ORDER | **8260. 53**

STANDARD INSTRUMENT DEPARTURES THAT USE RADAR VECTORS TO JOIN RNAV ROUTES

July 25, 2005

U. S. DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

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

Initiated by: AFS-420

RECORD OF CHANGES

8260.53

CHANGE TO BASIC	SUPPLEMENTS			OPTIONAL USE	CHANGE TO BASIC	SUPPLEMENTS			OPTIONAL USE

FOREWORD

This order provides the criteria to evaluate the use of radar vectors to join the initial departure fix (IDF) of an area navigation (RNAV) standard instrument departure (SID). This document is to be used in conjunction with the latest editions of Orders 8260.3, United States Standard for Terminal Instrument Procedures (TERPS); 8260.44, Civil Utilization of Area Navigation (RNAV) Departure Procedures; and 8260.46, Departure Procedure (DP) Program.

Area navigation offers significant advantages in establishing routes for departures. However, due to difficulties in implementation, there was a moratorium on developing new RNAV SIDs during 2003 and part of 2004. Radar vectoring affords the flexibility of routing and allows an aircraft to attain sufficient altitude/distance to achieve a satisfactory navigation solution prior to using RNAV.

James J. Ballough
Director, Flight Standards Service

TABLE OF CONTENTS

Page

STANDARD INSTRUMENT DEPARTURES THAT USE RADAR VECTORS TO JOIN RNAV ROUTES

TABLE OF CONTENTS (Continued)

Page

TABLE OF CONTENTS (Continued)

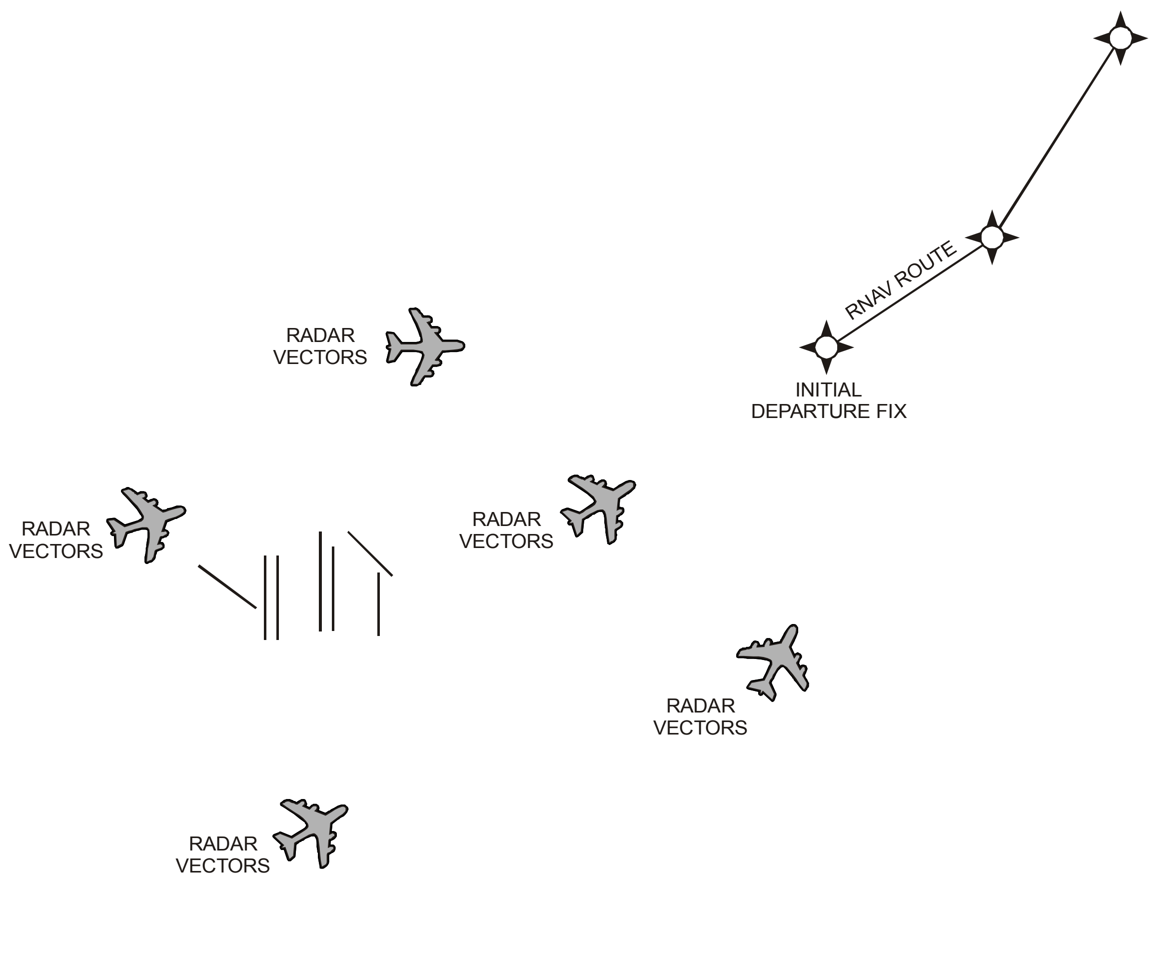
Page

STANDARD INSTRUMENT DEPARTURES THAT USE RADAR VECTORS TO JOIN RNAV ROUTES

1.0 PURPOSE.

This order provides the criteria to evaluate the use of radar vectors to join the initial departure fix (IDF) of an RNAV standard instrument departure (SID). As a matter of operational necessity, Air Traffic (AT) may require the use of radar vectors to pre-position departing aircraft prior to authorizing area navigation (RNAV) (see figure 1). This order is to be used in conjunction with the latest editions of Orders 8260.3, United States Standard for Terminal Instrument Procedures (TERPS); 8260.44, Civil Utilization of Area Navigation (RNAV) Departure Procedures; and 8260.46, Departure Procedure (DP) Program.

Figure 1. Radar Vectors to Join RNAV Routes



2.0 DISTRIBUTION.

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

3.0 EFFECTIVE DATE. September 1, 2005

4.0 BACKGROUND.

RNAV operations offer significant advantages in establishing routes for departures. However, due to difficulties in implementation, there was a moratorium on developing new RNAV SIDs during 2003 and part of 2004. Radar vectoring affords flexibility of routing and allows an aircraft to attain sufficient altitude/distance to achieve a satisfactory navigation solution prior to using RNAV.

5.0 DEFINITIONS.

NOTE: Additional definitions and explanations are in Orders 8260.3, Volume 4; 8260.44; and in the Aeronautical Information Manual (Pilot/Controller Glossary).

5.1 ALONG-TRACK (ATRK) Fix Displacement Tolerance (FDT).

The FDT measured along the designated flight track (see paragraph 5.10).

5.2 AREA NAVIGATION (RNAV).

RNAV operations provide enhanced navigational capability to the pilot. RNAV equipment can compute the airplane position, actual track and ground speed, and then provide meaningful information relative to a route of flight selected by the pilot. Typical RNAV equipment will provide the pilot with distance, time, bearing, and cross-track error relative to the selected “TO” or “active” waypoint (WP) and the selected route. Several navigational systems with different performance characteristics are capable of providing area navigational functions. Present day RNAV includes inertial navigation system (INS), distance measuring equipment (DME/DME), global positioning system (GPS), and wide area augmentation system (WAAS). Modern multi-sensor systems can integrate one or more of the above sensors/systems to provide a more accurate and reliable navigational system. Due to the different levels of performance, the wide range of RNAV capabilities can provide diverse airspace solutions incorporating different levels of lateral obstacle clearance protection.

5.3 CLIMB GRADIENT (CG).

Aircraft climb requirement expressed in feet per nautical mile (NM) or percentage; i.e. 200 ft/NM or 3.29% (see paragraphs 7.6 and 8.6).

5.4 CROSS-TRACK (XTRK) FDT.

The FDT measured perpendicular left or right of the designated flight track (see paragraph 5.10).

5.5 DEPARTURE END OF RUNWAY (DER).

The end of the area declared suitable for takeoff.

5.6 DEPARTURE ALTITUDE.

An altitude at the end of the departure evaluation area that satisfies the requirements for en route operations or for off route/off airway operations.

5.7 DEPARTURE PROCEDURE TERMINATION FIX.

The fix that ends the RNAV SID route, and may be located either within the en route structure or outside the en route structure (using transitions to enter the en route structure).

5.8 DISTANCE OF TURN ANTICIPATION (DTA).

A distance preceding a fly-by waypoint (WP) at which an aircraft is expected to start a turn to intercept the course/track of the next segment.

5.9 DME/DME NAVIGATION.

The use of distance measuring equipment (DME) facilities for navigation.

5.10 FIX DISPLACEMENT TOLERANCE (FDT).

The FDT is the largest distance from the plotted position of a waypoint/fix for an aircraft attempting to fly over the waypoint/fix considering all system error components. (Also see Waypoint Displacement Area/Fix Displacement Area, ATRK, and XTRK.) See paragraphs 5.1 and 5.4.

5.11 FLY-BY WAYPOINT.

A waypoint where a turn is initiated prior to reaching the fix/waypoint.

5.12 FLY-OVER WAYPOINT.

A waypoint over which an aircraft is expected to fly before the turn is initiated.

5.13 GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS).

The GNSS is a worldwide position and time determination system, which includes one or more satellite constellations, aircraft receivers, and system integrity monitoring. GNSS is augmented as necessary to support the required navigation performance for the actual phase of operation. The U.S. GNSS is the Global Positioning System.

5.14 GLOBAL POSITIONING SYSTEM (GPS).

GPS is a U. S. satellite-based radio navigational, positioning, and time transfer system operated by the Department of Defense (DOD). The system provides highly accurate position and velocity information and precise time on a continuous global basis to an unlimited number of properly equipped users.

5.15 INERTIAL REFERENCE UNIT (IRU).

Airborne equipment that can be used for navigation even during periods without sensor inputs. An IRU uses gyros and the previous sensor inputs, or ground reference points, to dead reckon until regaining sensor reception.

5.16 INITIAL CLIMB AREA (ICA).

An area beginning at the DER to provide unrestricted climb to at least 400 ft above DER elevation.

5.17 INITIAL DEPARTURE FIX (IDF).

The first published fix/waypoint used for the departure. In this order, the IDF denotes the beginning of the RNAV portion of the SID.

NOTE: IF is used for coding (per ARINC 424) of the IDF. The "IF" acronym is also used in conjunction with the intermediate fix of an instrument approach procedure.

5.18 OBSTACLE AREAS AND SURFACES.

5.18.1 Obstacle Evaluation Area (OEA) or Obstacle Clearance Area (OCA).

The area, defined by criteria, that is evaluated for obstacles.

5.18.2 Obstacle Clearance Surface (OCS).

A surface within the OEA/OCA where obstacle penetrations are not allowed. The OCS may be either an inclined surface or a flat surface. The required obstruction clearance (ROC) (sometimes referred to as required obstacle clearance) is the difference between the OCS and the lowest planned aircraft altitude.

5.18.3 Obstacle Identification Surface (OIS).

An OIS is the surface within the OEA/OCA where the surface is not required to clear obstacles, but the more prominent obstacles must be mitigated or identified for use in aircrew planning and operation. An example of mitigation of an OIS penetration is establishing a minimum climb gradient to raise the OCS above an obstacle. An example where the more prominent obstacles that penetrate an OIS must be identified for use in aircrew planning and operation is the initial climb area for the first 200 ft of climb after takeoff.

NOTE: The terms OIS and OCS are sometimes used interchangeably. As used in this document, they are not interchangeable; they differ in regard to whether it is allowable to have penetrations of the surface.

5.19 PILOT NAVIGATION AREA (PNA).

An area used to transition from radar vectoring to the area navigation route. The PNA is bounded by two lines, represented by the maximum intercept courses leading to the IDF, enclosed by an arc of specified radius centered on the IDF (see figure 3 and paragraph 8.0).

5.20 RADAR VECTOR AREA (RVA).

The area in which radar vectors are provided. The RVA extends from the runway(s) to the PNA arc boundary (see figure 3 and paragraph 7.0).

5.21 REQUIRED NAVIGATION PERFORMANCE (RNP).

A statement of the required navigational performance for operation within a defined airspace. Note that there may be additional requirements beyond accuracy applied to a particular RNP level.

5.22 RNAV MINIMUM RECEPTION ALTITUDE (MRA).

The minimum altitude required to form an RNAV solution. This is based on the minimum height/altitude that aircraft systems can begin RNAV operations, that flight procedures allow the use of RNAV, and that available sensors can generate an RNAV solution. The RNAV MRA depends on the navigation source required for the SID (see paragraph 6.3).

5.23 RNAV ROUTE.

The RNAV route begins at the IDF and contains all subsequent segments including transitions (see figure 3 and paragraph 9.0).

5.24 STANDARD INSTRUMENT DEPARTURE (SID).

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

5.25 TERPS.

Order 8260.3, United States Standard for Terminal Instrument Procedures.

5.26 WAYPOINT (WPT).

An RNAV fix defined in terms of latitude/longitude coordinates. Waypoints are used to establish beginning and ending points of RNAV departure route segments.

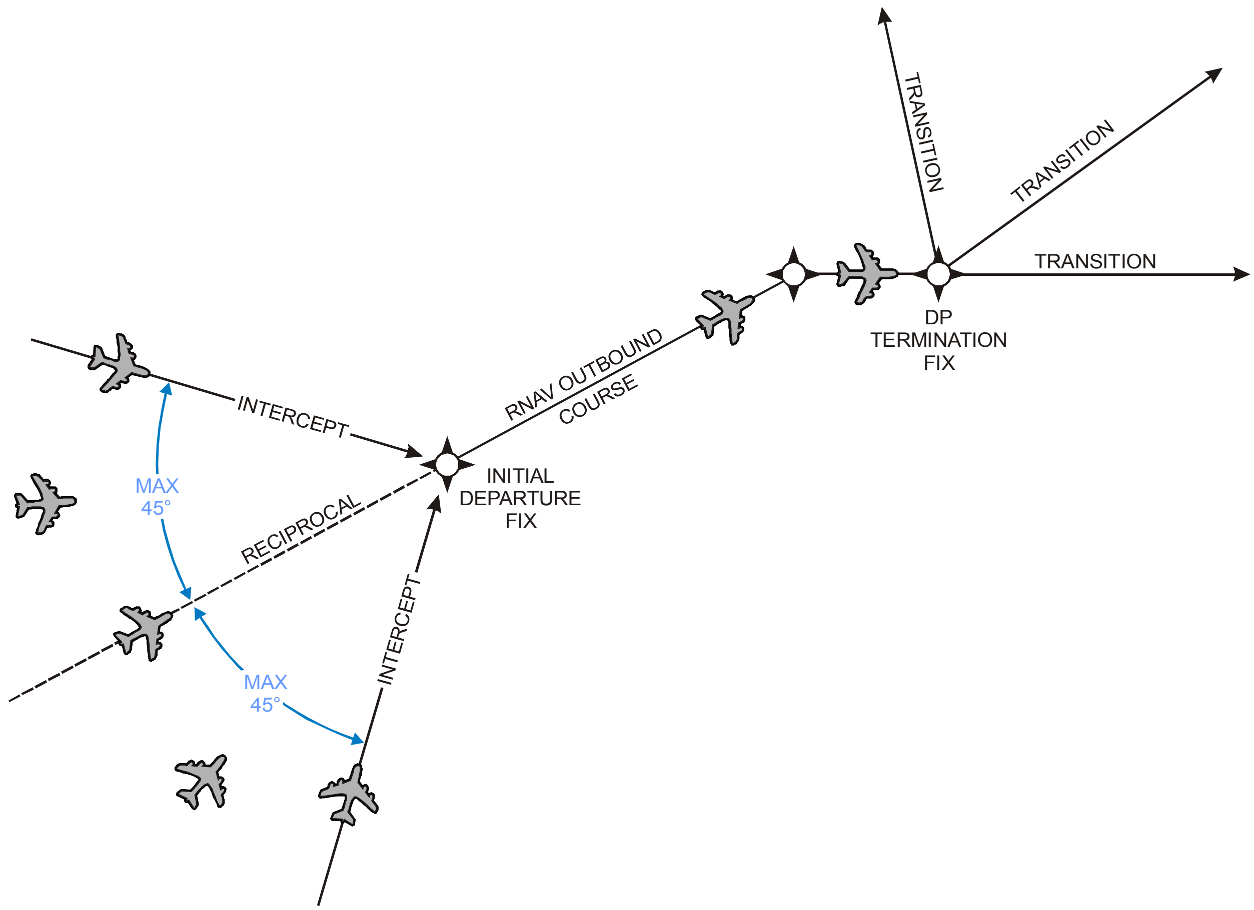
5.27 WAYPOINT DISPLACEMENT AREA/FIX DISPLACEMENT AREA.

The rectangular area formed around and centered on the plotted position of a waypoint/fix. This describes the region in which the aircraft could be placed when attempting to fly over the waypoint considering all system error components. Its dimensions are plus-and-minus the appropriate along-track and cross-track fix displacement tolerance values. (Also see Fix Displacement Tolerance.)

6.0 GENERAL.

When a SID begins with radar vectors, it may serve one or more runways at single or multiple airports. En route transitions are permitted. However, transitions must not originate at the IDF. A single RNAV course must be defined from the IDF. Terminate the basic DP at or beyond the first WP encountered after the IDF. Establish the termination fix within the en route structure OR, provide a transition(s) from the termination fix to the en route structure (see figure 2).

Figure 2. RNAV Route



6.1 PROCEDURE IDENTIFICATION.

See Order 8260.46, appendix 2.

6.2 INITIAL DEPARTURE FIX (IDF).

The IDF must be a fly-by waypoint. A track to fix (TF) leg must follow the IDF.

6.2.1 Placement.

Locate the IDF within the distance requirements outlined in paragraphs 7.0 and 8.0. Coordinate the location of the IDF with Air Traffic.

6.2.2 SID Limited to One Initial Departure Fix.

Each SID is limited to one IDF. Where more than one IDF is required, an additional SID(s) must be developed.

6.2.3 Maximum Intercept Angle.

The maximum intercept angle to join the IDF is ± 45° relative to the reciprocal of the RNAV course outbound from the IDF (see figure 2).

6.3 RNAV MINIMUM RECEPTION ALTITUDES.

6.3.1 GPS, GNSS, or DME/IRU RNAV Minimum Reception Altitude.

To establish the MINIMUM RNAV reception altitude for SIDs that require GPS, or GNSS, or IRU, use no less than the designated height above the DER elevation. That height will be 2,000 ft for Type A procedures or 500 ft for Type B procedures.

6.3.2 DME/DME RNAV Minimum Reception Altitude (MRA).

To establish the MINIMUM RNAV reception altitude for SIDs that authorize DME/DME, use no less than 2,000 ft above the DER or the computer model predicted altitude, whichever is higher. The computer model prediction is subsequently verified through flight inspection.

6.3.3 **RNAV MRAs** will be rounded up (not rounded down). Typical rounding is to the next higher 100-ft (MSL) increment.

NOTES:

1. The RNAV MRA based on DME/DME inputs is usually higher than the RNAV MRA based on GPS/GNSS inputs or the use of IRU.
2. The RNAV MRA is location specific; the RNAV MRA might be higher at location X than at location Y.
3. The RNAV MRA denotes the availability of PCG.
4. See paragraphs 7 through 9 for additional factors that apply to establishing altitudes.

6.3.4 **The altitude for each subsequent segment** of the departure must be at or above the altitude of the previous segment, even if the subsequent segment would qualify for a lower altitude due to lower MRA and lower obstacles/terrain.

6.4 CLIMB GRADIENT.

Climb gradients are used in this order for either obstacle clearance or to reach the RNAV MRA or an ATC required altitude. Gradients in excess of 200 ft per NM are to be submitted for publication. When a climb gradient is required in order to reach the RNAV MRA, submit that climb gradient for publication as an ATC climb gradient, not an obstacle climb gradient. If there is a requirement for both an obstacle climb gradient and an ATC climb gradient, always publish the obstacle climb gradient. Publish the ATC climb gradient when it is higher than the obstacle climb gradient.

6.5 SID OVERVIEW.

A SID incorporating radar vectors to join RNAV (see figure 3) is comprised of:

6.5.1 **A radar vector area** (see paragraph 7.0),

6.5.2 **A pilot navigation area** (see paragraph 8.0), and

6.5.3 **An RNAV route** (see paragraph 9.0).

Figure 3. SID Overview

7.0 RADAR VECTOR AREA (RVA).

Radar systems authorized to vector departing IFR aircraft may be used to vector to RNAV routes.

7.1 ALIGNMENT.

The radar area and the RNAV route must be aligned in a manner that meets the RNAV intercept requirements (± 45°). See paragraph 6.2.

7.2 AREA.

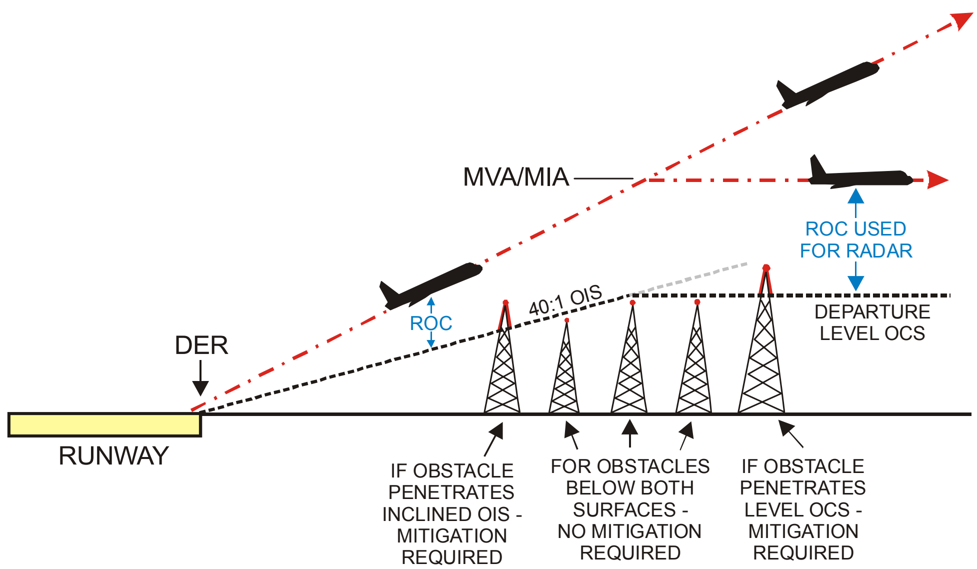
The obstacle evaluation area is the area available for radar vectoring for the SID.

NOTE: The area and minimum vectoring altitudes/minimum IFR altitudes (MVAs/MIAs), intended for radar vectoring to RNAV routes, are determined by Air Traffic and should be in the procedure request.

7.3 OBSTACLE CLEARANCE.

For each runway used in the SID, evaluate the RVA using an inclined obstacle surface and a level obstacle surface (see figure 4).

Figure 4. Departure Obstacle Evaluation Surfaces



7.3.1 Radar Departure Inclined Obstacle Evaluation Surfaces.

The purpose of an inclined (also called sloping or rising) obstacle identification surface or obstacle clearance surface is to ensure obstacle clearance for aircraft that are climbing. Because the evaluation uses a rising surface, procedures developed on the basis of this evaluation must not restrict the aircraft's climb until reaching the MVA/MIA.

7.3.1 **a. The departure inclined obstacle identification surface** rises at 40:1 from the DER, ICA baseline, runway, or from the edge of the initial climb area. For each runway authorized for the departure, evaluate for diverse departure as specified in Order 8260.3, Volume 4, chapter 2. Terminate the 40:1 OIS upon reaching the departure level OCS. When the inclined 40:1 OIS does not reach the departure level OCS in the RVA, continue the inclined 40:1 OIS evaluation in to the PNA.

7.3.1 **b. The departure inclined obstacle clearance surface** is used if obstacles penetrate the 40:1 OIS. Determine an OCS, at a steeper slope than the OIS, which will clear obstacles. See paragraphs 7.3.3 and 7.6 and figure 5.

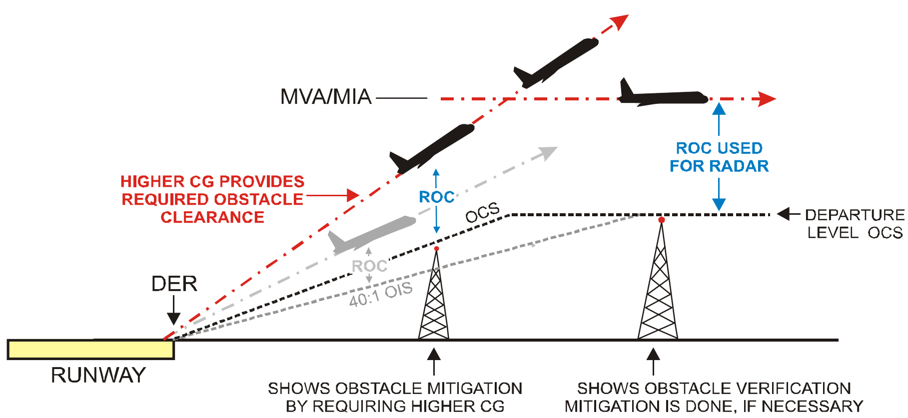
7.3.2 Radar Departure Level Obstacle Clearance Surface.

The purpose of the departure level OCS is to ensure obstacle clearance if the aircraft have to level off at the MVA/MIA. The level OCS is at an elevation equal to the MVA/MIA minus the ROC. The ROC is specified in applicable FAA directives used for developing MVAs/MIAs.

7.3.3 Mitigating Obstacle Penetrations.

If the 40:1 OIS is clear, departures are authorized in any direction from the evaluated runway and no further TERPS action is required (see figures 4 and 5). If the inclined OIS/OCS has obstacle penetrations, use the obstacle-avoidance methods described in Order 8260.3, Volume 4, and Order 8260.46, Departure Procedure (DP) Program, table 1, to mitigate the penetration(s), with the intended goal of retaining standard takeoff minimums and standard climb gradients to the extent possible.

Figure 5. Mitigating Obstacle Penetrations



7.3.4 Lateral Obstacle Clearance Below MVA/MIA.

If Air Traffic requests evaluation of an area(s) for vectoring below the MVA/MIA, provide data on any obstacle(s) that penetrates the OCS to allow appropriate buffers.

7.3.4 **a. The buffer distance**, 3 or 5 NM, for vectoring below an MVA/MIA is the same as the buffer distance for MVA/MIA chart sectors.

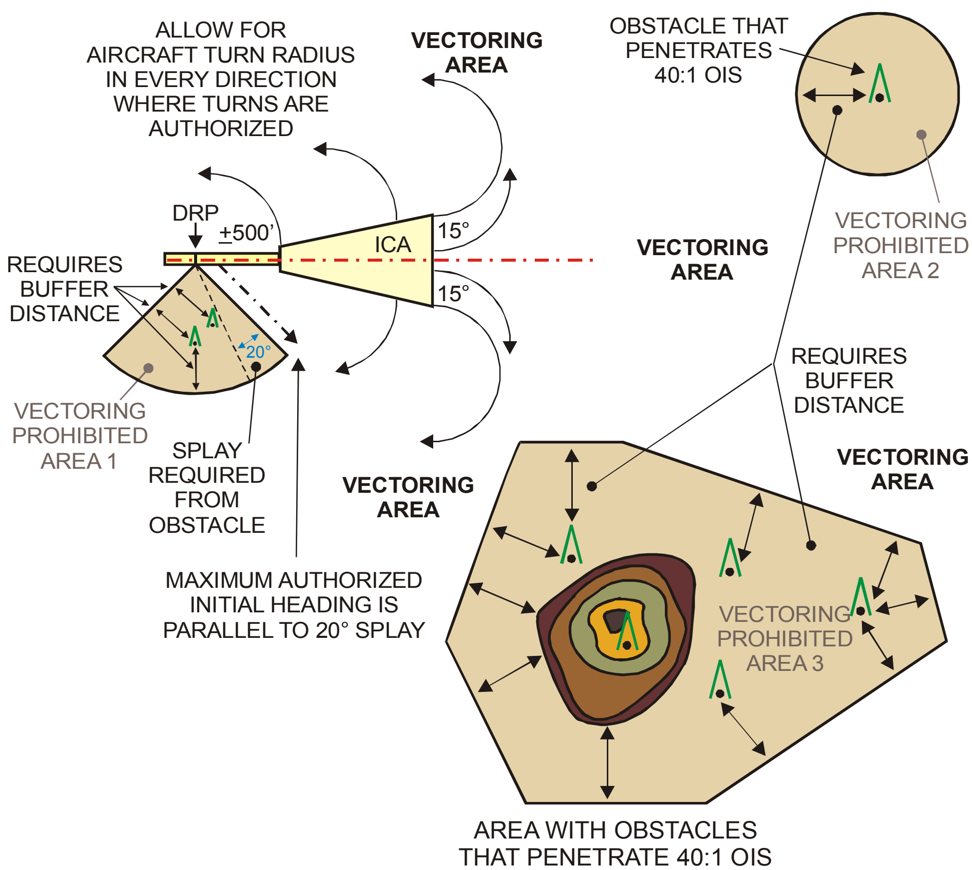
7.3.4 b. **The buffer area may be reduced**, near the departure runway, using the splay defined in Order 8260.3, Volume 4, paragraph 2.2, for the initial assigned heading(s). Note that the splay, as described and illustrated in TERPS paragraph 2.2, extends from the departure reference point (DRP), or from the ICA, or from the outer boundary radius of the first turn. The splay provides at least 20 degrees separation between the assigned initial headings and penetrating obstacles. One example is the vectoring prohibited area 1 in figure 6. Another example is the initial portion of the obstacle evaluation area in figure 8.

7.3.4 c. **The inclined OIS** originates from the ICAB, the runway, and the ICA. It extends upward within the vectoring areas and the buffer areas until reaching the level OCS associated with the MVA/MIA.

7.3.5 **Vectoring Prohibited Areas.**

7.3.5 a. **A vectoring prohibited area/sector is used to laterally avoid** the penetrating obstacle(s) (see figure 6). Boundaries of any vectoring prohibited area/sector must provide at least the buffer distance, described in paragraph 7.3.4, from all penetrating obstacle(s). Additional guidance is in Order 8260.3, Volume 4, paragraphs 2.2 and 2.3.

Figure 6. Example of Vectoring Prohibited Areas

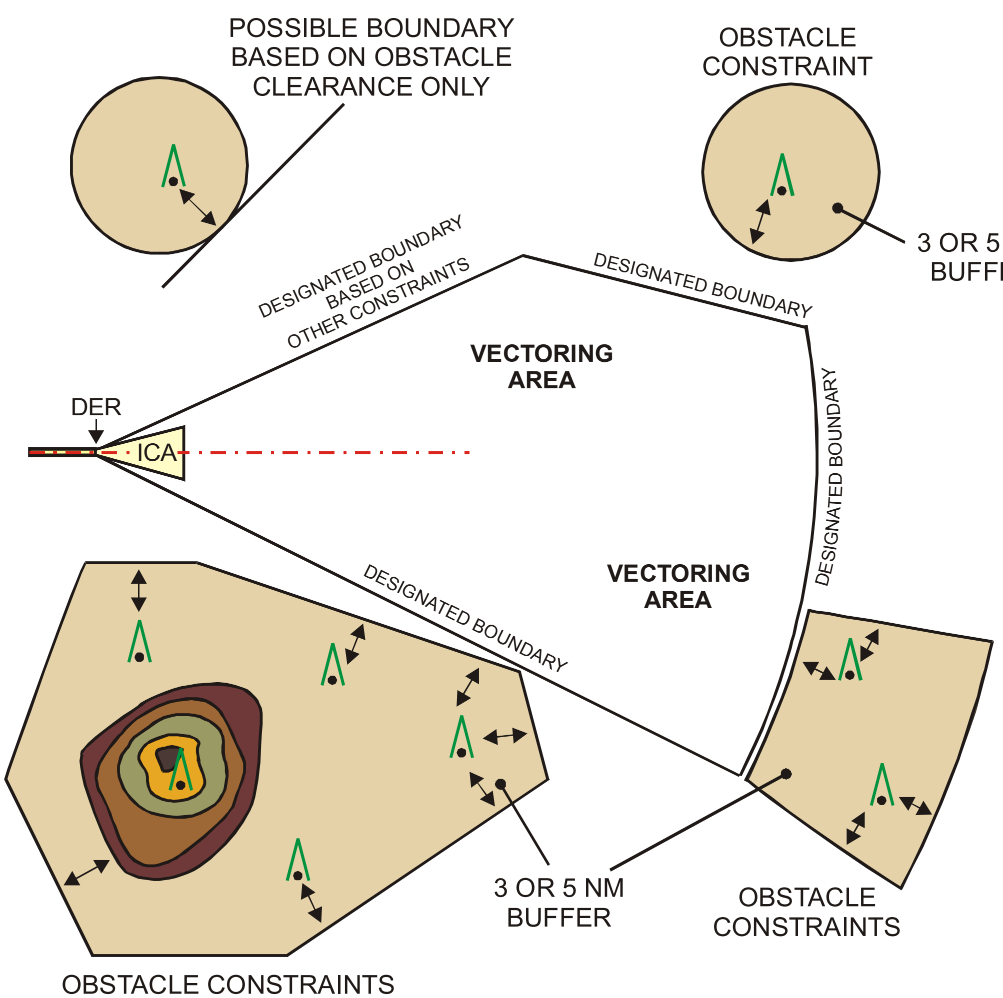


7.3.5 b. **To allow enough distance for aircraft to turn** prior to a vectoring prohibited area/sector, the distance between the ICA and the boundary of a vectoring prohibited area/sector, must be equal to or greater than an aircraft turn distance. Use a turn distance based on the "Outer Boundary Radius" in Order 8260.3, Volume 4, chapter 3, table 3-2. This minimum distance requirement does not apply to sectors used for the initial heading(s) from the runway. For example, in figure 6 the minimum distance requirement does not apply to vectoring prohibited area 1; but it does apply between the ICA and the boundary of vectoring prohibited areas 2 and 3.

7.3.6 Vectoring Within a Designated Boundary.

When requested by air traffic, evaluate a radar departure vectoring area/sector for obstacle clearance. The designated boundary must provide the obstacle clearance buffer distance from penetrating obstacles. The designated boundary may be moved further away from penetrating obstacles, for reasons such as air traffic flow, airspace, or environmental needs, but must not be moved closer than the buffer distance. See figure 7 for an example area.

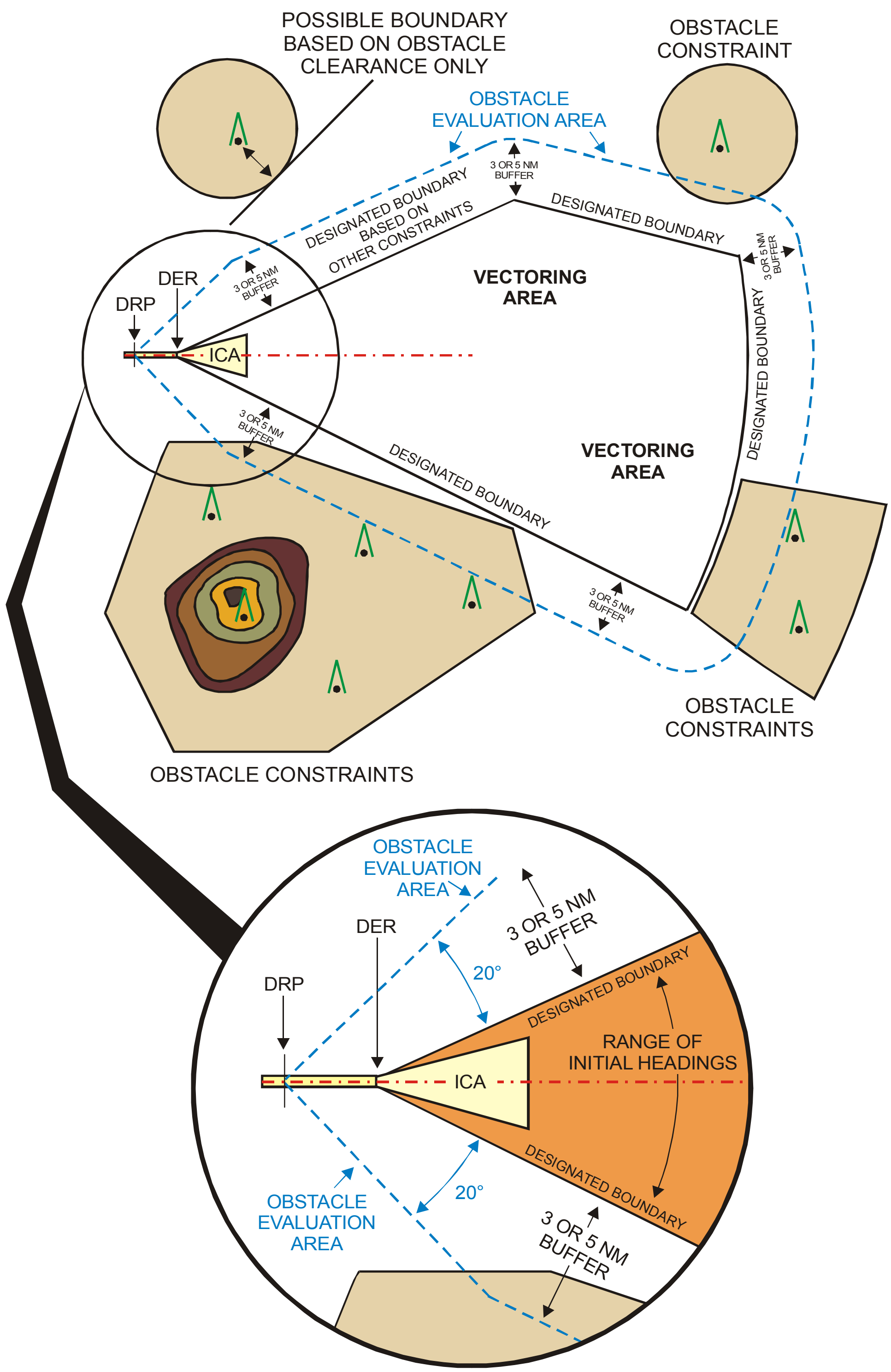
Figure 7. Vectoring Within a Boundary to Reach MVA/MIA



7.3.7 Obstacle Evaluation for Vectoring Within a Designated Boundary.

The obstacle evaluation area for a radar departure vectoring area/sector includes a buffer beyond the designated boundary of the vectoring area (see figure 8). Use the buffer distance described in paragraph 7.3.4.

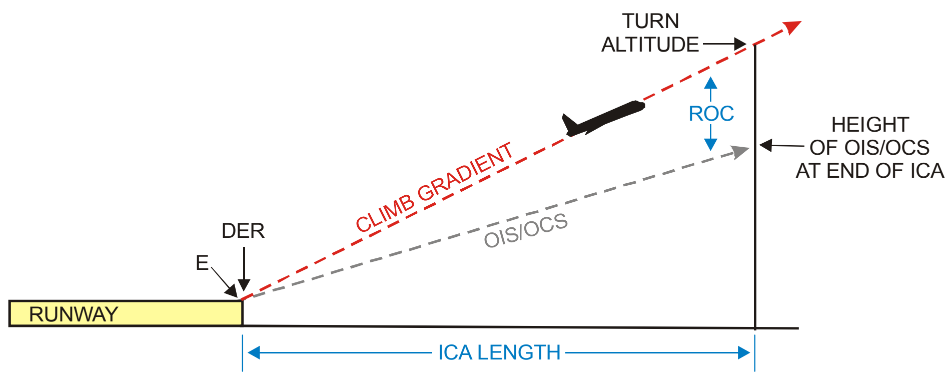
Figure 8. OEA for Vectoring Within a Boundary to Reach MVA/MIA



7.3.8 **Height of the OIS or OCS at the Runway/ICA Boundary.**

7.3.8 **a. For an initial climb to 400 ft**, the height of the OIS or OCS at the ICA end is 303.81 ft above the DER elevation.

Figure 9. Height of ICA Obstacle Clearance Surface - Profile View



7.3.8 **b. When climbing to an altitude higher than 400 ft** above the DER, calculate the height of the OIS or OCS (HOCS) at the end of the ICA (see figure 9), based on the turn altitude, as follows:

$$HOCS = ((\text{Turn Altitude} - E) \times .76) + E$$

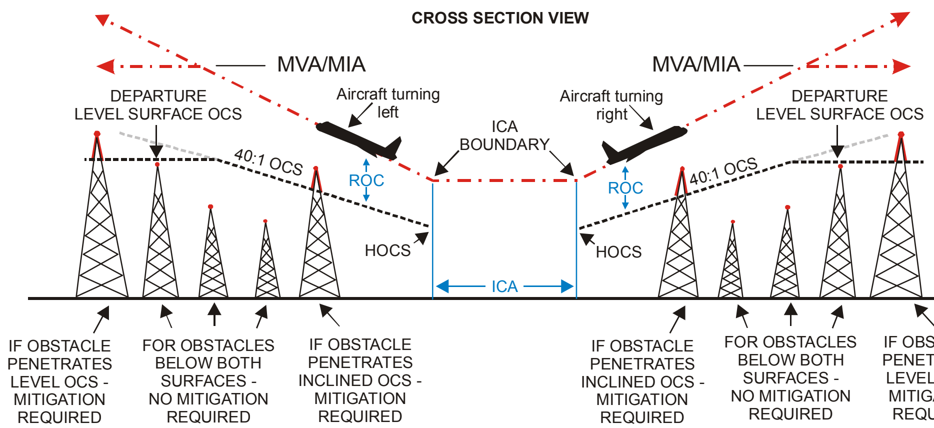
Where:

HOCS = Height (MSL) of the origin, at end of ICA, for OIS/OCS measurements
Turn Altitude = Lowest altitude authorized for the first turn after departure
DERe = Departure end of runway (DER) elevation
E = Origin starting elevation, at DER/ICAB. Use DERe for ICA calculations.
ICAB = Initial Climb Area Baseline

NOTES:

1. Use this formula where the initial climb is to an altitude rather than a fix or distance.
2 If various turn altitudes are allowed, use the lowest altitude for this calculation. When a specific turn altitude is not assigned, use DERe + 400 ft.
3. For the value ".76," in the departure obstacle surface formulas, you may substitute a value with a greater number of digits; for example, you may substitute ".7595" or ".759514435" for the ".76."
4. DOD procedures may use the DOD option in Order 8260.3, Volume 4, paragraph 1.4.1, as follows: HOCS = Turn Altitude – ROC, Where ROC = 48 X length of ICA, Where length of ICA = (Turn Altitude – E) / CG.
5. If the ICA OIS has penetrations of 35 ft or less, also use Order 8260.3, Volume 4, paragraph 1.3, and applicable policy letters. Note that the applicable policy letters, and paragraph 1.3, as modified, address using a runway length reduction rather than an origin increase as allowed by the earlier (superseded) criteria.

Figure 10. Height of Obstacle Clearance Surface - Cross Section View



7.3.8 **c. For evaluating "diverse A area" obstacles,** use the height of the OIS/OCS (HOCS) at the ICA end (MSL) as the origin elevation at the ICA boundary (see figure 10). The "diverse A area" is based on Order 8260.3, Volume 4, paragraph 2.1. It includes obstacles to the side of the runway, to the side of the ICA, or beyond the ICA and outside of the ICA splay.

NOTE: This order modifies the "diverse A area" to exclude the extended splay area, which is grouped with the ICA in order to base the CG calculations from the DER/ICAB rather than the end of the ICA.

7.3.8 **d. For evaluating "diverse B area" obstacles,** the OIS/OCS origin elevation, at the DRP, is at least 400 ft above the airport elevation. If the turn altitude is higher than 400 ft above the airport elevation, the "diverse B area" origin elevation equals the turn altitude (MSL). See figure 10. The "diverse B area" is determined using Order 8260.3, Volume 4, paragraph 2.1 and includes obstacles, encountered after turning, that are behind the departure reference line.

7.4 RVA ALTITUDE.

The RVA minimum altitude is the altitude to which aircraft must climb before a level off is allowed. Plan on the RVA altitude(s) being the applicable MVA/MIA from existing radar procedures, unless Air Traffic requests a redesign.

7.5 MINIMUM DISTANCE.

The distance from the DER to the PNA boundary must be sufficient to allow aircraft to reach the PNA minimum altitude (see paragraphs 8.4 and 8.5).

7.6 CLIMB GRADIENT.

Apply the standard climb gradient of 200 ft per NM from Order 8260.3, Volume 4 unless a higher gradient is required by the calculations below. Before implementing a higher than standard CG also consider relocating the IDF and/or the PNA.

7.6.1 CG Calculations to Mitigate a Penetration of the Inclined OIS.

The obstacle climb gradient calculation for the inclined OCS depends on the location of the obstacle. For obstacles within the ICA or within the extended splay lines of the ICA (figure 11), use paragraph 7.6.2. For all other obstacles within the OEA, use paragraph 7.6.3.

7.6.2 CG for the ICA and Straight-Ahead Portion of Climb.

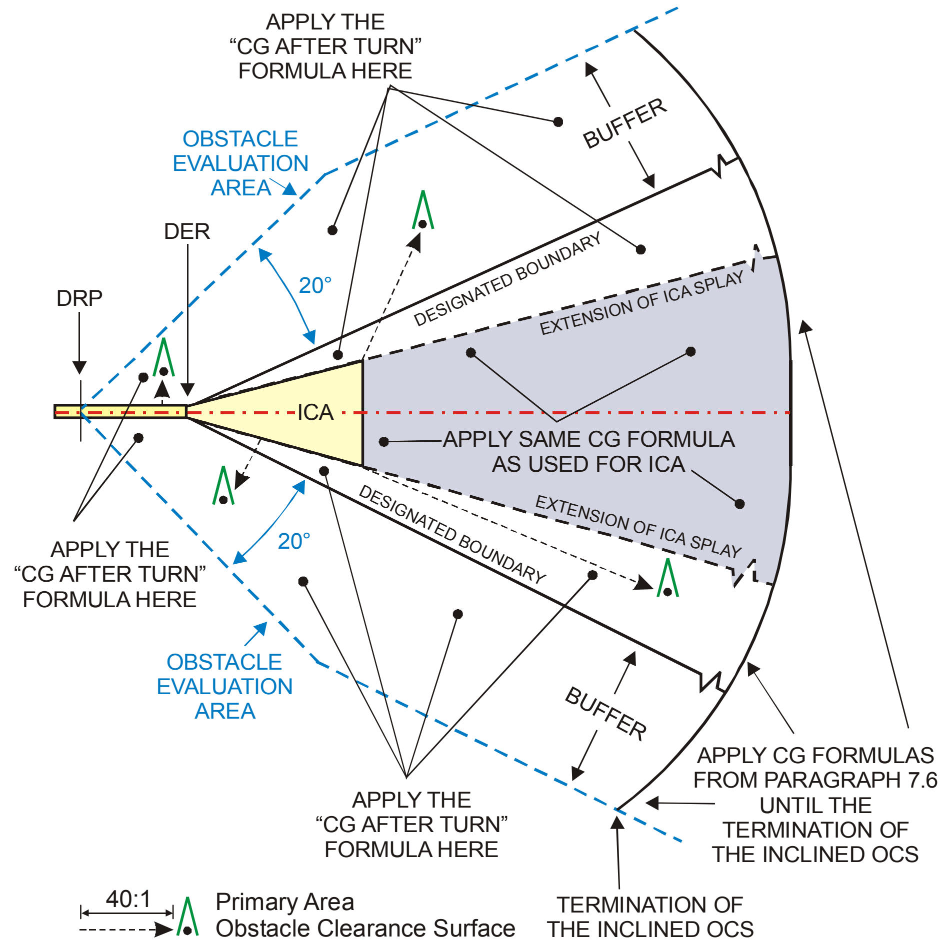
7.6.2 a. The evaluation of the straight-ahead portion of the climb extends to the termination of the OIS originating at the DER.

7.6.2 a. (1) The termination altitude of the inclined OIS equals the level OCS, which is in each MVA/MIA sector, the MVA/MIA minus the ROC.

7.6.2 a. (2) The distance (in feet) from the DER to the OIS/OCS termination is calculated by multiplying the OIS/OCS slope times the rise of the OIS/OCS. The rise is the termination altitude minus the origin (DER) elevation.

NOTE: This distance to the OIS/OCS termination will also be used in paragraph 8.6.3.

Figure 11. Inclined OIS Measurements and Climb Gradient Calculations



7.6.2 **b. For obstacles within the ICA or within the extended splay** lines of the ICA and prior to the termination of the OIS originating at the DER, determine the obstacle clearance climb gradient from the DER/ICAB to an obstacle as follows:

$$CG = \frac{O - E}{.76\,D}$$

Where

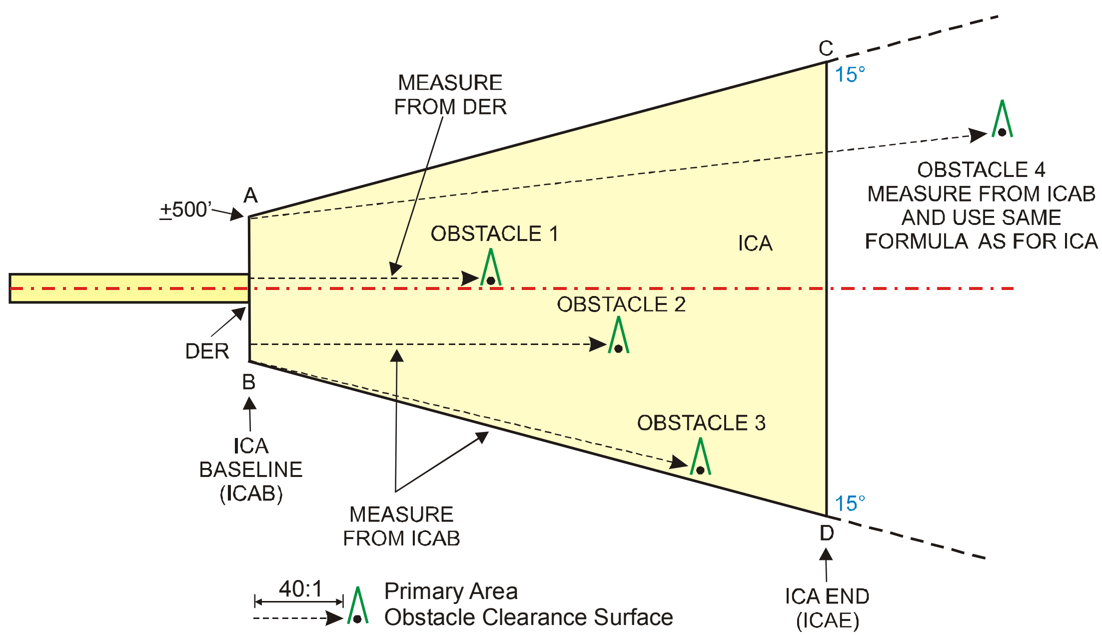
CG = Climb gradient, in ft per NM, that provides the minimum ROC
O = Obstacle (MSL) elevation
E = CG origin starting (MSL) elevation. Use DERe as the origin elevation for obstacles within the ICA or within the extended splay lines of the ICA.
D = Distance (NM) from DER or ICA baseline (ICAB). See figure 12.

NOTES:

1. CG formula is from Order 8260.3, Volume 4, Chapter 1, paragraph 1.4.1. DOD procedures may use the DOD option in paragraph 1.4.1.
2. In addition to obstacles within the ICA, this CG formula also applies to obstacles beyond the ICA that are within the extension of the ICA splay lines

and prior to the termination point of the inclined OIS that originates from the DER. See figures 11 and 12 for RVA obstacles.
3. Measurements for obstacle distance (D) for CG calculations are made from the same origin as the measurements for the OIS/OCS calculations.
4. If the CG is required to avoid obstacles within 3 statute miles of the DER, provide ceiling and visibility values as an alternative to the CG. See Order 8260.46, table 1.
5 If the ICA OIS has penetrations of 35 ft or less, use Order 8260.3, Volume 4, paragraph 1.3, and applicable policy letters. Note that the applicable policy letters, and paragraph 1.3 as modified, address using a runway length reduction rather than an origin increase as allowed by the earlier (superseded) criteria.
6. The relationship between OCS and CG is as follows:
OCS = 8000 / CG and CG = 8000 / OCS
7. After determining a higher CG or a higher turn altitude (TA), recalculate the ICA length. For an initial climb to an altitude, ICA length equals (TA – E) / CG.

Figure 12. Measurements to Obstacles Within ICA or Extended Splay Lines



7.6.2 **c. Determine the "climb to" altitude (CTA)** for the CG as follows:

CTA = E + (CG X D)

Where
CTA = Climb-to altitude (MSL) for climb gradient termination
E = CG origin starting (MSL) elevation. Use DERe for ICA calculations.
CG = Climb gradient in feet per NM
D = Distance (NM) from DER or ICA baseline (ICAB) to obstacle (see figure 11).

NOTES:

1. Climb to Altitude formula is from Order 8260.3, Volume 4, paragraph 1.4.2.
2. This CTA is for the ICA and straight ahead climb CG in paragraph 7.6.2a.
3. This formula provides the minimum/optimum CTA for an individual obstacle. For multiple obstacles that require climb gradients, apply Order 8260.3, Volume 4, paragraph 1.4.4, and applicable policy letters.

7.6.3 CG for Use after the Initial Climb to the First Turn Altitude.

7.6.3 **a. The evaluation for after the initial climb** extends from the ICA, or runway, to the termination of the OIS originating at the ICA/runway.

7.6.3 **a. (1) The termination altitude** of the inclined OIS equals the level OCS, which is, in each MVA/MIA sector, the MVA/MIA minus the ROC.

7.6.3 **a. (2) The distance (in feet) from the ICA/runway to the OIS/OCS termination** is calculated by multiplying the OIS/OCS slope times the rise of the OIS/OCS. The rise is the termination altitude minus the origin altitude.

NOTE: This distance to the termination of the inclined OIS will also be used in paragraph 8.6.

7.6.3 **b. For obstacles outside the ICA and outside of the extended splay** lines of the ICA, determine the obstacle clearance climb gradient from the ICA/runway to an obstacle as follows:

$$CG = \frac{O - E}{.76\,D}$$

Where
CG = Climb gradient in feet per NM
O = Obstacle (MSL) elevation
E = CG origin starting (MSL) elevation
For origin elevation, use the elevation of the OCS at the area A/B origin
D = Distance (NM) from the runway or ICA boundary to the obstacle

NOTES:

1. This CG is a variation of Order 8260.3, Volume 4, chapter 1, paragraph 1.4.1. DOD procedures may use the DOD option in paragraph 1.4.1.
2. This "after reaching a turn altitude" formula is based on the aircraft having already accomplished the initial climb, allowing the use of a higher origin.
3. Use this formula with the "diverse A area" origin elevation for obstacles to the side of the runway, or to the side of the ICA, or outside of the extended splay lines of the ICA. Use this formula with the "diverse B area" origin elevation for obstacles behind the departure reference line, as shown in Order 8260.3, Volume 4, paragraph 2.1.
4 Measurements for obstacle distance (D) for CG calculations are made from the same origin as the measurements for the OIS/OCS calculations.

7.6.3 **c. Determine the "climb to" altitude** (CTA) for the "after turn" CG, as follows:

CTA = TA + (CG X D) For a "diverse A area" obstacle

CTA = TA + 126 + (CG X D) For a "diverse B area" obstacle

Where

CTA = Climb-to altitude (MSL) for climb gradient termination
TA = Turn altitude (the minimum aircraft altitude at the end/side of the ICA)
CG = Climb gradient in feet per NM from the ICA/DRP to an obstacle
D = Distance (NM) from the runway or ICA boundary to the obstacle

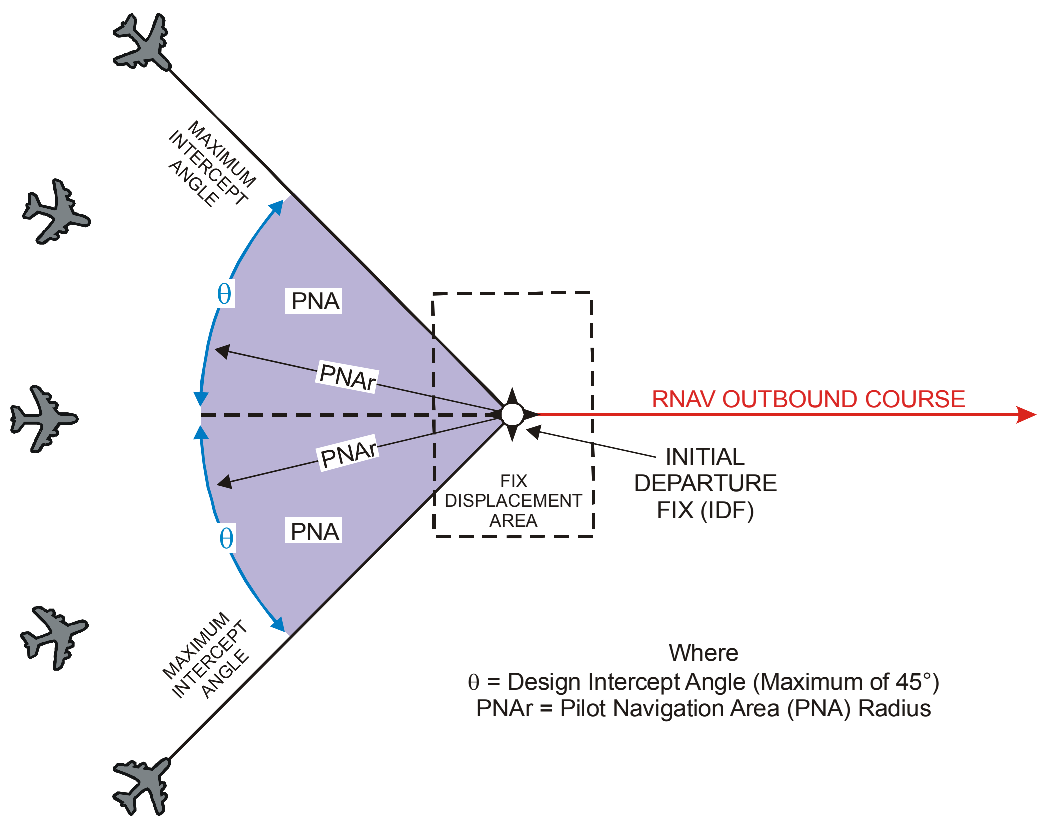
NOTES:

1. "Climb to" altitude formula is a variation of Order 8260.3, Volume 4, paragraph 1.4.
2. Use this CTA formula with the CG calculation in paragraph 7.6.3b.
3 For CTA calculation with a "diverse A area" controlling obstacle, the CG starting (MSL) elevation is the TA.
4. For CTA calculation with a "diverse B area" controlling obstacle, the CG starting (MSL) elevation is the TA plus 126 feet (Note: 126 is based on 96/.76).
5. This formula provides the minimum/optimum CTA for an individual obstacle. For multiple obstacles that require climb gradients, apply Order 8260.3, Volume 4, paragraph 1.4.4, and applicable policy letters.

8.0 PILOT NAVIGATION AREA (PNA).

The PNA is bounded by two lines and an arc (see figure 13). The lines represent the maximum intercept courses and the arc allows a distance to begin area navigation.

Figure 13. Example of Pilot Navigation Area



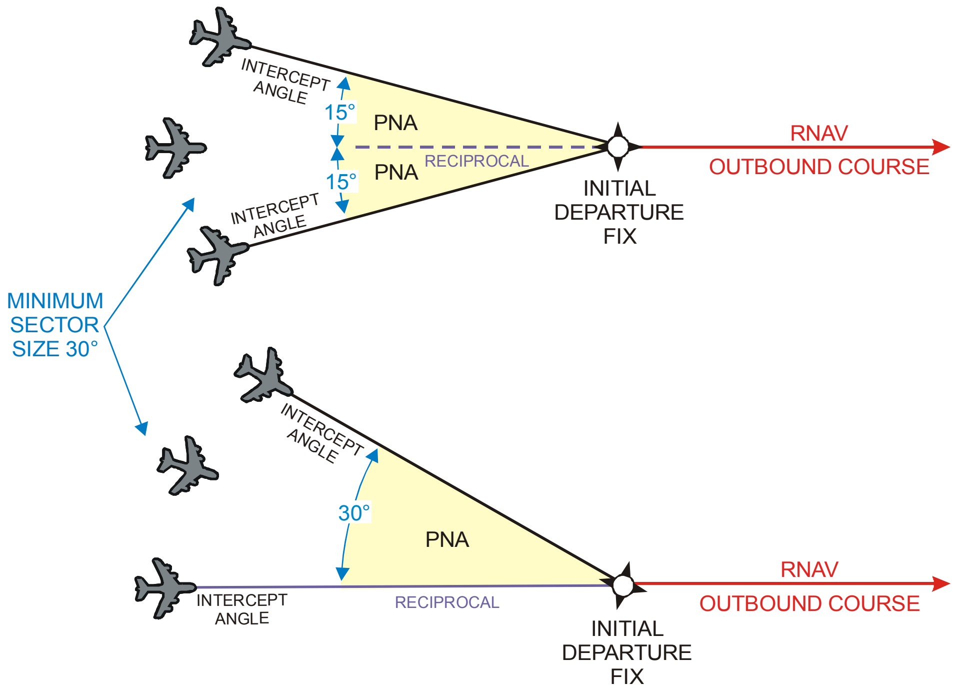
8.1 ALIGNMENT.

Align the PNA to the RNAV course (paragraph 9.0) outbound from the IDF. Measure the intercept angles from the reciprocal of the RNAV outbound course.

8.1.1 Sector Size.

The MINIMUM sector size is 30° (see figure14).

Figure 14. Examples of Minimum Sector Size for PNA



8.1.2 Alignment of DER and PNA.

To qualify for this type SID, the departure end of each authorized runway must be located within the area formed by the maximum intercept angles extended from the PNA to the extremities of the RVA (see figure 3). When that alignment cannot be met, approval is required from Flight Standards Service. Approval requests need to include documentation of the size of OCA considered and an explanation of how the aircraft will be brought within the maximum intercept angles in sufficient time to turn to the IDF.

8.2 AREA.

8.2.1 PNA.

This is the area that is identified to air traffic, as sufficient to start pilot navigation. Construct the PNA centered on the IDF, bounded by the maximum intercept courses, and using the PNA arc radius (PNAr) distance from table 1.

Table 1. Pilot Navigation Area Arc Radius

PNA Altitude and Airspeed	Radius for Level 1	Radius for Level 2
Below 10,000 MSL and At or Below 250 KIAS	6 NM	7 NM
At or Above 10,000 MSL or Above 250 KIAS	9 NM	10 NM

8.2.1 **a. The altitude,** for application of table 1, is generally determined using the method in Order 8260.44, paragraph 12.3.2 along the flight track distance (see paragraph 8.5.1) However, when that calculation indicates an altitude at or above 10,000 MSL at the IDF, also consider any altitude restrictions and radar assigned altitudes. If aircraft will be limited to below 10,000 MSL at the IDF (and not authorized in excess of 250 KIAS), use the "Below 10,000 MSL" row in the table, even if the calculation indicates an altitude above10,000 MSL.

8.2.1 **b. The airspeed,** for application of table 1, is generally determined by the standard speed in Order 8260.44, paragraph 11.1 (250 KIAS below 10,000 and 310 KIAS above 10,000). Exceptions: if a speed in excess of 250 KIAS will be published/coded for the procedure or if a speed in excess of 250 KIAS is otherwise authorized to be used below 10,000 MSL, for example by high performance aircraft, use the row for "Above 250 KIAS."

8.2.1 **c. Both the altitude and airspeed** requirements must be met in order to use the smaller radius values in the top row of table 1.

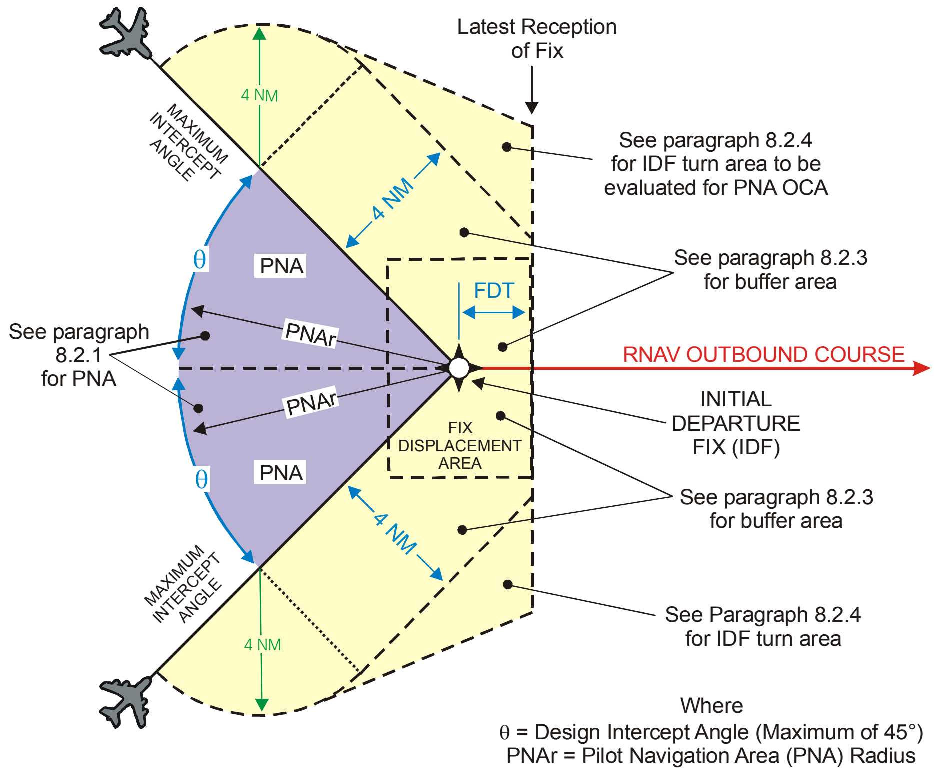
8.2.1 **d. The level of RNAV criteria** for use in table 1 is the level used for design of the RNAV route outbound from the IDF. To use level 1 criteria, the procedure must be limited to the RNAV "Type" and/or RNP level indicated in Order 8260.46 and the IDF must be within 30 NM of the departure airport.

8.2.1 **e. For intercept angles smaller than** 45° and/or airspeed less than 250 KIAS**,** a reduction to the PNA arc radius values in table 1 may be requested. Reduced PNA arc radius values require approval from Flight Standards Service.

8.2.2 PNA Obstacle Evaluation Area.

In addition to the area identified for pilot navigation (paragraph 8.2.1), also evaluate a PNA buffer area (paragraph 8.2.3) and an IDF turn expansion area (paragraph 8.2.4) for required obstacle clearance (see figure 15). Evaluate from the PNA boundary through the OEA to the latest reception of the IDF.

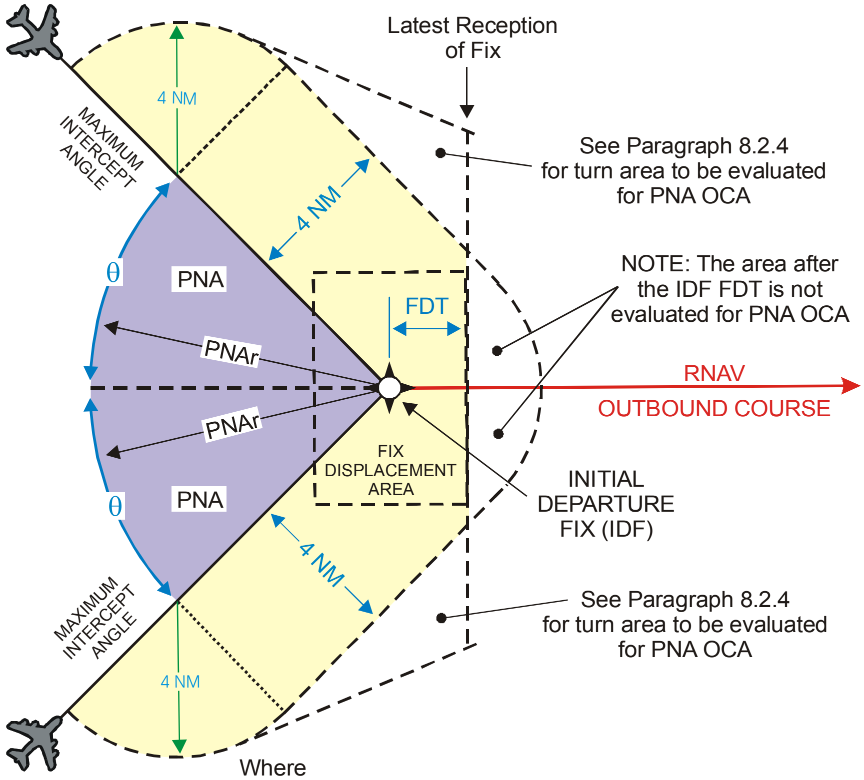
Figure 15. PNA Obstacle Evaluation Area



8.2.3 PNA Buffer Area.

An obstacle buffer surrounds the PNA on the RNAV route side of the PNA and extends to the latest reception of the IDF (see figure 16). The buffer is normally 4 NM. However, when the radar system used to vector aircraft to the PNA uses a 5 NM buffer, as indicated in Order 8260.19, use 5 NM for this buffer also.

Figure 16. PNA Buffer Area



Where
θ = Design Intercept Angle (Maximum of 45°)
PNAr = Pilot Navigation Area (PNA) Radius
4 NM is the normal buffer. The buffer increases to
5 NM when required by paragraph 8.2.3.

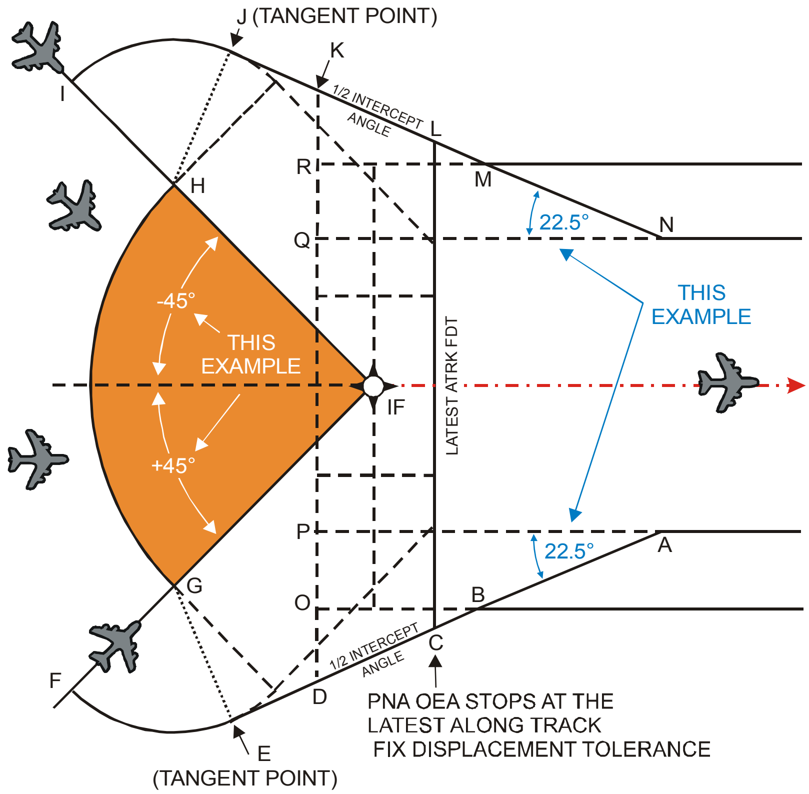
8.2.4 IDF Turn Area.

The IDF turn area is a maneuvering area required to transition from the PNA to the RNAV route and requires expansion of the PNA and RNAV route areas, as shown in figures 17 and 18. The turn area construction is based on aircraft using a distance of turn anticipation (DTA) as they "fly-by" the IDF. Connect to the RNAV route area as follows:

8.2.4 **a. Construct areas** for the PNA (paragraph 8.2.1), PNA buffer (paragraph 8.2.3), and for the RNAV route (paragraphs 9.1 and 9.2).

8.2.4 **b. Connect a DTA expansion line** equal to 1/2 of the maximum IDF intercept angle, to each point of tangency (points E and J in figures 17 and 18) at the PNA buffer boundary. Extend this line to intersect both the primary and secondary boundary of the RNAV route (to points B and A and to points M and N in figures 17 and 18).

Figure 17. Connecting PNA to RNAV Route, ±45° Intercept Angle



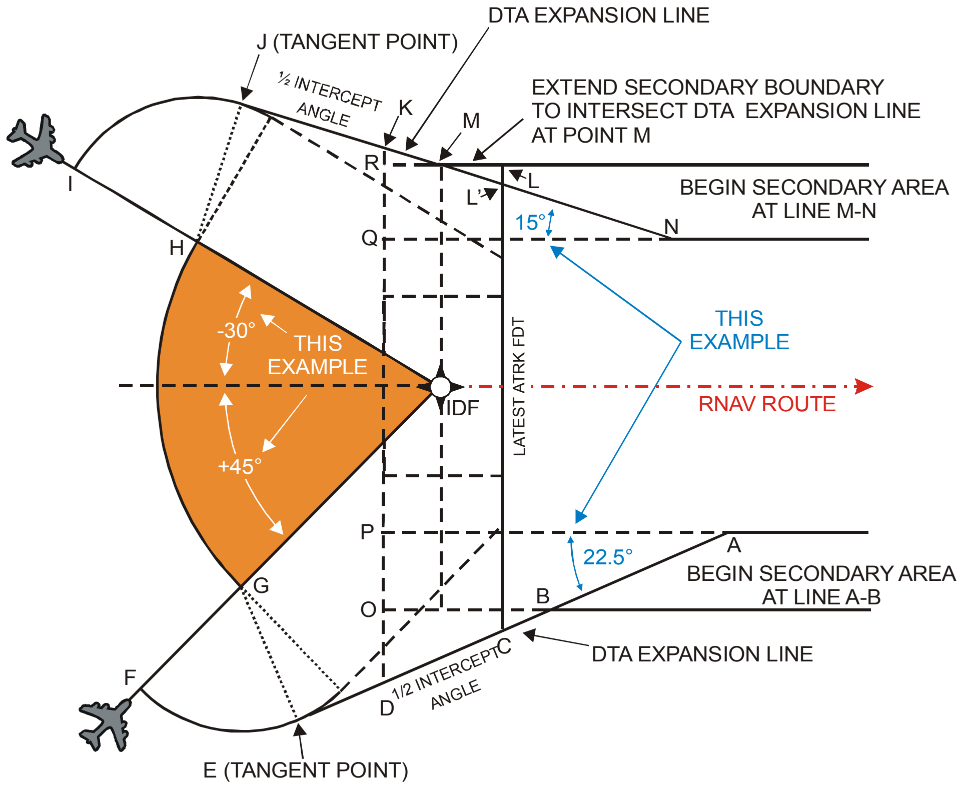
8.2.4 **c. Construct a line** perpendicular to the RNAV course at the latest IDF fix displacement tolerance (FDT) measured along the flight track (ATRK). Extend the line to intersect the DTA expansion line or the RNAV route secondary boundary, whichever occurs last (to points C and L in figures 17 and 18).

8.2.4 **d. The PNA obstacle evaluation area** is enclosed by points C-E, PNA buffer arc to F, F-G, PNA arc to H, H-I, PNA buffer arc to J, J-L, and L-C in figure 17. Evaluate the area enclosed by points C-D-K-L-C as both a part of the PNA OEA and a part of the OEA of the first segment of the RNAV route. Evaluate this area as all primary area.

8.2.4 **e. Extend the route secondary boundary** as necessary to intersect the DTA expansion line, even if the intersect point occurs PRIOR to the latest along-track FDT. An example is point M in figure 18.

8.2.4 **e. (1) A 30-degree intercept** is shown in figure 18 as an example of when it is required to extend the route secondary boundary to the DTA expansion line.

Figure 18. Connecting PNA to RNAV Route,
Example Using +45°/-30° Intercept Angle Construction



8.2.4 e. (2) **The PNA obstacle evaluation area** is enclosed by points C-E, PNA buffer arc to F, F-G, PNA arc to H, H-I, PNA buffer arc to J, J-M, M-L, L-C in figure 18. Evaluate the area enclosed by points C-D-K-M-L-L'-C as both a part of the PNA OEA and a part of the OEA of the first segment of the RNAV route. Evaluate this area as all primary area except for the segment M-L-L'-M which may be considered as secondary area.

8.2.4 f. **If the point of tangency (point E or point J)** is on or inside the RNAV route SECONDARY boundary line (extended), connect the DTA expansion line to the earliest ATRK FDT line of the IDF (connecting point J to R or point E to O).

NOTE: This paragraph only needs to be considered for small intercept angles. For example, when points R and O are 6 NM from the RNAV route and the PNA radius is 7 NM, this paragraph only applies at an intercept angle of 16.6 degrees or smaller.

8.2.4 g. **If the point of tangency (point E or point J) is on or inside** the RNAV route PRIMARY boundary line (extended), connect the DTA expansion line to the earliest ATRK FDT line of the IDF (connecting point J to Q or point E to P).

NOTE: This paragraph only needs to be considered for a zero degree intercept angle (where intercepts are planned for only one side of the RNAV course, as shown in the lower portion of figure 14).

8.3 OBSTACLE CLEARANCE.

Evaluate the PNA OEA with an inclined OIS/OCS and a level OCS. Use the inclined OIS/OCS until reaching the level OCS. Use the level OCS from the PNA boundary, or maximum intercept line, until abeam the latest reception point of the Initial Departure Fix (line C-L in figures 17 and 18).

8.3.1 PNA Inclined Obstacle Evaluation Surfaces.

The PNA inclined OIS rises at a 40:1 slope (see figures 19 and 20). Use a higher OCS, and associated CG, if there are penetrations of the 40:1 OIS. The starting height of the OIS at the PNA boundary equals the height of the RVA OIS/OCS. If a minimum crossing altitude (MCA) at the PNA boundary is requested, see paragraph 8.4.2. Terminate the inclined OIS/OCS if it reaches the level OCS associated with the PNA altitude.

Figure 19. PNA OIS/OCS Continuing from RVA OIS/OCS

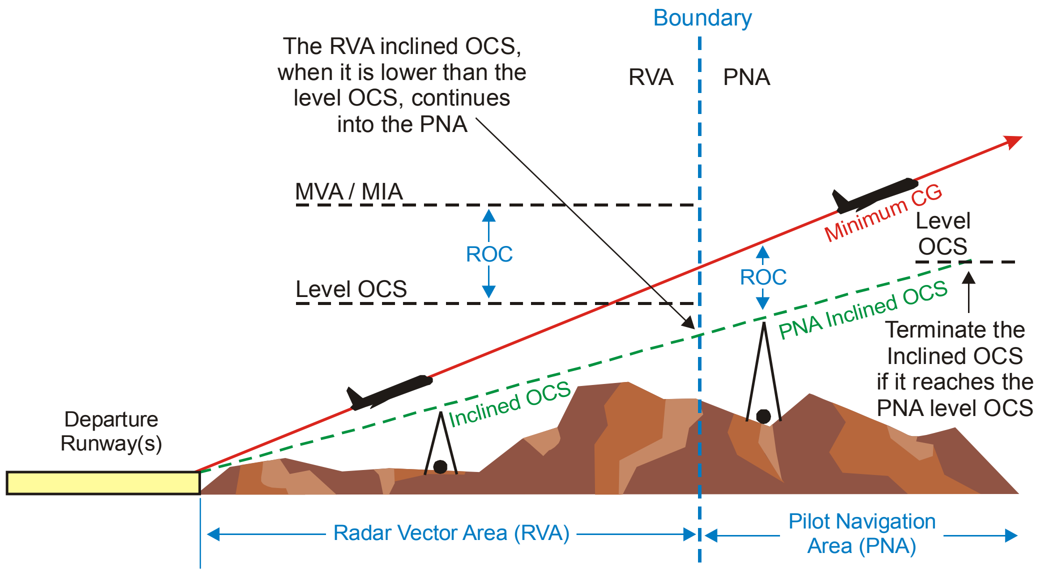
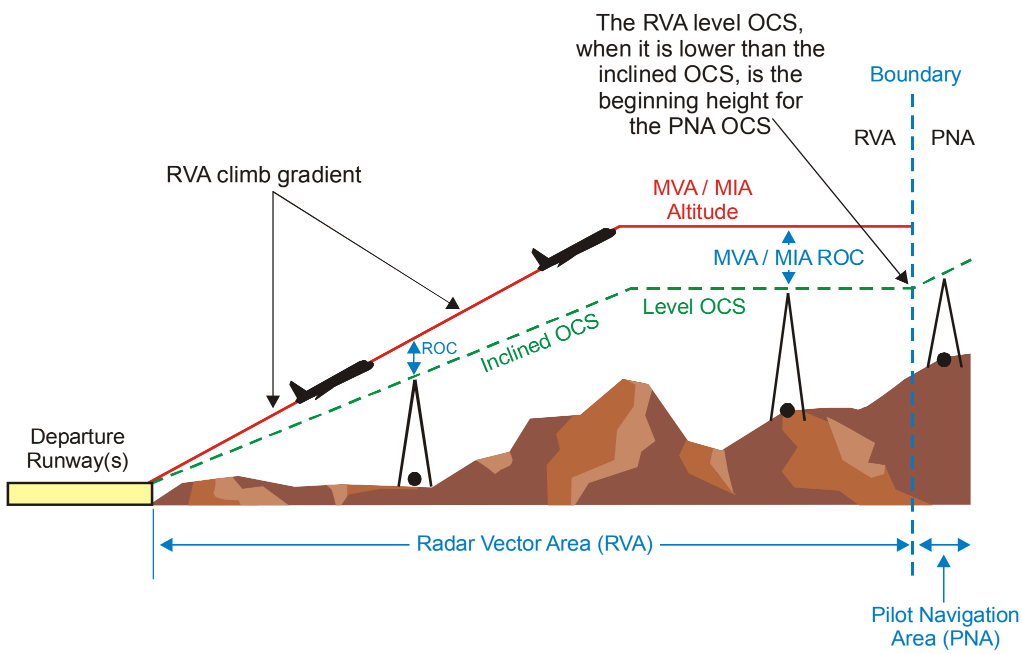


Figure 20. PNA OCS Starting at Height of RVA Level OCS



8.3.2 PNA Level Obstacle Clearance Surface.

Use the ROC indicated in Order 8260.19, chapter 3, section 7.

NOTES:

1. *This is the same ROC and same rounding method used for radar sectors.*
2. *Also see accuracy requirements in Order 8260.19, chapter 2, section 11.*

8.3.3 Mitigating Obstacle Penetrations.

The preferred method of obstacle mitigation is to use a less onerous route. The next choice is a climb gradient, using paragraph 8.6. Also see Order 8260.3, Volume 4, and Order 8260.46.

8.4 PNA ALTITUDE.

The PNA minimum altitude (PNAma) is the altitude aircraft must reach to safely proceed through the PNA to the IDF. Provide this altitude to Air Traffic as indicated in Order 8260.46.

8.4.1 PNA Minimum Altitude.

Determine the PNAma as the *higher* of the following:

8.4.1 a. RNAV Minimum Reception Altitude.

See paragraph 6.3.

8.4.1 b. Altitude Based on Obstacle Clearance.

Evaluate the OEA from the PNA boundary to the latest reception of the IDF (see paragraph 8.3).

8.4.1 c. Altitude Based on Airspace Analysis of the PNA OEA.

Evaluate the PNA OEA using Order 8260.19, paragraph 504, and Order 7400.2, Procedures for Handling Airspace Matters, Part 4. Apply a terminal rather than an en route airspace buffer when evaluating the PNA.

8.4.1 d. Altitude Based on Other Operational Factors.

Operational necessity may require an altitude increase. Examples include Air Traffic Control (ATC) requests, minimum crossing altitude (MCA), radar and communications coverage, noise abatement, national security, or environmental.

8.4.1 e. Altitude Based on Flight Inspection.

If the flight inspection indicates a higher altitude is required, use that altitude. An example would be to recommend an increase based on precipitous terrain.

8.4.2 PNA Boundary Minimum Crossing Altitude.

The recommended design is for aircraft to cross the PNA boundary at or above the PNA minimum altitude, as calculated in paragraph 8.4.1. If a PNA boundary minimum crossing altitude is established, it must be at or above the RNAV MRA. Raise the starting height of the PNA inclined OCS, described in paragraph 8.3.1, to a height that equals the PNA boundary minimum crossing altitude minus the ROC indicated in Order 8260.19, chapter 3, section 7. An MCA must provide the ROC; that is, no penetrations of the PNA inclined OCS are allowed.

8.5 MINIMUM DISTANCE/MAXIMUM CG FROM DER TO THE PNA BOUNDARY.

The minimum distance from the DER to the PNA boundary must be sufficient to allow aircraft to reach the PNA minimum altitude. When a PNA altitude is determined or modified, verify the distance/gradient to the PNA boundary.

8.5.1 CG Calculation.

Calculate this ATC CG along the shortest flight distance allowed by the radar vectoring procedures, as follows:

$$CG = (PNAma - DERe) / FTD.$$

Where

CG = ATC Climb Gradient from takeoff to the PNAma
PNAma = Pilot navigation area minimum altitude (paragraph 8.4.1)
DERe = Departure end of runway elevation
FTD = Minimum flight track distance from takeoff to the PNA

8.5.1 **a. If using the straight-line distance from DER to PNA,** as an approximation of the FTD in the CG formula above, indicates an acceptable gradient, there is no requirement to estimate the flight track distance.

8.5.1 **b. If the estimated flight track distance is required** and if ATC provides an estimate of the shortest flight track distance, use that estimated distance as the FTD for this CG calculation.

8.5.1 **c. If estimated distance or vectoring procedure information is not provided**, use a flight track distance defined by an initial climb to 400 ft (or higher minimum turn altitude if one is specified) then along the shortest allowable headings/routes to proceed toward the initial departure fix.

8.5.2 **CG Calculation.**

Submit the CG from this calculation to be published if it is greater than the applicable obstacle CG/standard CG.

8.5.2 **a. This CG is an ATC climb gradient,** rather than an obstacle CG, if required under this paragraph.

8.5.2 **b. The "climb-to" altitude** is the PNA minimum altitude, if a CG is required.

8.5.3 **The flight track distance to the PNA** must not require a climb gradient in excess of 500 ft per NM, unless approval is obtained from Flight Standards. Before submitting a request for a climb gradient of more than 500 ft per NM to reach an RNAV MRA, also consider modifying vectoring procedures or changing the location of the PNA, or requiring IRU or GPS (if that would lower the CG).

8.6 **CLIMB GRADIENT.**

Apply the standard climb gradient of 200 ft per NM from TERPS Volume 4 unless a higher gradient is required.

8.6.1 **CG from DER to PNA Boundary.**

See paragraph 8.5.

8.6.2 **CG from PNA Boundary to the IDF.**

8.6.2 **a. When an altitude restriction is required at the IDF**, such as an MCA or an operational/ATC restriction, determine the climb gradient from the PNA boundary to the IDF as follows:

$$CG = (IDFxa - PNAma) / PNAr$$

Where

CG = Climb gradient required from the PNA boundary to the IDF
IDFxa = Initial departure fix minimum crossing altitude/restriction
PNAma = Pilot navigation area minimum altitude
PNAr = Pilot navigation area radius (estimated distance through the PNA)

NOTES:

1. This is a variation of the CG formula in Order 8260.3, Volume 4, paragraph 1.4.

2. This formula applies when the Initial Departure Fix minimum crossing altitude is required for either obstacle clearance reasons or other reasons, such as ATC. Submit the CG, for publication, as an obstacle CG if the crossing altitude is an MCA required for obstacle clearance; otherwise, submit it as an ATC CG.
3. If a minimum crossing altitude at the PNA boundary was established, use that crossing altitude instead of the PNAma in the formula.
4. An example calculation is an initial departure fix minimum crossing altitude of 4,000 ft MSL, a pilot navigation area minimum altitude of 1,900 ft MSL, and a pilot navigation area radius of 7 NM gives a CG of 300 ft per NM.
5. An example of submitting a climb gradient is as follows: With no obstacle CG required in the RVA or the RNAV route and the CG calculated above, the values to submit would be a CG of 300 ft per NM (from takeoff) to 4,000 MSL. An alternative for the CG termination is until crossing [waypoint name of the IDF].

8.6.2 **b. If the climb gradient from the PNA altitude** to the IDF minimum crossing altitude requires higher than the standard climb gradient, take one of the following actions:

8.6.2 b. (1) Raise the pilot navigation area minimum altitude.

8.6.2 b. (2) Re-orient the RNAV route.

8.6.2 b. (3) Relocate the IDF.

8.6.2 b. (4) Publish a climb gradient. Use the climb gradient calculations from paragraph 8.6.2a.

8.6.2 b. (5) A combination of the actions listed above.

NOTE: If changes are made to distances, routes or altitudes, you must evaluate again any related gradients, distances, or altitudes that are adversely affected by the change.

8.6.3 CG to Mitigate a Penetration of the PNA Inclined OIS.

The obstacle climb gradient calculation, for the inclined OIS/OCS, depends on the location of the obstacle and the origin of the inclined OIS. Use the applicable paragraph as indicated in table 2.

**Table 2. Climb Gradient Calculation –
Determining Paragraph to Use**

	Location of Obstacle	
Origin of PNA Inclined OIS	**Within Extended ICA Splay**	**Outside Extended ICA Splay**
PNA OIS Continues from the RVA Inclined OCS	Paragraph 8.6.4	Paragraph 8.6.5
PNA OIS Starts at the RVA Level OCS	Paragraph 8.6.6	

8.6.4 **CG to Mitigate a Penetration of the PNA OIS for Obstacles Within the Extended ICA Splay When the PNA OIS Continues from the RVA OIS/OCS.**

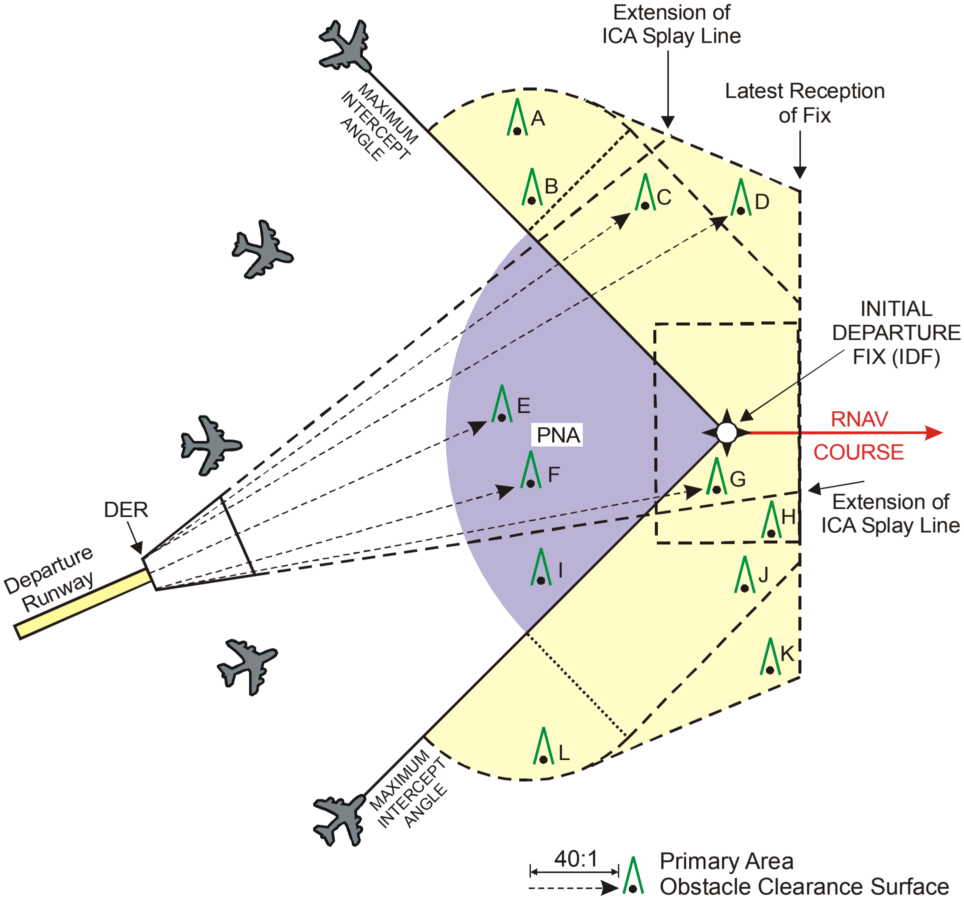
8.6.4 **a. An obstacle(s) must be within the extended splay lines** of the ICA to use this paragraph. Figure 21 shows example obstacle measurements from the DER/ICAB to obstacles C, D, E, F, and G.

8.6.4 **b. The PNA inclined OIS/OCS** must originate at the same height as the RVA inclined OIS/OCS, as shown in figure 19, to use this paragraph. See paragraph 7.6.2a for the termination altitude and distance of the RVA inclined OCS.

8.6.4 **c. The climb gradient calculation** is done as indicated in paragraph 7.6.2b.

8.6.4 **d. For the "climb to" altitude,** use the PNA minimum altitude, from paragraph 8.4, unless a lower altitude is needed. For an obstacle within the extended splay lines of the ICA (see figure 21), the CTA may be established as low as the value calculated in paragraph 7.6.2c.

Figure 21. Measurements to Obstacles Within the ICA Splay - When PNA OIS/OCS Continues from RVA



8.6.5 CG to Mitigate a Penetration of the PNA OIS for Obstacles <u>Outside</u> the Extended ICA Splay When the PNA OIS Continues from the RVA OCS.

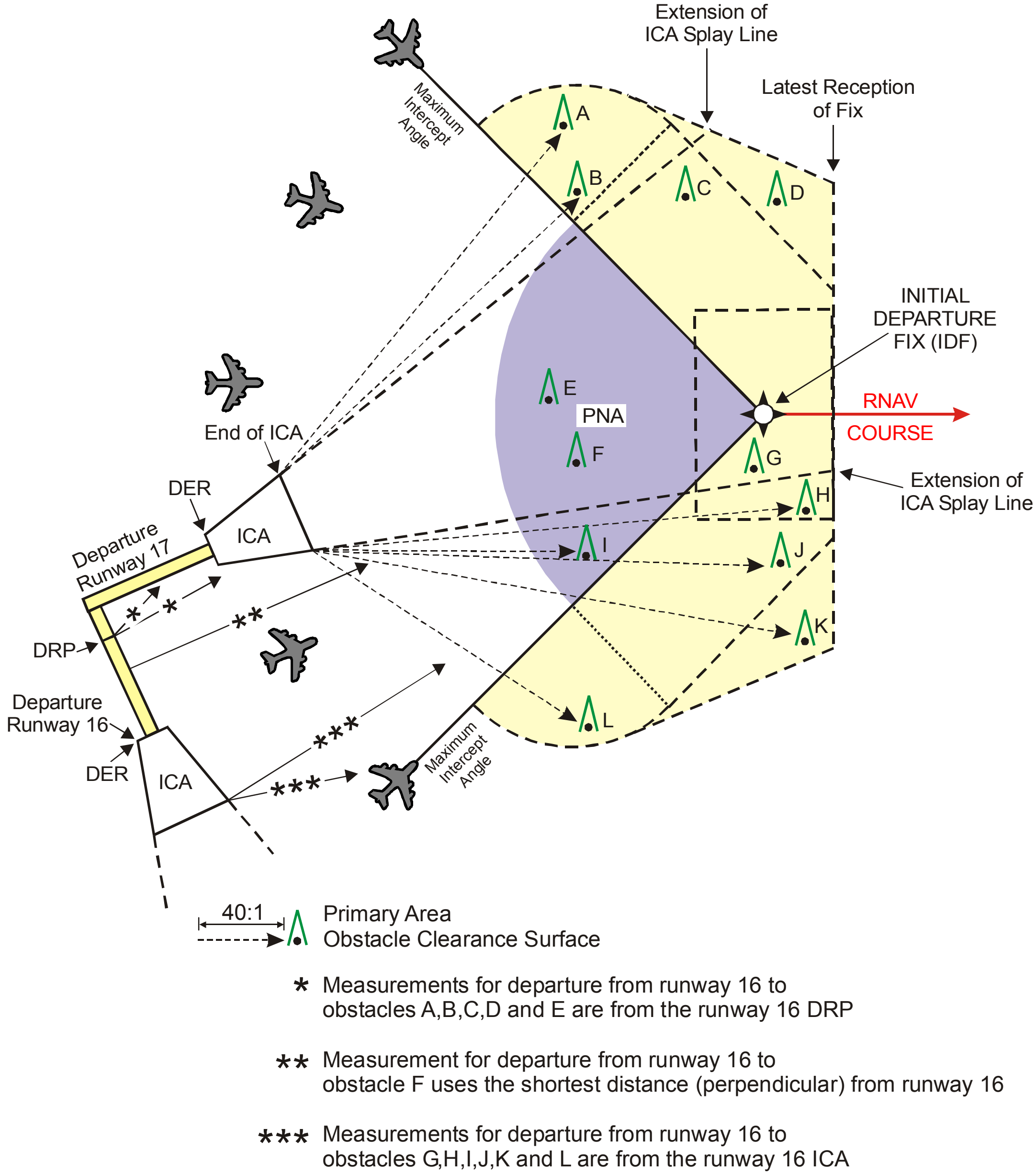
8.6.5 a. **An obstacle(s) must be outside the extended splay lines** of the ICA to use this paragraph to determine the obstacle clearance climb gradient. Figure 22 shows example obstacle measurements from the ICA to obstacles A, B, H, I, J, K, and L for the example runway 07. Measurements are the shortest distance to the obstacle from the DRP, runway, or ICA as shown for the example runway 16.

8.6.5 b. **The PNA inclined OIS/OCS** must originate at the same height as the RVA inclined OIS/OCS, to use this paragraph. See paragraph 7.6.3a for the termination altitude and distance of the RVA inclined OIS.

8.6.5 c. **The climb gradient calculation** is done as indicated in paragraph 7.6.3b.

8.6.5 d. **For the "climb to" altitude,** use the PNA minimum altitude, from paragraph 8.4, unless a lower altitude is needed. For an obstacle outside the extended splay lines of the ICA (figure 22), the CTA may be established as low as the value calculated in paragraph 7.6.3c.

Figure 22. Measurements to Obstacles Outside ICA Splay - When PNA OIS/OCS Continues from RVA



8.6.6 CG to Mitigate a Penetration of the PNA OIS When the OIS Originates at the Height of the RVA Level OCS.

8.6.6 **a. An obstacle(s) may be either inside or outside the extended splay lines** of the ICA to use this paragraph. Figure 23 shows example obstacle measurements using the shortest distance from the PNA boundary, or the maximum intercept lines, to all obstacles.

8.6.6 **b. The RVA inclined OIS/OCS** must have reached the RVA level OCS as shown in figure 20. The PNA inclined OIS starts at the height of the RVA level OCS.

8.6.6 **c. Calculate the obstacle clearance climb gradient**, when the PNA inclined OIS starts at the height of the RVA level OCS, as follows:

$$CG = \frac{O - E}{.76\ D}$$

Where

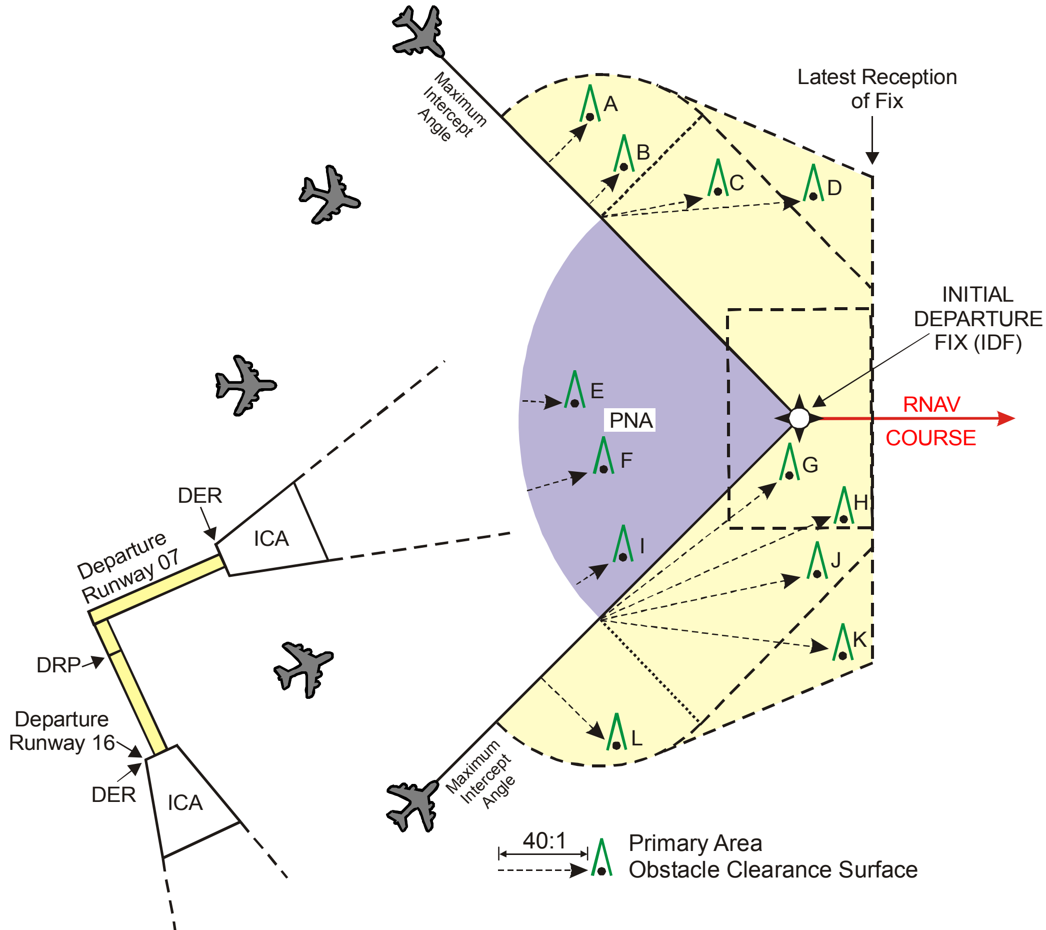
CG = Climb gradient in ft per NM
O = Obstacle (MSL) elevation
E = CG origin starting (MSL) elevation.
For origin elevation, use the elevation of the RVA OCS at the PNA boundary.
D = Distance (NM) from the PNA boundary, or intercept lines, to the obstacle.

NOTES:

1. This CG is a variation of Order 8260.3, Volume 4, chapter 1, paragraph 1.4.1. DOD procedures may use the DOD option in paragraph 1.4.1.
2. Measurements for obstacle distance (D) for CG calculations are made from the same origin as the measurements for the OIS/OCS calculations.

8.6.6 **d. The "climb to" altitude** is the PNA minimum altitude, from paragraph 8.4.

Figure 23. Measurements to Obstacles - When PNA OIS/OCS Starts at the Height of the RVA Level OCS



Measurements for all runways are from the closest point on the PNA Boundary or, for obstacles A, B, and L, from the maximum intercept angle line.
The origin height is the RVA level OCS elevation.

8.6.7 End of PNA Inclined Obstacle Surface and CG Evaluation.

Obstacle measurements and climb gradient calculations under paragraphs 8.6.4, 8.6.5, and 8.6.6 are only required until the inclined OIS/OCS reaches the height of the PNA level surface OCS. Then, the inclined OIS/OCS is terminated and PNA obstacle mitigation is through the level OCS and establishing the PNA altitude.

9.0 RNAV ROUTE.

The RNAV route begins at the IDF and includes all subsequent segments including transitions.

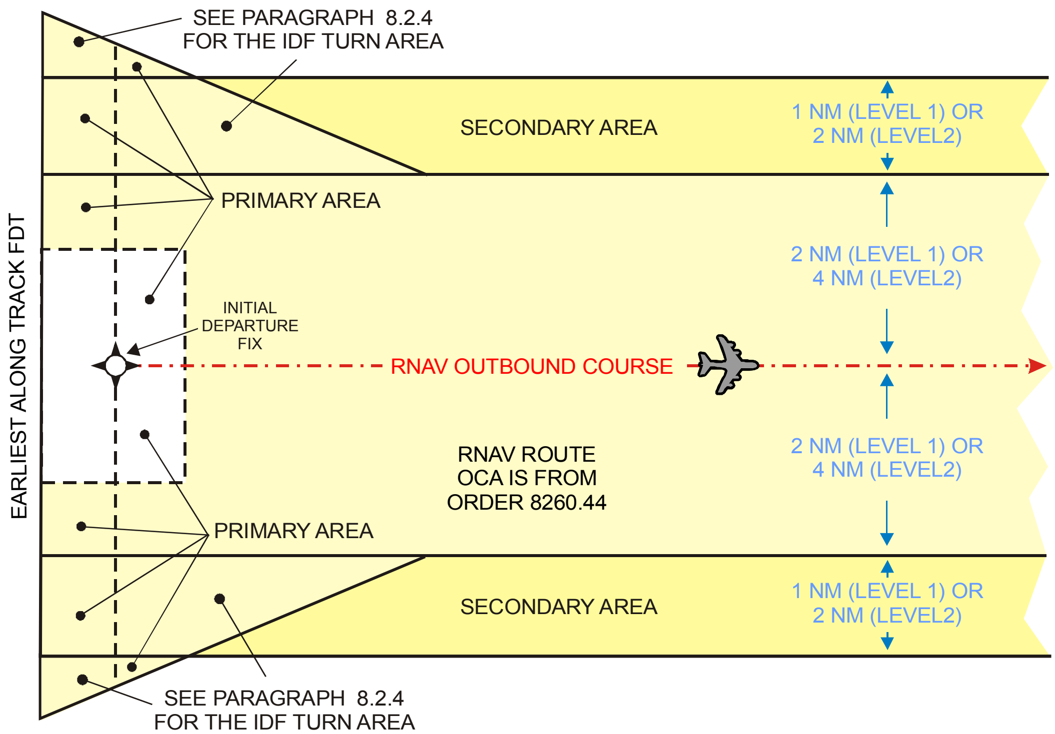
9.1 ALIGNMENT.

The RNAV route obstacle clearance area for the first RNAV segment is aligned on the outbound course from the IDF.

9.2 AREA.

Apply level 2 (RNP 2.0) route width, as described in Order 8260.44, to the RNAV route segment of the SID. Exception: You may use level 1 (RNP 1.0) criteria, within 30 NM of the departure airport, if the conditions and limitations stated in Orders 8260.44 and 8260.46 are met. If level 1 criteria are used, the area width beyond 30 NM is the same as level 2 primary and secondary area widths. Additional area for the IDF turn area must be considered in the obstacle evaluation of the RNAV route as indicated in paragraph 8.2.4 (see figure 24).

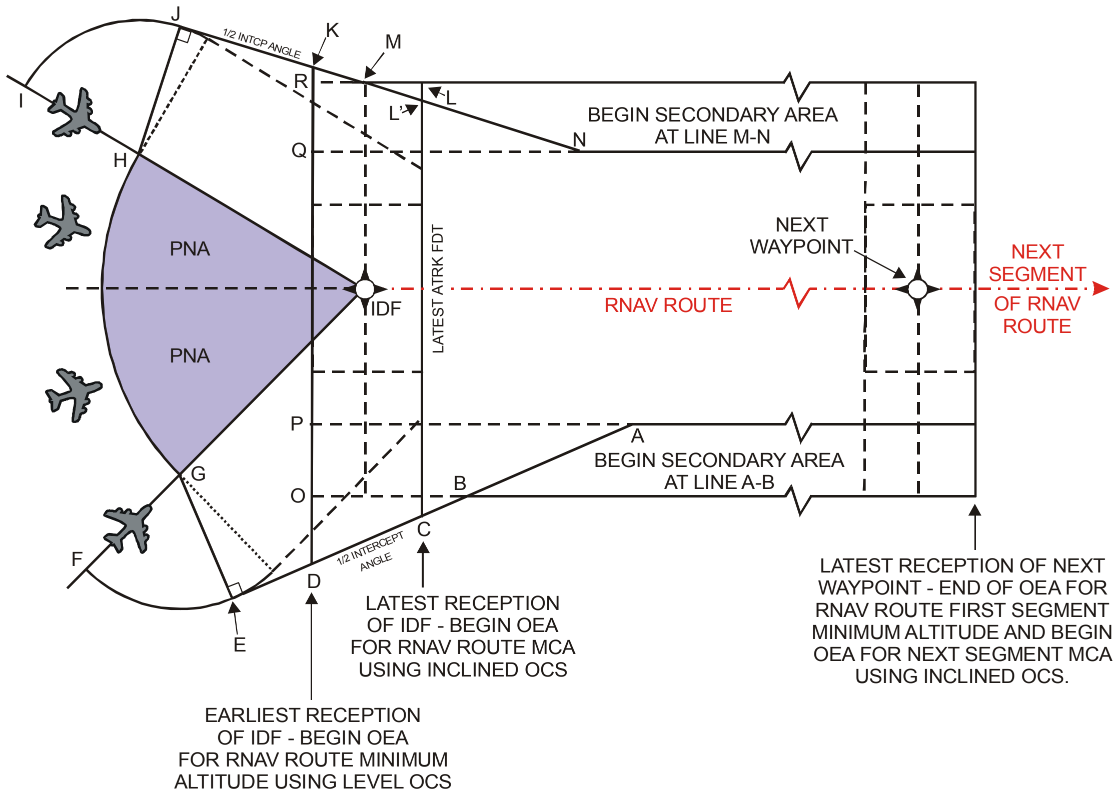
Figure 24. Area for First Segment of RNAV Route



9.3 OBSTACLE CLEARANCE.

Evaluate the RNAV route area, including the IDF turn expansion area, each subsequent segment, and each transition using Orders 8260.3, 8260.44, and 8260.46. The Obstacle evaluation area starts abeam the earliest reception point (the earliest along-track fix displacement tolerance) of the IDF and continues until abeam the latest reception point (the latest along-track fix displacement tolerance) of the next fix or waypoint (see figure 25).

Figure 25. RNAV Route Obstacle Evaluation Area



9.3.1 MCA Inclined Obstacle Clearance Surface.

The MCA OCS starts at the latest reception (latest ATRK FDT) of the previous segment, as shown by line C-L in figure 25 and rises as described in Order 8260.3, Volume 1 or Volume 4, as applicable. The starting height begins at the lower of the inclined or level surface height from the previous segment, as shown in figures 26 and 27. Terminate the inclined OCS upon reaching the level OCS associated with the RNAV route segment MEA or minimum altitude.

9.3.2 RNAV Route Level Obstacle Clearance Surface.

Use the surfaces and ROC as described in Order 8260.3, Volume 1 or Volume 4, as applicable.

Figure 26. MCA OCS Continuing from Previous OCS

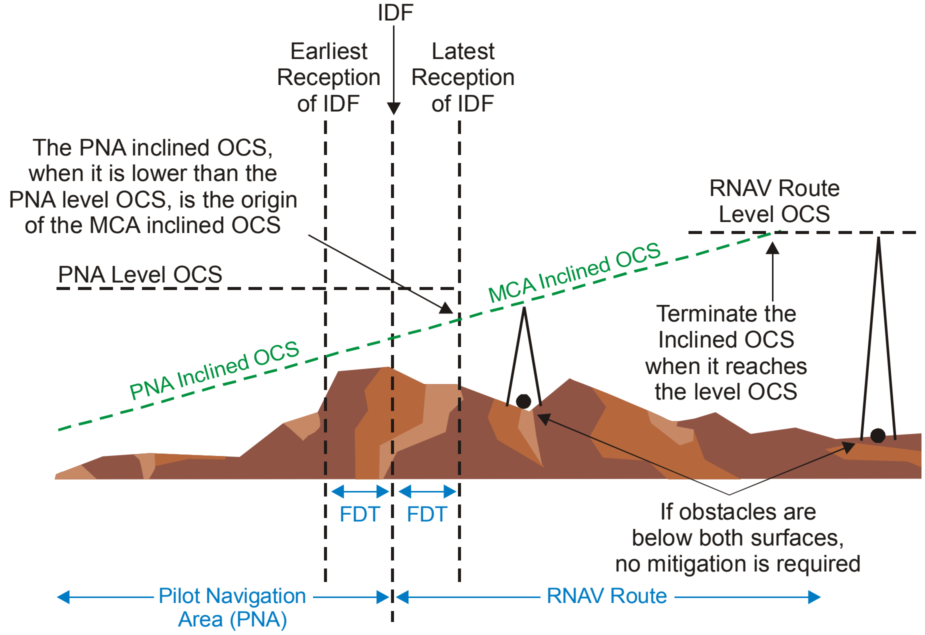
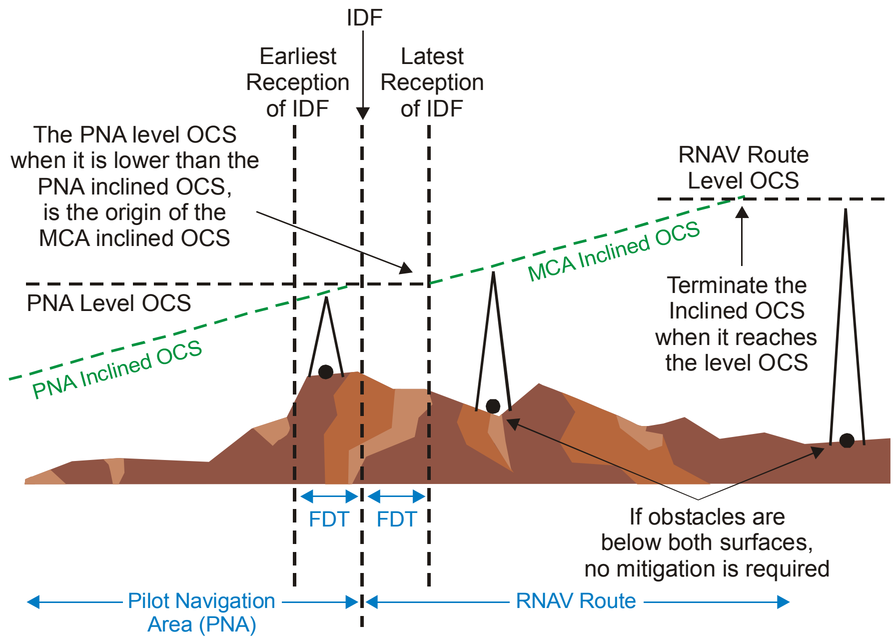


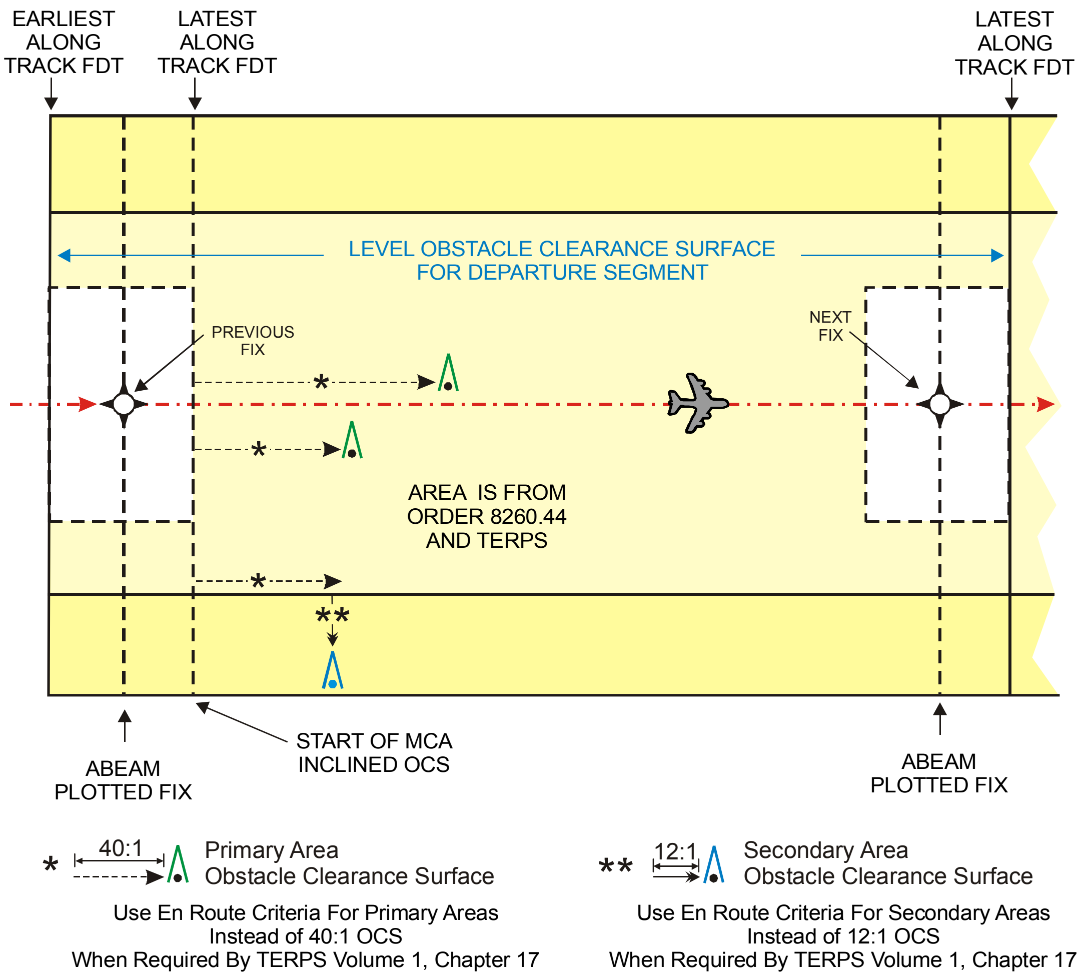
Figure 27. MCA OCS Starting from Level OCS



9.3.3 Obstacle Measurements.

Obstacle measurements are the shortest distance from the start of the inclined OCS to the obstacle within the primary area and perpendicular to the course within the secondary area, as shown in figure 28.

Figure 28. Obstacle Areas and Measurements



9.4 RNAV ROUTE ALTITUDE.

Publish a minimum altitude/minimum en route altitude (MEA) for all segments following the IDF. Publish a minimum crossing altitude when required.

9.4.1 RNAV Route Minimum Altitude.

The MINIMUM altitude for each segment of the RNAV Route is the *higher* of:

9.4.1 a. **Previous Segment Altitude.** Use at least the PNA minimum altitude (paragraph 8) in determining the altitude for the first segment after the IDF. Then, use at least the previous segment altitude for each following segment.

9.4.1 b. **Altitude Based on Obstacle Clearance.** Use paragraph 9.3, and Order 8260.3, Volume 4 or, when applicable, Volume 1, chapter 17.

9.4.1 c. **Altitude Based on Airspace Analysis.** Use Orders 8260.19 and 7400.2.

9.4.1 **d. Altitude Based on Other Operational Factors/Operational Necessity.** Examples include noise abatement, environmental, ATC operational requirements/restrictions, radar and communications coverage, or national security.

9.4.1. **e. Altitude Based on Flight Inspection.** A minimum altitude resultant from flight inspection.

9.4.2 Minimum Crossing Altitude.

Evaluate each segment for MCA using Order 8260.3, Volume 4 or Volume 1, chapter 17, as applicable. You may raise a previous segment minimum altitude to meet the subsequent segment MCA calculated altitude (and remove the need for publishing the MCA) when there is no adverse effect on the previous segment gradient.

10.0 COORDINATION, DOCUMENTATION, AND PROCESSING.

Refer to Order 8260.46.

11.0 INFORMATION UPDATE.

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

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 8260.53, Standard Instrument Departures that Use Radar Vectors to Join RNAV Routes

To: DOT/FAA
Flight Procedure Standards Branch, AFS-420
P.O. 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: ___________________

FTS Telephone Number: _________________________________ Routing Symbol: ________

FAA Form 1320-19 (8-89)