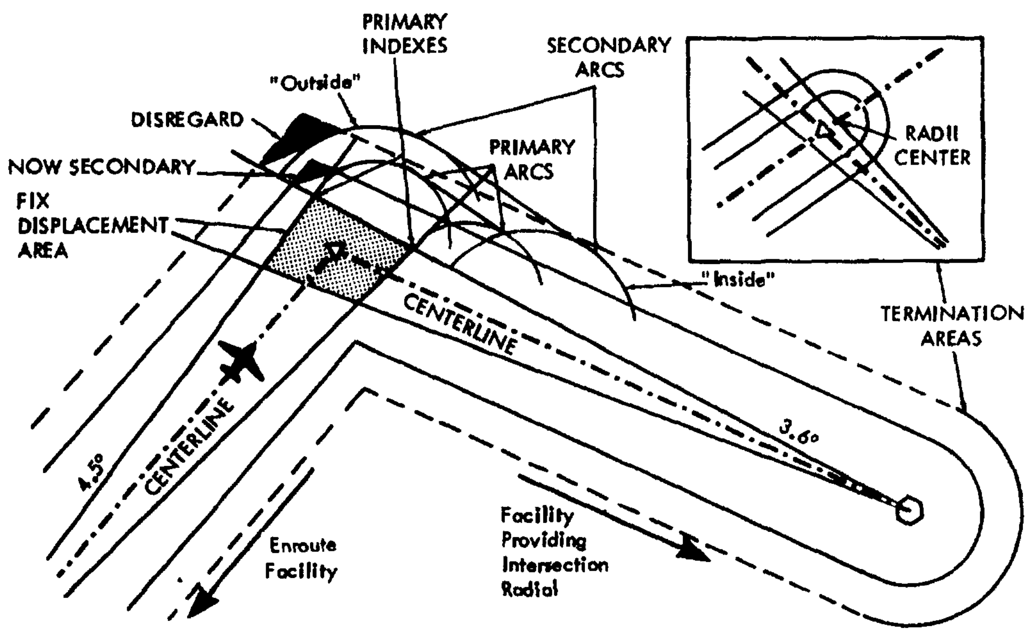


Figure 17-8 TURNING AREA, INTERSECTION FIX (Facility Distance Less than 51 NM) Par 1715 a and b

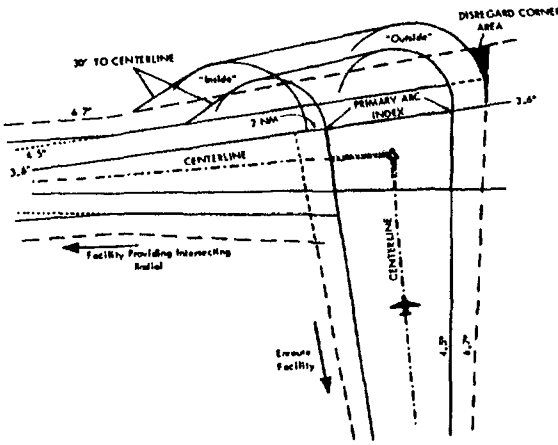


Figure 17-9. TURNING AREA, INTERSECTION FIX (Facility Distance Beyond 51 NM). Par 1715 a and b

(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.

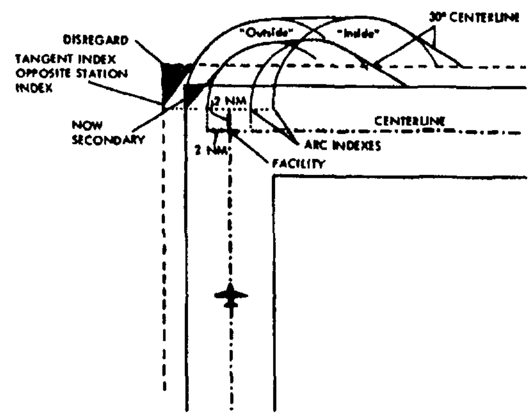
(b) Where the distance from the enroute facility to the fix is more than 51 NM but the magnitude of the turn is less than 45 degrees, the "inside" curves do not increase the size of the secondary area.

(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.

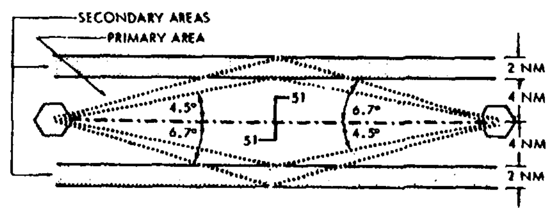


Figure 17-11. COP EFFECT Short Airway or Route Segment
Par 1716 a

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.

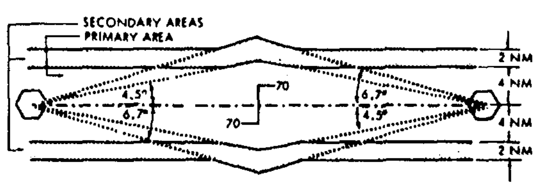


Figure 17-12. COP EFFECT Long Airway or Route Segment
Par 1716 b

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.

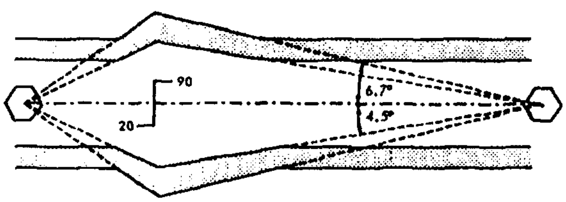


Figure 17-13 OFFSET COP. Par 1716 c

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.

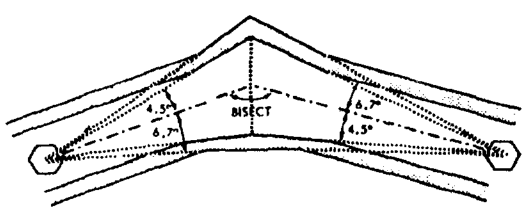


Figure 17-14 DOGLEG SEGMENT. Par 1716 d.

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

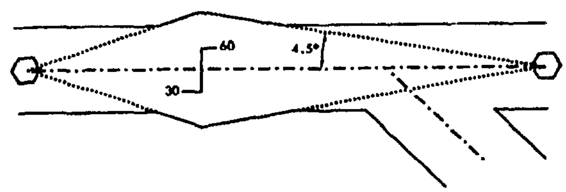


Figure 17-15 COURSE CHANGE EFFECT Par 1717.

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.

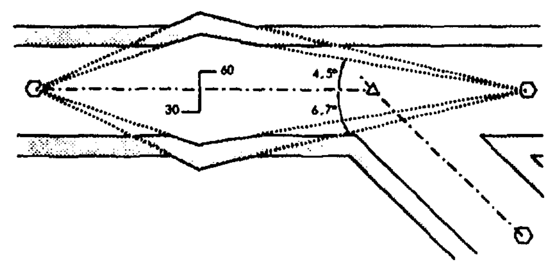


Figure 17-16 APPLICATION OF SECONDARY AREAS Par 1717

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.*

D' 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.

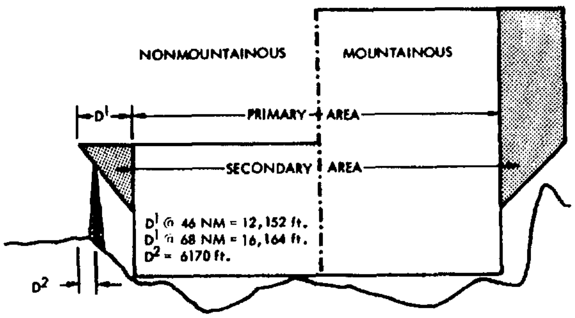


Figure 17-17 CROSS SECTION, SECONDARY AREA OBSTACLE CLEARANCES. Par 1721.

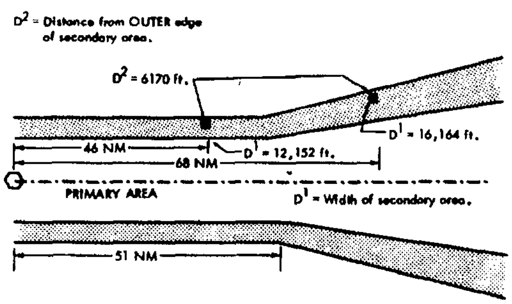


Figure 17-18. PLAN VIEW, SECONDARY AREA OBSTACLE CLEARANCES. Par 1721.

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.

D' is 12,152 feet.
D" 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).

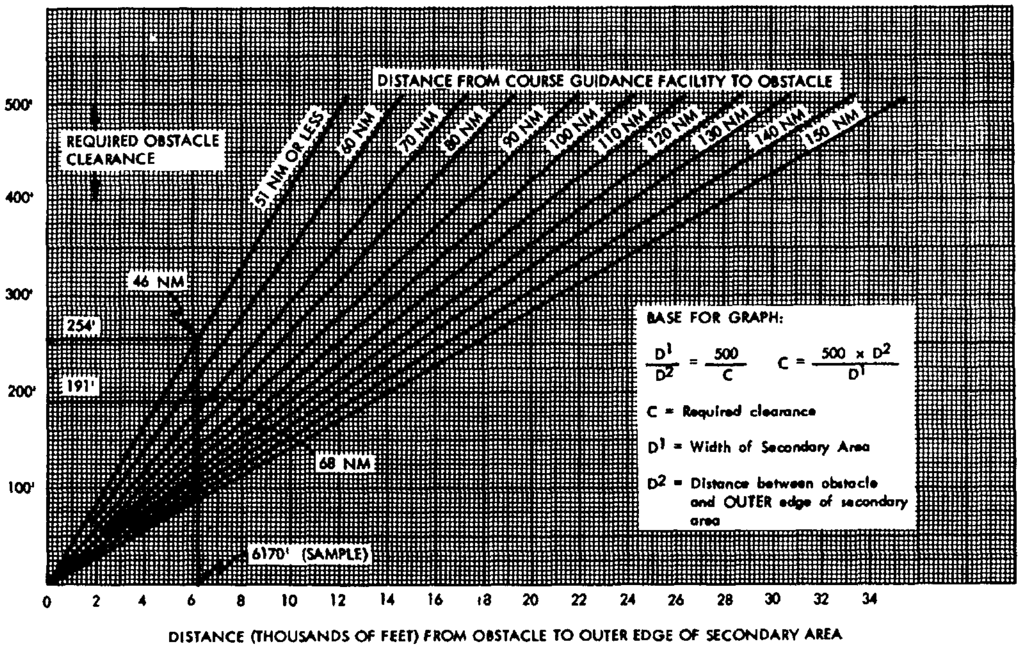


Figure 17-19 SECONDARY AREA OBSTACLE CLEARANCE Par 1722

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.

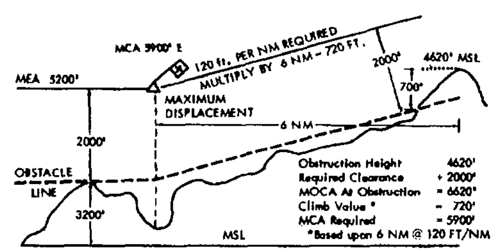


Figure 17-20 MCA DETERMINATION POINT. Par 1730

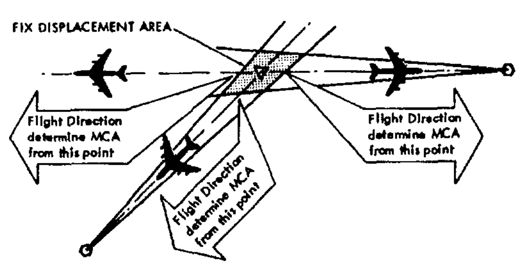


Figure 17-21. DETERMINATION OF MCA Par 1730.

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 change 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 1740.b.(2).

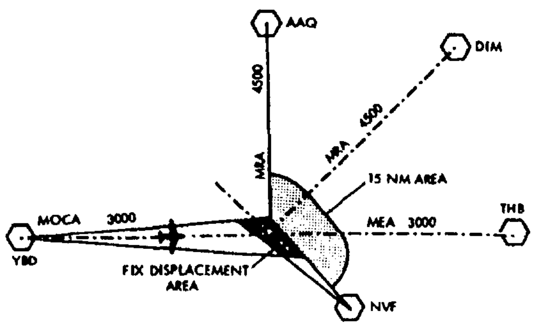


Figure 17-22. MEA WITH NAVIGATION GAP AT TURNING POINT. Par 1740 b (2)

1731. ENROUTE MINIMUM HOLDING ALTITUDES. Criteria for holding pattern airspace are contained in FAA Handbook 7130.3 and provide for separation of aircraft from aircraft. The criteria contained herein deal with the clearance of holding aircraft from obstacles.

a. Area. The primary obstacle clearance area for holding shall be based on the appropriate holding pattern airspace area specified in FAA Handbook 7130.3, Holding Pattern Criteria. No reduction in the pattern sizes for "on-entry" procedures is permitted. In addition, when holding is at an intersection fix, the selected pattern shall also be large enough to contain at least 3 corners of the fix displacement area. See paragraphs 284, 285, and Figure 37. A secondary area 2 miles wide surrounds the perimeter of the primary area.

b. Obstacle Clearance. The minimum obstacle clearance of the route shall be provided throughout the primary area. In the secondary area 500 feet of obstacle clearance shall be provided at the INNER edge, tapering to zero feet at the outer edge. For computation of obstacle clearance in the secondary area, see Appendix 2, paragraph 5 for use of Figure 123. Allowance for precipitous terrain should be considered as stated in paragraph 323.a. The altitudes selected by application of the obstacle clearance specified in this paragraph may be rounded to the nearest 100 feet.

c. Communications. The communications on appropriate ATC frequencies (as determined by ATS) shall 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 shall be authorized at an altitude where the communications are satisfactory. For communications to be satisfactory, they must meet the standards as set forth in FAA Handbook OA P 8200.1, The U.S. Standard Flight Inspection Manual.

d. Holding Patterns On/Adjacent to ILS Courses. Holding patterns on or adjacent to ILS courses shall comply with FAA Handbook 7130.3, Holding Pattern Criteria, paragraph 54.

e. High Altitude. All holding patterns in the high altitude structure shall be coordinated with the Flight Standards National Field Office prior to being approved.

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 1740.c., 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 45,000 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 1740.b.(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. MEAs with gaps shall be authorized only where a specific operational requirement exists. Where gaps exceed the distance in 1740.a.(1), or are in conflict with the limitations in 1740.a.(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 1740.a.(1), or;

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

(2) For turning segments. Turns to intercept radials with higher MEAs 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 1740.b.(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 which obviate the effective use of airspace, consideration may be given to the establishment of MEA

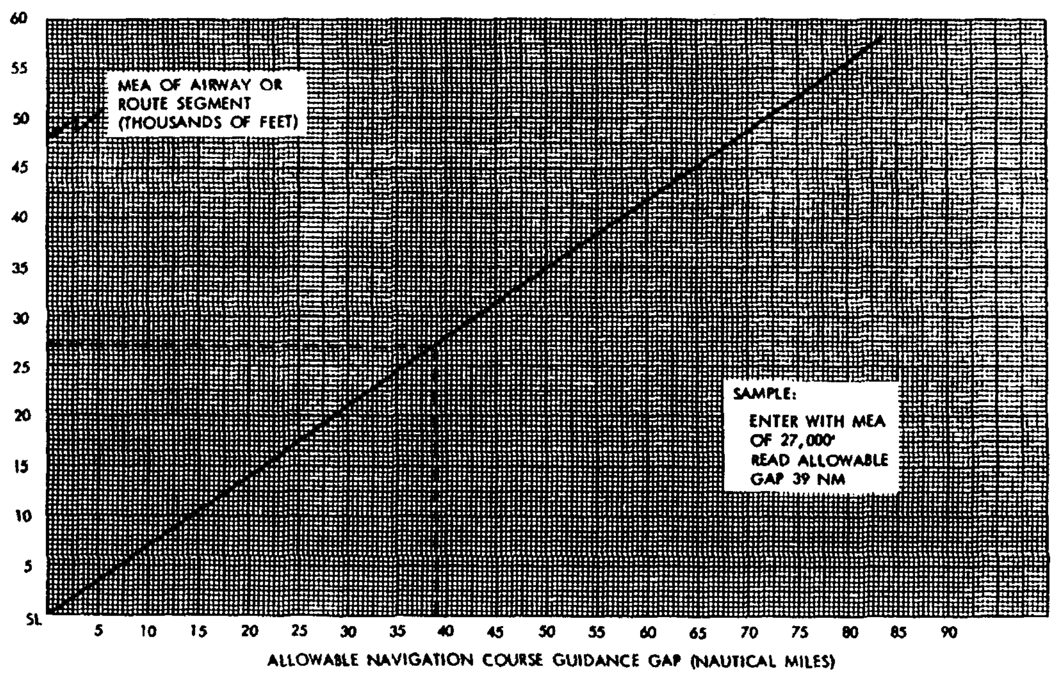


Figure 17-23. NAVIGATION COURSE GUIDANCE GAPS Par 1740

"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.

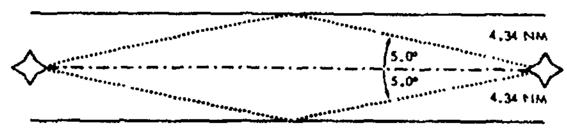


Figure 17-24 LF SEGMENT PRIMARY OBSTACLE CLEARANCE AREA Par 1750 b

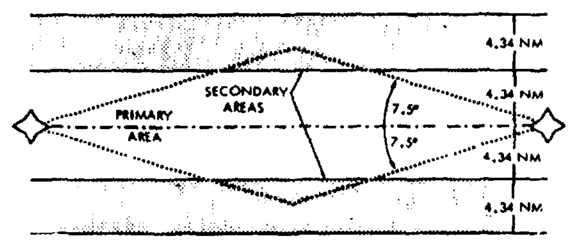


Figure 17-25. LF SEGMENT SECONDARY OBSTACLE CLEARANCE AREA Par 1750 b

(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.

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.

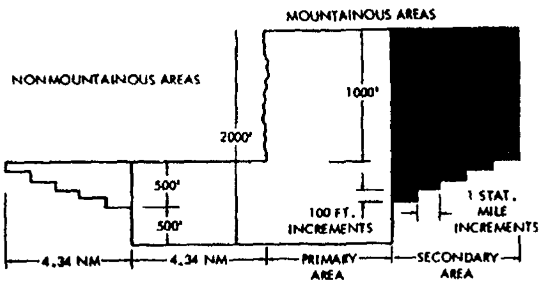


Figure 17-26 LF SEGMENT OBSTACLE CLEARANCE WITHIN 25 NM OF ENROUTE FACILITY
Par 1750 d

(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.

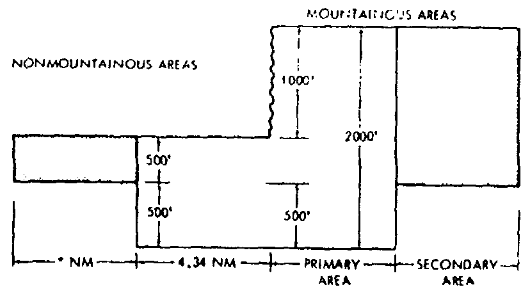


Figure 17-27 LF SEGMENT OBSTACLE CLEARANCE OVER 25 NM FROM ENROUTE FACILITY
Par 1750 d

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.

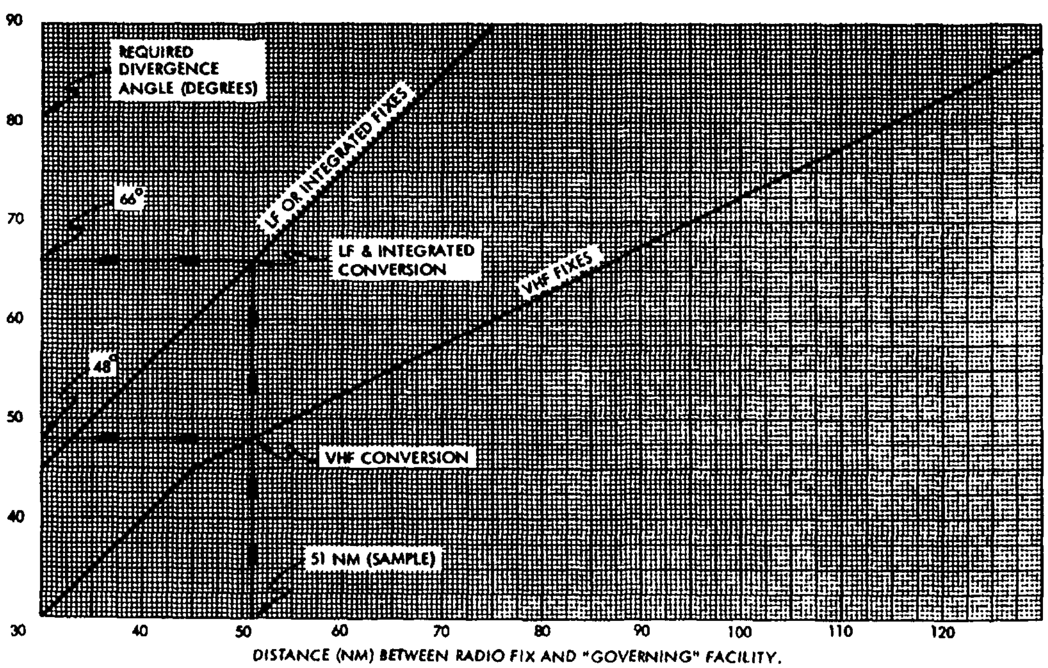


Figure 17-28 MINIMUM DIVERGENCE ANGLE FOR RADIO FIX Par 1761 b and 1762 b

1. APPENDIX APPLICATION. The material contained in these appendices applies to support criteria contained in the several chapters of the handbook. 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 2. Procedures Charts. These charts depict secondary area obstacle problems, solutions, methods of computing glide slope threshold crossing heights, glide slope antenna location, applications of ILS/PAR obstacle clearance criteria, and an analysis of obstacle clearances.

c. Appendix 3. This appendix contains lists of Figures, a list of Tables, and a list of References to other publications.

d. Appendix 4. 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.

e. Appendix 5. Approach Lighting. 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.

f. Appendix 6. Alphabetical Index.

2. GLOSSARY. Definitions shown in this glossary apply to Terminal Instrument Procedures Criteria in this Handbook.

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.

Approach Surface Baseline An imaginary horizontal line at threshold elevation.

Approving Authority Headquarters representatives 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 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".

Decision Height (DH) The height, specified in MSL, above the highest runway elevation in the touchdown zone at which a missed approach shall 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 ILS or PAR.

DME 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 the 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.

MAP Missed Approach Point (Paragraph 272).

MDA Minimum Descent Altitude (Paragraph 320).

MHA Minimum Holding Altitude.

NDB(ADF) A combined term which indicates that a nondirectional beacon (NDB) provides an electronic signal for use with airborne automatic direction finding (ADF) equipment.

Obstacle An existing object, object of natural growth, or terrain at a fixed geographical location, or 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 $\boxed{500}$ 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 are examples 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 enables 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 which 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.

Threshold Crossing Height The height of the straight line extension of the glide slope above the runway at the threshold.

TDZ Touchdown Zone.

Touchdown Zone The first 3000 feet of runway beginning at the threshold.

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.

Visual Descent Point (VDP) The visual descent point 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.

PRECISION

1. COMPUTING GLIDE SLOPE THRES-HOLD CROSSING HEIGHT.

a. Definitions.

(1) **Straight Line Extension of GS.** The assumed path which the GS would follow if it were a straight line in space from a point over the outer marker to a point of interception with the approach surface baseline.

(2) **Threshold Crossing Height (TCH).** The height of the straight line extension of the GS above the runway at the threshold.

(3) **Established Glide Slope Angle.** The angle of the GS as determined by the currently effective commissioning flight check. Flight inspection will provide information concerning the height of the GS at the outer marker, middle marker, or other point of known distance from the runway threshold on final approach.

(4) **Runway Point of Intercept (RPI).** The point where the extended GS intercepts the runway centerline on the runway surface.

b. Computation Method. The GS threshold crossing height is computed as follows: (See figure 126).

(1) **Multiply "D_1"** (the distance in feet from the GPI to a point abeam the runway threshold "T") by the tangent of the established GS angle. The result is the TCH.

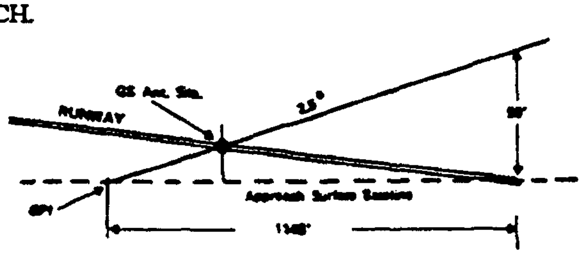


Figure 126. COMPUTING THRESHOLD CROSSING HEIGHT. Par 1b.

(2) **Problem:** Find the TCH if:

GS angle is 2 1/2 °. (Tan is .04366).
Distance "D_1" is 1,145 feet.
TCH = D_1 tan GS angle
= 1,145 x .04366
= 50 feet.

c. Glide Slope Antenna Location The GS antenna will be sited in accordance with appropriate civil or military installation standards to provide the desired TCH and GPI.

2. COMPUTATION OF GPI WHEN TCH IS KNOWN.

The GPI will be located abeam the glideslope antenna only when the terrain in the vicinity of the runway is perfectly flat. When the terrain slopes significantly between the runway threshold and the GS antenna location, the GPI will not be located abeam the GS antenna. This is because the GPI is the point at which the straight line extension of the glideslope intersects the approach surface base line (ASB). The ASB has the same elevation as the runway threshold. Therefore, the GPI will always be the same distance from the threshold when TCH and GS angles are the same. See figures 129, 129A, 129B, and 129C.

3. APPLICATION OF ILS/PAR OBSTACLE CLEARANCE CRITERIA.

Obstacle clearance in the final segment is achieved through application of obstacle clearance surfaces (OCS). See figure 127.

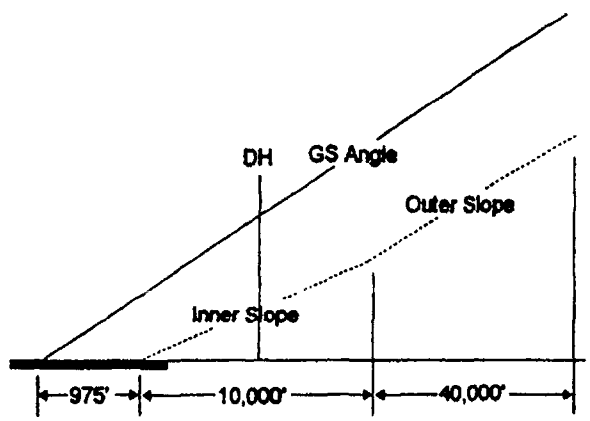


Figure 127. OBSTACLE CLEARANCE SURFACES. Par 3.

a. Definitions.

(1) **Ground Point of Intercept (GPI).** A point in the vertical plane of the runway centerline at which it is assumed that the straight line extension of the glideslope intercepts the approach surface baseline.

(2) **Approach Surface Baseline (ASBL).** An imaginary horizontal line at the threshold elevation.

(3) **Final Approach OCS.**

(a) **Inner OCS (OCS_I).** An incline plane that originates at the ASBL 975 feet outward from GPI and extends to a point 10,975 feet from GPI.

(b) **Outer OCS (OCS_O).** An incline plane that originates at the 10,975' point of the inner slope, and extends 40,000 feet.

b. Evaluating the OCS. Compare obstacle height to the appropriate OCS/transitional surface using the formulae below.

(1) **Inner OCS (OCS_I).** Calculate the height of the OCS_I at any distance D less than 10,975 feet from GPI using the following formula:

$$OCS_I \text{ Height Above THR} = \left[\left(\tan(gs) - 0.02366\right) \times D\right] - 20$$

where: gs = glideslope angle
D = distance from GPI in feet

(2) **Outer OCS (OCS_O).** Calculate the height of the OCS_O at any distance D greater than or equal to 10,975 feet from GPI using the following formula:

$$OCS_O \text{ Height Above THR} = \left[\left(\tan(gs) - 0.01866\right) \times D\right] - 75$$

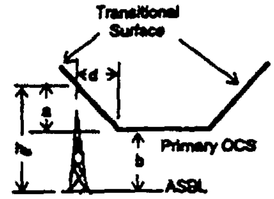
where: gs = glideslope angle
D = distance from GPI in feet

(3) **Transitional Surface.** Calculate the height of the transitional surface (h_{ts}) at any distance (d) from the edge of the primary area measured perpendicular to the final approach course using the following formulae.

(1) $a = \frac{d}{7}$

(2) $h_{ts} = a + b$

Where a = amount of surface adjustment
b = OCS_I or OCS_O as appropriate



c. Evaluating the Visual Portion of the Final Segment. See figure 128. Apply the criteria in paragraph 251 to determine the effect of obstacles on minimums.

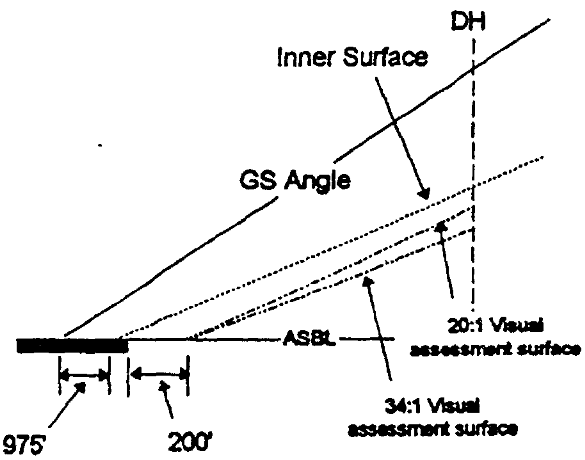
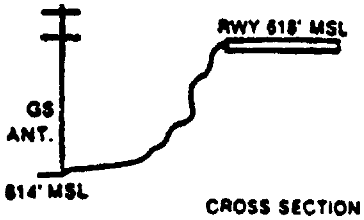
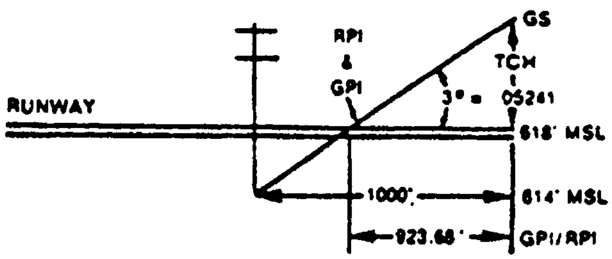


Figure 128. VISUAL SEGMENT SURFACES. Par 3c.



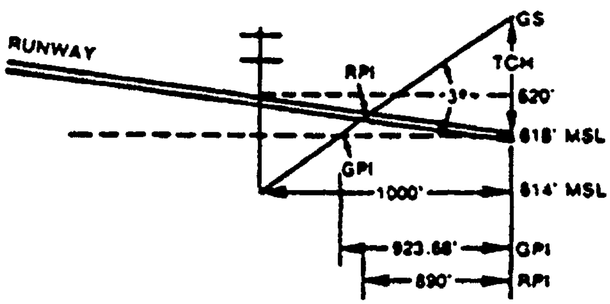
ILS ANTENNA ELEVATION IS MEASURED AT THE ANTENNA PAD (PROPOSED OR ESTABLISHED) WHEN TERRAIN DROPS OFF RAPIDLY FROM RUNWAY TO ANTENNA.

RUNWAYS WITH ZERO SLOPE



TCH = (TAN GS) (DIST ANT TO TH) - (TH ELEV-ANT ELEV)
TCH = (.05241) (1000) - (618-614) = 48.41'
GPI = TCH ÷ TAN GS
GPI = 48.41 ÷ .05241 = 923.68'
RPI = GPI

POSITIVE SLOPING RUNWAYS

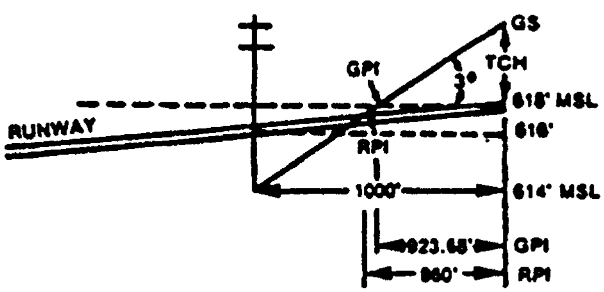


TCH = (TAN GS) (DIST ANT TO TH) - (TH ELEV-ANT ELEV)
TCH = (.05241) (1000) - (618-614) = 48.41'
GPI = TCH ÷ TAN GS
GPI = 48.41 ÷ .05241 = 923.68'

$$RPI = \frac{(TCH)\,(DIST\ ANT\ FROM\ TH)}{TCH + (RWY\ CROWN\ ELEV\ ABEAM\ ANT - ANT\ ELEV)}$$

$$RPI = \frac{(48.41)\,(1000)}{48.41 + (620-614)} = 890'$$

NEGATIVE SLOPING RUNWAYS

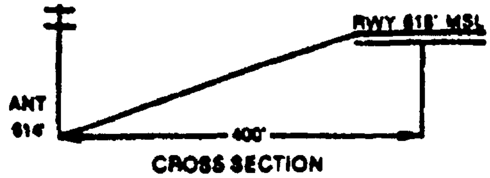


TCH = (TAN GS) (DIST ANT TO TH) - (TH ELEV - ANT ELEV)
TCH = (.05241) (1000) - (618-614) = 48.41'
GPI = TCH ÷ TAN GS
GPI = 48.41 ÷ .05241 = 923.68'

$$RPI = \frac{(TCH)\,(DIST\ ANT\ FROM\ TH)}{TCH + (RWY\ CROWN\ ELEV\ ABEAM\ ANT - ANT\ ELEV)}$$

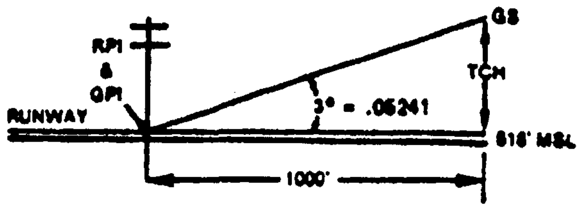
$$RPI = \frac{(48.41)\,(1000)}{48.41 + (618-614)} = 960'$$

Figure 129. RPI/GPI/TCH COMPUTATIONS FOR ILS WITH RAPIDLY DROPPING TERRAIN. Par 2, Appendix 2.



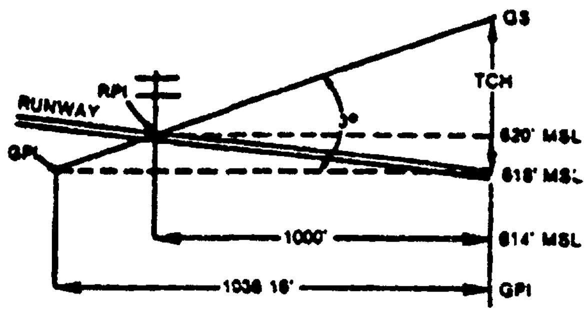
THE ILS GS ANTENNA IS ASSUMED TO BE AT RUNWAY CROWN ELEVATION WHEN TERRAIN FROM RUNWAY TO ANTENNA SITE (PROPOSED OR ESTABLISHED) HAS A RELATIVELY SMOOTH AND UNIFORM GRADIENT.

RUNWAY WITH ZERO SLOPE



TCH = (TAN GS) (DIST ANT FROM TH)
TCH = (.05241) (1000) = 52.41'
GPI = TCH ÷ TAN GS
GPI = 52.41 ÷ .05241 = 1000'
RPI = GPI

POSITIVE SLOPING RUNWAYS



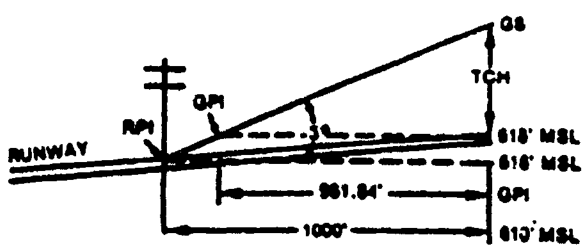
TCH = (TAN GS) (DIST ANT FROM TH) - (TH ELEV - RWY CROWN ELEV ABEAM ANT)
TCH = (.05241) (1000) - (618-620) = 54.41'
GPI = TCH ÷ TAN GS
GPI = 54.41 ÷ .05241 = 1038.16'

RPI = (TCH + (TH ELEV - RWY CROWN ELEV ABEAM ANT)) / TAN GS

RPI = (54.41 + (618-620)) / .05241 = 1000'

NEGATIVE SLOPING RUNWAYS

TCH = (TAN GS) (DIST ANT FROM TH) - (TH ELEV - RWY CROWN ELEV ABEAM ANT)
TCH = (.05241) (1000) - (618-616) = 50.41'



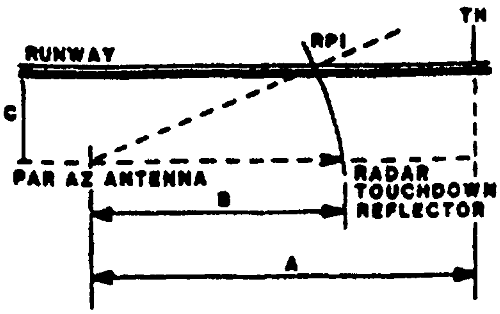
GPI = TCH ÷ TAN GS
GPI = 50.41 ÷ .05241 = 961.84'

RPI = (TCH + (TH ELEV - RWY CROWN ELEV ABEAM ANT)) / TAN GS

RPI = (50.41 + (618-616)) / .05241 = 1000'

Note: GPI has same elevation as end of runway. RPI is the point where the extended glide path intercepts the runway centerline.

Figure 129A. RPI/GPI/TCH COMPUTATIONS FOR ILS WITH RELATIVELY SMOOTH TERRAIN, Par 2, Appendix 2.

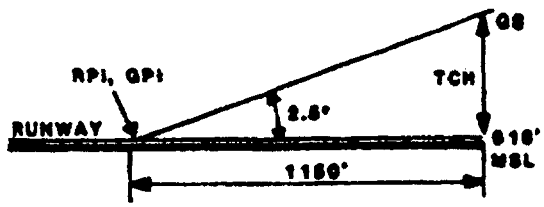


THE RPI IS LOCATED ON THE RUNWAY CENTERLINE THE DISTANCE FROM THE PAR ANTENNA TO THE RPI IS EQUAL TO THE DISTANCE FROM THE PAR ANTENNA TO THE TOUCHDOWN REFLECTOR. RPI DISTANCE FROM THRESHOLD MAY BE DETERMINED FROM THE FORMULA.

$$RPI = A - \sqrt{B^2 - C^2}$$

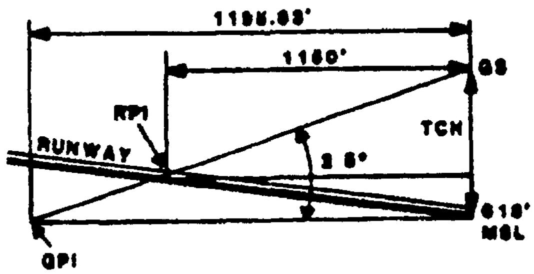
A = DIST ANT FROM TH
B = DIST REFLECT FROM ANT
C = DIST ANT FROM RWY CENTERLINE

RUNWAY WITH ZERO SLOPE



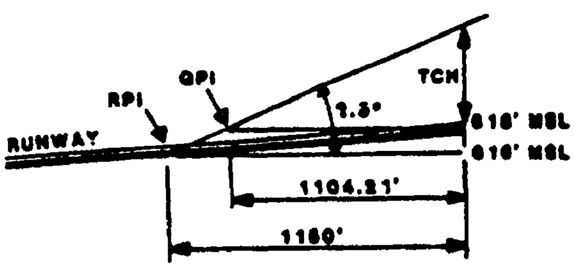
TCH (TAN GS) (DIST TH FROM RPI)
TCH = (0.04366) (1150) = 50.21'
GPI = TCH ÷ TAN GS
GPI = 50 21' ÷ 0.04366 = 1150'
RPI = GPI

POSITIVE SLOPING RUNWAYS



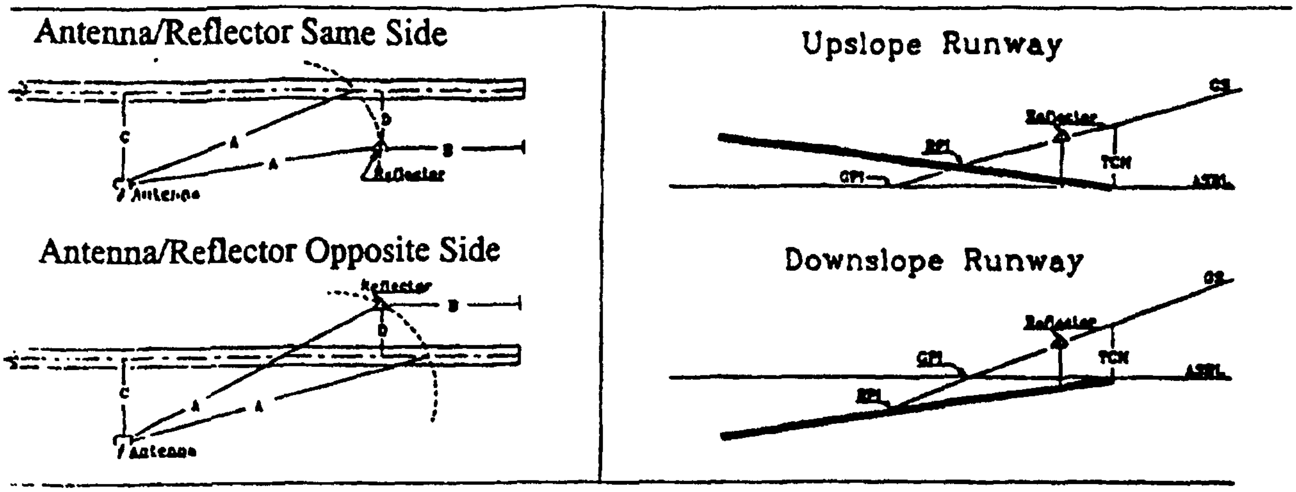
TCH = (TAN GS) (DIST TH FROM RPI) +
(RPI EL − TH EL)
TCH = (0.04366) (1150) + (620 − 618) = 52 2
GPI = TCH ÷ TAN GS
GPI = 52.21' ÷ 0.04366 = 1195.83'

NEGATIVE SLOPING RUNWAYS



TCH = (TAN GS) (DIST TH FROM RPI) −
(TH EL − RPI EL)
TCH = (0.04366) (1150) − (618 − 616) = 48.21'
GPI TCH TAN GS
GPI = 48.21' ÷ 0.04366 = 1104.21'

Figure 129B. RPI/GPI/TCH COMPUTATIONS FOR PRECISION APPROACH RADAR. Par 2, Appendix 2.



REQUIRED INFORMATION

ELEVATIONS (MSL):		DISTANCES (FEET):		
Runway threshold	__________	PAR AZ antenna to reflector	(A)	__________
Touchdown reflector	__________	TD reflector to threshold	(B)	__________
Runway crown in TDZ	__________	PAR AZ antenna to centerline	(C)	__________
RPI (if known)	__________	TD reflector to centerline	(D*)	__________
GLIDE SLOPE ANGLE:	__________	RUNWAY GRADIENT (if required)		__________

*negative value if antenna and reflector are on same side of runway

COMPUTATIONS

STEP 1. Determine the parallel-to-centerline distance from the antenna to the touchdown reflector wb correcting for any difference in distance from antenna-to-centerline and reflector-to-centerline.
Formula: $\sqrt{[A^2 - (C + (D))^2]}$

STEP 2. Determine the parallel distance of the antenna-to-threshold.
Formula: Step 1 + Reflector-to-threshold distance (B)

STEP 3. Determine the parallel distance from the antenna to a point where the reflector would be if displaced to the runway centerline and subtract this distance from the parallel antenna-to-threshold distance. This is considered touchdown point (TDP) for Naval applications.
Formula: Step 2 - $\sqrt{(A^2 - C^2)}$

STEP 4. Determine the reflector height above the threshold elevation.
Formula: Reflector height - Threshold elevation

STEP 5. Determine the distance from displaced reflector position to GPI.
Formula: Step 4 ÷ Tangent GS

STEP 6. Determine the distance from threshold to GPI. Formula: Step 3 + Step 5

STEP 7. Determine the Threshold Crossing Height. Formula: GPI x Tangent GS

STEP 8. Determine runway gradient if required.
Formula: (Runway crown elevation - threshold elevation) ÷ Threshold-to-crown distance.

STEP 9. Determine the RPI distance from threshold.
Formula:
RPI EL Known: (TCH - (RPI El - TH El)) ÷ Tangent GS
RPI EL Unknown: (GPI x Tangent GS) ÷ [Tangent GS + (Gradient)]

Figure 129C. RPI/GPI/TCH COMPUTATIONS FOR USN/USA PRECISION APPROACH RADAR. Par 2, Appendix 2.

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.

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		

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

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)

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.

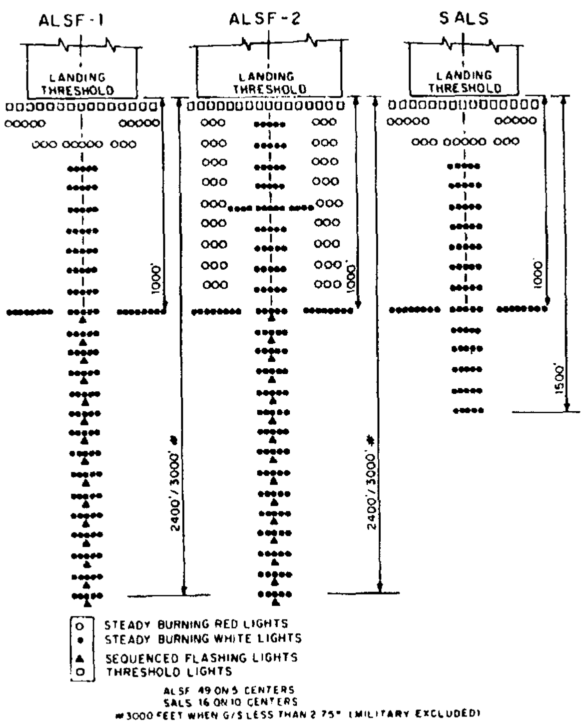


Figure 134 APPROACH LIGHTING SYSTEMS.

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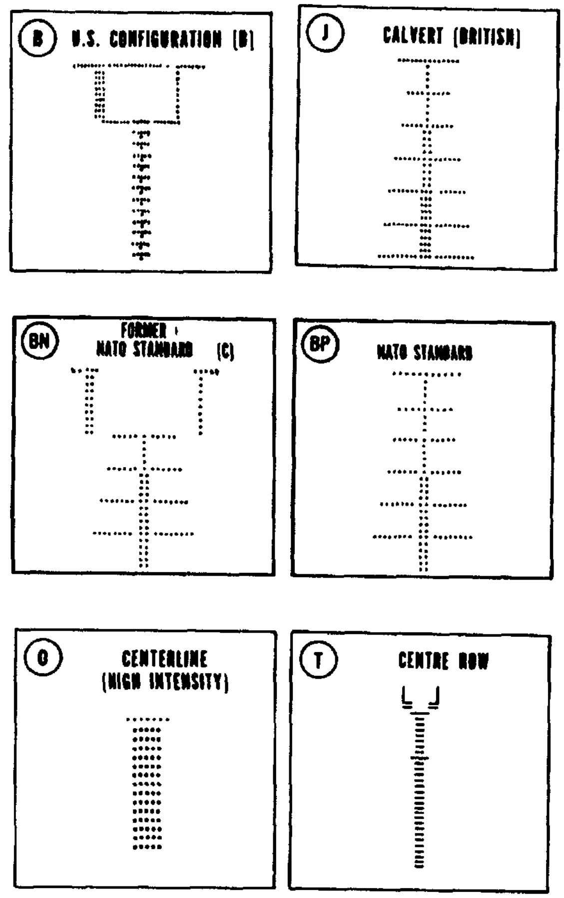


*

Figure 135. SYSTEMS EQUIVALENT TO U.S STANDARD A, ALSF—I

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.*

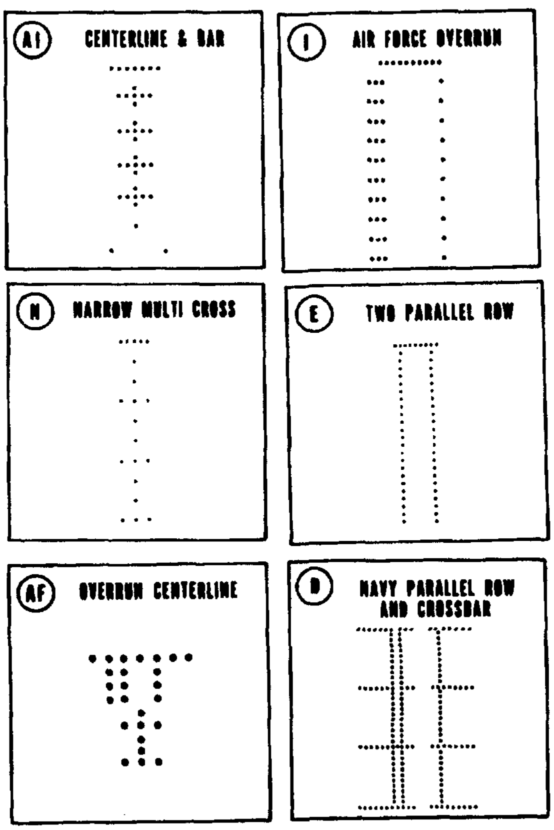


Figure 136. SYSTEMS EQUIVALENT TO SALS, SSALS, SSALF, MALS, AND MALSF.

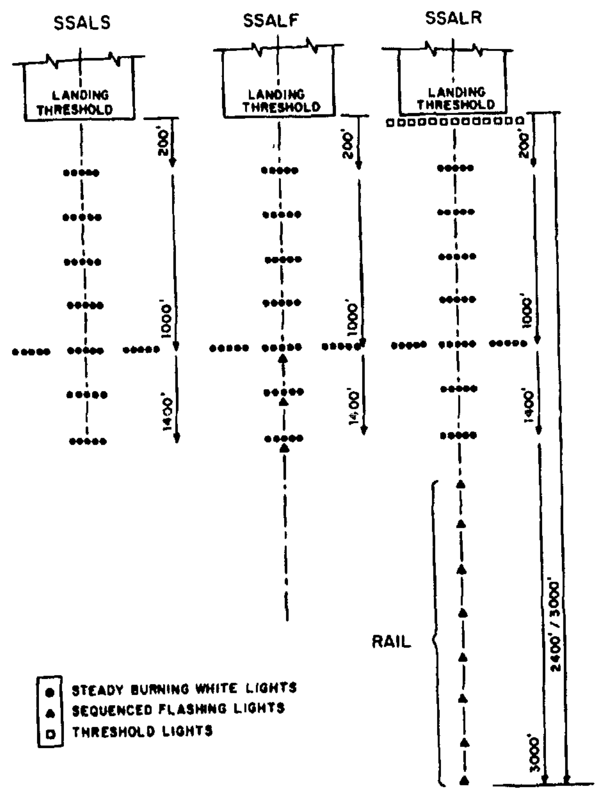


Figure 137. SIMPLIFIED SHORT APPROACH LIGHTING SYSTEMS *

* *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)

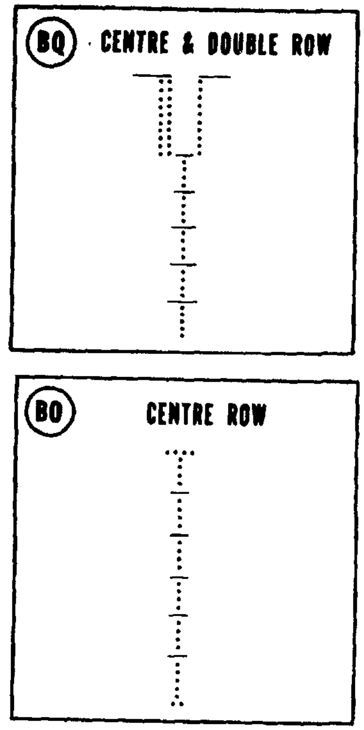


Figure 138. SYSTEMS EQUIVALENT TO SSALR AND MALSR.

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. *

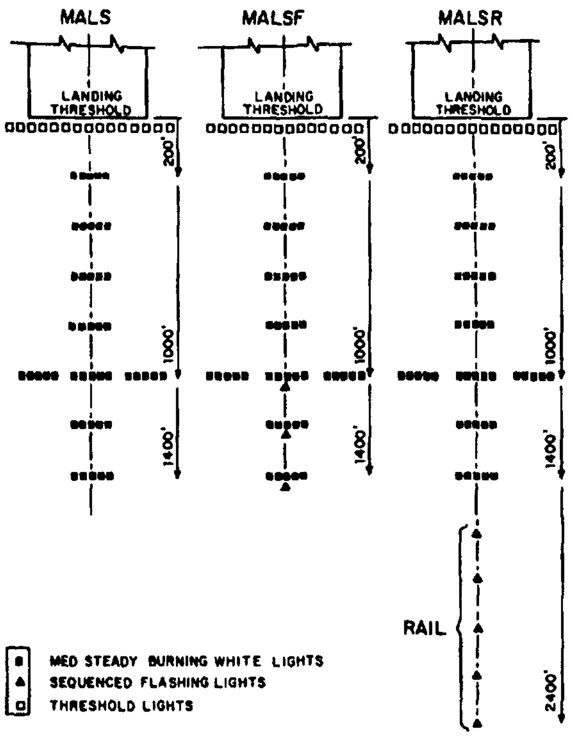


Figure 139. MEDIUM INTENSITY APPROACH LIGHTING SYSTEMS.

(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.

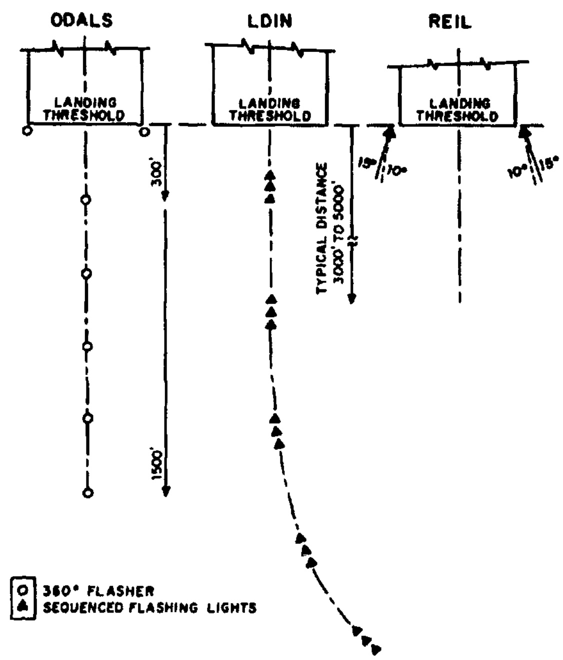


Figure 140. OMNIDIRECTION, LEAD-IN, AND RUNWAY END IDENTIFIER LIGHTING SYSTEMS

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.

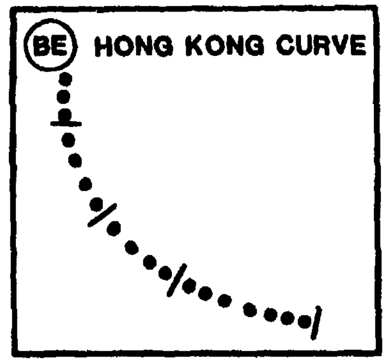


Figure 142. SYSTEM EQUIVALENT TO LDIN.

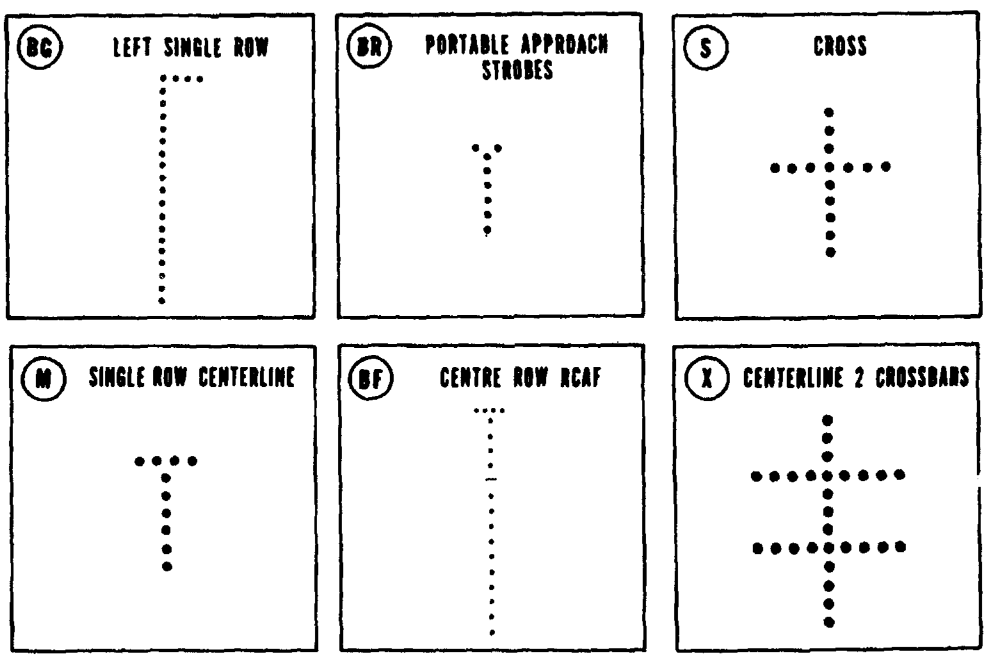


Figure 141. SYSTEMS EQUIVALENT TO U.S. ODALS paragraph 8, appendix 5.

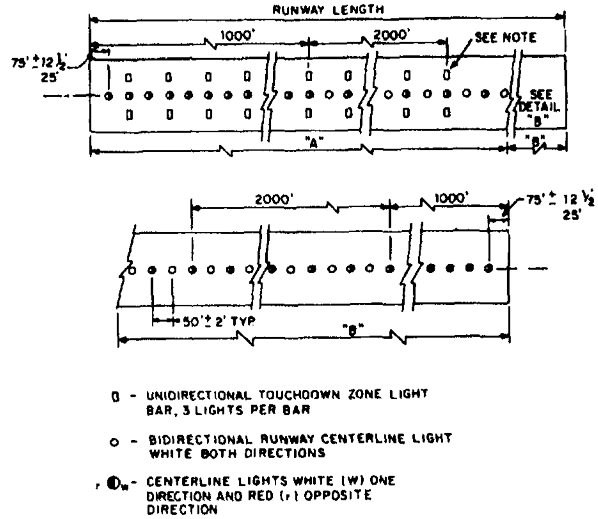
*

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.

ALPHABETICAL INDEX

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.

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		14 thru 16	2/79
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Pages 11 and 12	7/76	Page 11	7/76
		12	2/79

J. A. Ferrarese

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

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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

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Kenneth S. Hunt

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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.

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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.

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Director of Flight Operations

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.

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Remove Pages	Dated	Insert Pages	Dated
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		182	11/15/83

William Brennan

William T. Brennan
·ting Director of Flight Operations

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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.

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		66	1/27/84
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William T. Brennan
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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.

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180	6/80	180	6/80

Kenneth S. Hunt

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CHANGE

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FEDERAL AVIATION ADMINISTRATION

8260.3B CHG 8

3/24/86

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 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).

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21 and 22	4/1/83	21	3/24/86
		22	4/1/83

William T. Brennan
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CHANGE

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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.

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		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

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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.

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		44	4/1/83

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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 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. PURPOSE. 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. DISPOSITION OF TRANSMITTAL. 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 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 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 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
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78	4/1/83	78	9/10/93
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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

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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
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 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.

PAGE CONTROL CHART

REMOVE PAGES	DATED	INSERT PAGES	DATED
vii (thru ix)	7/26/90		
x	9/10/93		
xi (thru xiii)	7/26/90		
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xvi (thru xx)	7/26/90	vii (thru xix)	2/13/98
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7	12/6/84		
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13	12/6/84		

Distribution: A-W(FS/AT/AS/ND)-2; AVN-100 (100 cys); AMA-200 (80 cys)
A-X(FS)-2; and Special Military and Public Addressees

Initiated By: AFS-420

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REMOVE PAGES	DATED	INSERT PAGES	DATED
14	3/12/93		
15 (thru 21)	3/24/86		
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41	5/7/92		
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43	9/10/93	39 (thru 43)	2/13/98
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45 (thru 47)	7/76	45(thru 47)	2/13/98
48	7/76	48	7/76
49 (and 50)	7/76	49 (and 50)	2/13/98
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		
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84 (and 85)	3/12/93	77 (thru 85)	2/13/98
86	9/10/93	86	9/10/93
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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
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APPENDIX 2		APPENDIX 2	
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6 (thru 8)	7/76		

PAGE CONTROL CHART (Continued)

REMOVE PAGES	DATED	INSERT PAGES	DATED
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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 | **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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REMOVE PAGES	DATED	INSERT PAGES	DATED
1 thru 6	2/13/98	1	2/13/98
		2 thru 5 (and 6)	11/12/99
13 and 14	2/13/98	12-1 thru 14	11/12/99
21 thru 26	2/13/98	21	2/13/98
		22 thru 26-1	11/12/99
31 thru 34	2/13/98	31	11/12/99
		32	2/13/98
		33	11/12/99
		34	2/13/98
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		41	2/13/98
		42	11/12/99
		43	2/13/98
44	5/21/92	44	5/21/92
44-1 (and 44-2)	4/1/83	44-1 (and 44-2)	4/1/83
89 (and 90)	2/13/98	89 (and 90)	11/12/99
15-11 and 12	2/13/98	15-11	11/12/99
		15-12	2/13/98

L. Nicholas Lacey
Director, Flight Standards Service

U.S. Department
of Transportation

**Federal Aviation
Administration**

Directive Feedback Information

Please submit any written comments or recommendations for improving this directive, or suggest new items or subjects to be added to it. Also, if you find an error, please tell us about it.

Subject: Order 8260.3B CHG 18, United States Standard for Terminal Instrument Procedures (TERPS)

To: DOT/FAA
ATTN: Flight Procedure Standards Branch, AFS-420
PO Box 25082
Oklahoma City, OK 73125

(Please check all appropriate line items)

An error (procedural or typographical) has been noted in paragraph ______ on page ______.

Recommend paragraph ______ on page ______ be changed as follows:
(*attach separate sheet if necessary*)

In a future change to this directive, please include coverage on the following subject:
(*briefly describe what you want added*):

Other comments:

I would like to discuss the above. Please contact me.

Submitted by: ________________________________ Date: ______________

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