ORDER | **8260. 48**

AREA NAVIGATION (RNAV) APPROACH CONSTRUCTION CRITERIA

April 8, 1999

U. S. DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

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RECORD OF CHANGES

DIRECTIVE NO. **8260.48**

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

FOREWORD

This order establishes policy and provides the approach construction criteria for developing instrument approach procedures using the Wide Area Augmentation System (WAAS). This order also augments information contained in FAA Orders 8260.3, United States Standard for Terminal Instrument Procedures (TERPS); 8260.19, Flight Procedures and Airspace; 8260.36, Civil Utilization of Microwave Landing System (MLS); 8260.38, Civil Utilization of Global Positioning System (GPS); 8260.44, Civil Utilization of Area Navigation (RNAV) Departure Procedures; 8260.45, Terminal Arrival Area (TAA) Design Criteria; 8260.47, Barometric Vertical Navigation (VNAV) Instrument Procedures Development; and 7130.3, Holding Pattern Criteria.

The WAAS is a major step in the evolution of aeronautical satellite navigation. FAA Order 8260.38 introduced two-dimensional (2D) nonprecision approach construction criteria based on performance of TSO-C129 certified GPS receivers. This order introduces positive vertical guidance, e.g., three-dimensional (3D) approach construction criteria based on the performance of receivers utilizing positional corrections from components of the WAAS. Precision and nonprecision minimums are possible using this system.

L. Nicholas Lacey
Director, Flight Standards Service

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CHAPTER 1. GENERAL

1.1 PURPOSE.

This document specifies criteria for developing area navigation (RNAV) instrument approach procedures.

1.2 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.

1.3 BACKGROUND.

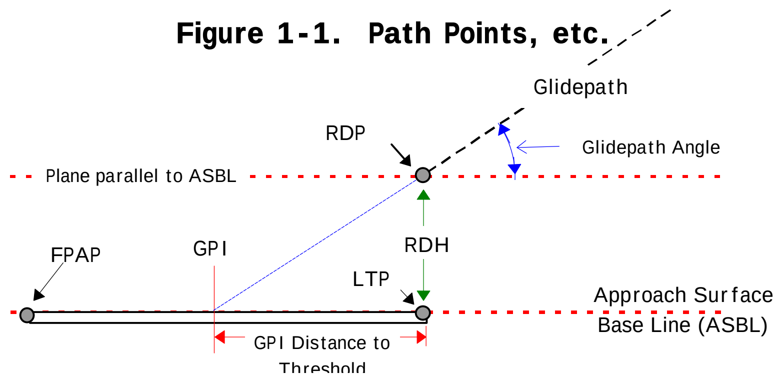
The Wide Area Augmentation System (WAAS) is a major step in the evolution of aeronautical satellite navigation. FAA Order 8260.38, Civil Utilization of Global Positioning System (GPS), introduced two-dimensional (2D) nonprecision approach construction criteria based on performance of Technical Standard Order (TSO)-C129 certified GPS receivers. This order introduces positive vertical guidance, e.g., three-dimensional (3D) approach construction criteria based on the performance of receivers utilizing positional corrections from components of the WAAS. Precision and nonprecision minimums are possible using this system.

1.4 DEFINITIONS.

1.4.1 Approach Surface Base Line (ASBL).

The horizontal line tangent to the surface of the earth at the runway threshold (RWT) point, aligned with the final approach course (see figure 1-1).

Figure 1-1. Path Points, etc.



1.4.2 Barometric Altitude.

Altitude above the orthometric Geoid surface; i.e., mean sea level (MSL), based on atmospheric pressure measured by an aneroid barometer. This is the most common method of determining aircraft altitude.

1.4.3 Decision Altitude (DA).

A specified barometric altitude at which a missed approach must be initiated if the required visual references to continue the approach have not been established.

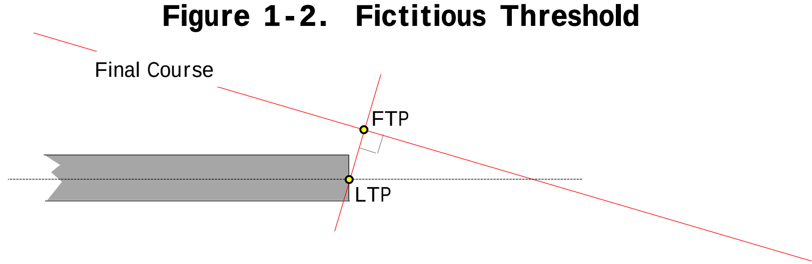
1.4.4 Departure End of Runway (DER).

The end of the runway that is opposite the landing threshold. It is sometimes referred to as the stop end of runway.

1.4.5 Fictitious Threshold Point (FTP).

The equivalent of the landing threshold point (LTP) when the final approach course is offset from runway centerline. It is the intersection of the final course and a line perpendicular to the final course that passes through the LTP. FTP elevation is the same as the LTP (see figure 1-2).

Figure 1-2. Fictitious Threshold



1.4.6 Flightpath Alignment Point (FPAP).

The FPAP is a 3D point defined by World Geodetic System (WGS) 84/North American Datum (NAD)-83 latitude, longitude, MSL elevation, and WGS 84 geoid height (see figures 1-1 and 1-3). The FPAP is used in conjunction with the landing threshold point (LTP) and the geometric center of the WGS 84 ellipsoid to define the vertical plane of a precision RNAV final approach course. The course may be offset up to 3° by establishing the FPAP left or right of centerline along an arc centered on the LTP.

1.4.7 Geoid Height (GH).

The height of the geoid (reference surface for orthometric or MSL heights) relative to the WGS 84 ellipsoid. It is a positive value when the geoid is above the WGS 84 ellipsoid, and negative when it is below. The value is used to convert an MSL elevation to an ellipsoidal or geodetic height - the height above ellipsoid.

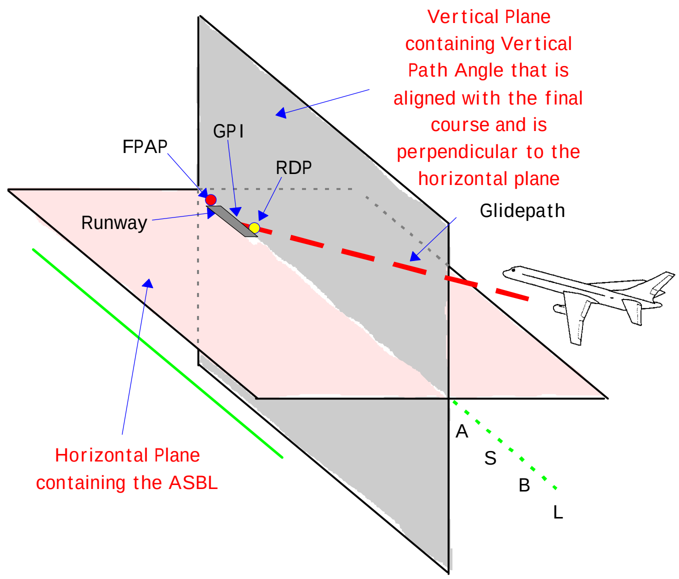
1.4.8 Glidepath Angle (GPA).

The angular displacement of the vertical guidance path from a horizontal plane that passes through the reference datum point (RDP). This angle is published on approach charts (e.g., 3.00°, 3.20°, etc.). GPA is sometimes referred to as vertical path angle (VPA).

1.4.9 Ground Point of Intercept (GPI).

A point in the vertical plane containing the vertical path where the vertical path intercepts the ASBL. GPI is expressed as a distance from THR (see figure 1-3).

Figure 1-3. 3D Path & Course



1.4.10 Height Above Ellipsoid (HAE).

A height expressed in feet above the WGS 84 ellipsoid. This value differs from a height expressed in feet above the geoid (essentially MSL) because the reference surfaces (WGS 84 Ellipsoid and the Geoid) do not coincide. To convert an MSL height to an HAE height, algebraically add the geoid height value to the MSL value. HAE elevations are not used for instrument procedure construction, but are documented for inclusion in airborne receiver databases.

EXAMPLE:	Given:	KOUN RWY 35	Runway ID
		N 35 14 31.65	Latitude
		W 97 28 22.84	Longitude
		1177.00	MSL Elevation
		-87.29 feet (-26.606 m)	Geoid Height (GH)

$$HAE = MSL + GH$$
$$HAE = 1177 + (-87.29)$$
$$HAE = 1089.71$$

1.4.11 Height Above Touchdown (HAT).

The HAT is the height of the DA above touchdown zone elevation (TDZE).

1.4.12 Inner-approach Obstacle Free Zone (OFZ).

The airspace above a surface centered on the extended runway centerline. It applies to runways with an approach lighting system (see figure 2-3).

1.4.13 Inner-transitional OFZ.

The airspace above the surfaces located on the outer edges of the runway OFZ and the inner-approach OFZ. It applies to runways with approach visibility minimums less than ¾ statute mile (see figure 2-3).

1.4.14 Instrument Procedure with Vertical Guidance (IPV).

Satellite or Flight Management System (FMS) LNAV navigation with computed positive vertical guidance based on barometric or satellite elevation.

1.4.15 Landing Threshold Point (LTP).

The LTP is a 3D point at the intersection of the runway centerline and the runway threshold. It is defined by WGS 84/NAD 83 latitude, longitude, MSL elevation, and geoid height. See figure 1-1. It is used in conjunction with the FPAP and the geometric center of the WGS 84 ellipsoid to define the vertical plane of an RNAV final approach course. LTP elevation applies to the FTP when the final approach course is offset from runway centerline.

1.4.16 Lateral Navigation (LNAV).

Azimuth navigation, without positive vertical guidance. This type of navigation is associated with nonprecision approach procedures.

1.4.17 Object Free Area (OFA).

An area on the ground centered on a runway, taxiway, or taxilane centerline provided to enhance the safety of aircraft operations by having the area free of objects, except for objects that need to be located in the OFA for air navigation or aircraft ground maneuvering purposes.

1.4.18 Obstacle Clearance Surface (OCS).

An inclined surface associated with a WAAS or IPV glidepath angle. The separation between this surface and the vertical path angle at any given distance from GPI define the MINIMUM required obstruction clearance at that point.

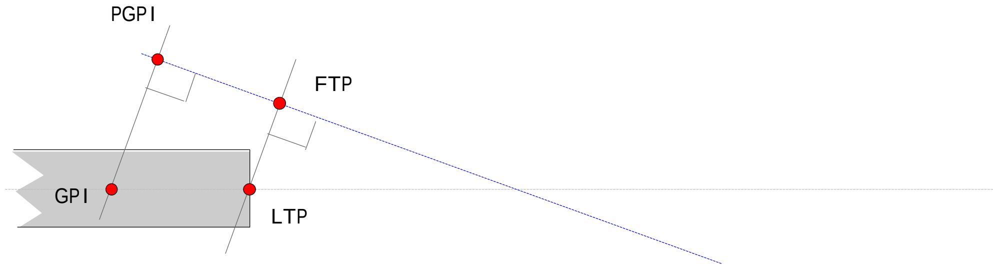
1.4.19 Precision Final Approach Fix (PFAF).

A 2D point located on the final approach course at a distance from LTP/FTP where the glidepath angle (GPA) intercepts the intermediate segment altitude (glidepath intercept altitude). The PFAF marks the outer end of the precision final segment.

1.4.20 Pseudo Ground Point of Intercept (PGPI).

Phantom location abeam the GPI when the approach course is offset. PGPI elevation is the same as ASBL (see figure 1-4).

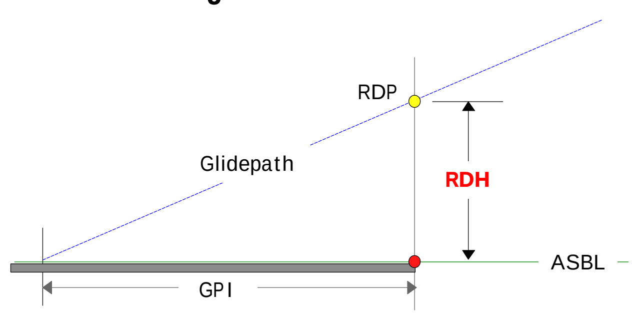
Figure 1-4. PGPI and FTP Locations



1.4.21 **Reference Datum Height (RDH).**

The height above ASBL of the vertical path at the LTP. It is sometimes referred to as TCH (see figure 1-5).

Figure 1-5. RDH



1.4.22 **Reference Datum Point (RDP).**

The RDP is a 3D point defined by the LTP or FTP latitude/longitude position, MSL elevation, and a reference datum height (RDH) value. See figure 1-5. The RDP is in the vertical plane of the final approach course and is used to relate the glidepath angle of the final approach track to the landing runway. It is sometimes referred to as the TCH point (see figure 1-5).

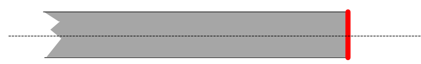
1.4.23 **Required Navigational Performance (RNP).**

Navigational performance necessary to operate in a given airspace or perform a particular procedure.

1.4.24 **Threshold (THR).**

The THR marks the beginning of that part of the runway usable for landing (see figure 1-6).

Figure 1-6. Threshold



1.4.25 Three-Dimensional (3D) Point/Waypoint.

A waypoint defined by WGS 84 latitude and longitude coordinates, MSL elevation, and GH.

1.4.26 Touchdown Zone Elevation (TDZE).

The highest elevation in the first 3,000 feet of the landing surface.

1.4.27 Two-Dimensional (2D) Point/Waypoint.

A waypoint defined by WGS 84 latitude and longitude coordinates.

1.4.28 Vertical Path Angle (VPA).

A published angle, measured from the FAF position and altitude to the LTP or FTP position at TCH MSL elevation, indicative of the designed descent rate for the procedure. The angle is measured relative to a horizontal plane containing the RDP that is parallel to the ASBL (see figure 1-1). The term is used in reference to approach systems that do not provide positive vertical guidance, e.g., LNAV, VOR, NDB, etc..

1.4.29 Wide Area Augmentation System (WAAS).

A method of navigation based on the GPS. Ground correction stations transmit position corrections that enhance system accuracy and add VNAV features.

1.5 INFORMATION UPDATE.

Any deficiencies found, requests for clarification, or suggested improvements regarding the content of this order shall be forwarded for consideration to:

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

1.5.1 Your Assistance is Welcome.

FAA Form 1320-19, Directive Feedback Information, is included at the end of this order for your convenience.

1.5.2 Other Comments Block.

Use the “Other Comments” block of this form to provide a complete explanation of why the suggested change is necessary.

CHAPTER 2. GENERAL CRITERIA

2.1 POLICY DIRECTIVES.

FAA Orders 8260.3, United States Standard for Terminal Instrument Procedures (TERPS); 8260.19, Flight Procedures and Airspace; 8260.36, Civil Utilization Of Microwave Landing System (MLS); 8260.38, Civil Utilization of Global Positioning System (GPS); 8260.44, Civil Utilization of Area Navigation (RNAV) Departure Procedures; 8260.45, Terminal Arrival Area (TAA) Design Criteria; 8260.47, Barometric Vertical Navigation (VNAV) Instrument Procedures Development; and 7130.3, Holding Pattern Criteria, apply unless specified in this order. The final and missed approach criteria described in this order supersedes the other publications listed above, except as noted.

2.2 DATA RESOLUTION.

Perform calculations using at least 0.01 unit of measure accuracy. Document WGS 84/NAD 83 latitudes and longitudes to the nearest one hundredth (0.01) arc second; MSL and HAE elevations to the nearest foot; courses, GPA's, and VPA's to the nearest one hundredth (0.01) degree, and distances to the nearest hundredth (0.01) unit.

2.3 PROCEDURE IDENTIFICATION.

Title an RNAV approach procedure RNAV RWY (Runway number). Examples: **RNAV RWY 13, RNAV RWY 34R.** A typical RNAV approach chart will depict minima for WAAS, IPV, LNAV, and circling.

2.4 EN ROUTE, INITIAL, AND INTERMEDIATE SEGMENTS.

Apply Order 8260.38, paragraphs 8-12, for construction of the en route, initial, and intermediate segments except as noted.

2.4.1 **Initial Segment.** Apply Order 8260.45, paragraph 5, if a TAA is desired.

2.4.2 **Intermediate segment.** The intermediate segment primary and secondary boundary lines connect at the plotted position of the FAF/PFAF at the appropriate primary and secondary final segment beginning widths. Turns at the FAF are not permitted for WAAS or IPV procedures.

2.5 REQUIRED NAVIGATIONAL PERFORMANCE (RNP) VALUES.

Procedures designed under this order are intended for use by aircraft navigation systems certified to RNP values. Each segment of an RNAV procedure has a specific RNP value. Table 2-1 lists RNP values by segment type.

Table 2-1. Segment RNP Values

Segment	Lateral (NM)	Vertical (feet)
En Route	2.0	500
Initial	1.0	500
Intermediate	0.5	250
WAAS Final	0.0384	40.57
IPV Final	0.30	125
LNAV	0.30	125
Missed Approach	1.0	

2.6 MAXIMUM AUTHORIZED GLIDEPATH ANGLES (GPA'S).

These tables list the MAXIMUM allowable GPA's and MINIMUM visibility by aircraft category, and MAXIMUM TCH values for allowing light credit (see tables 2-2A, B, and C).

Table 2-2A. Maximum GPA's

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

Table 2-2B. Standard Precision Landing Minimums

<table>
<tr><th colspan="2" rowspan="3">GLIDEPATH ANGLE
(WITH APPROACH LIGHT CONFIGURATION)</th><th rowspan="3">MINIMUM HAT</th><th colspan="4">AIRCRAFT CATEGORY</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>D & E</th></tr>
<tr><th colspan="4">MINIMUM VISIBILITY</th></tr>
<tr><td rowspan="3">3.00° — 3.10°</td><td>★</td><td>200</td><td colspan="4">3/4 4000</td></tr>
<tr><td>#</td><td>200</td><td colspan="4">1/2 2400</td></tr>
<tr><td>$</td><td>200</td><td colspan="4">1800</td></tr>
<tr><td rowspan="6">3.11° — 3.30°</td><td>★</td><td>200</td><td colspan="2">3/4 4000</td><td colspan="2">NA</td></tr>
<tr><td>★</td><td>250</td><td colspan="2">3/4 4000</td><td>1 5000</td><td>NA</td></tr>
<tr><td>#</td><td>200</td><td colspan="2">1/2 2400</td><td colspan="2">NA</td></tr>
<tr><td>#</td><td>250</td><td colspan="2">1/2 2400</td><td>3/4 4000</td><td>NA</td></tr>
<tr><td>$</td><td>200</td><td colspan="2">1800</td><td colspan="2">NA</td></tr>
<tr><td>$</td><td>250</td><td colspan="2">1800</td><td>½ 2400</td><td>NA</td></tr>
<tr><td rowspan="6">3.31° — 3.60°</td><td>★</td><td>200</td><td colspan="2">3/4 4000</td><td colspan="2">NA</td></tr>
<tr><td>★</td><td>270</td><td colspan="2">3/4 4000</td><td>1 5000</td><td>NA</td></tr>
<tr><td>#</td><td>200</td><td colspan="2">1/2 2400</td><td colspan="2">NA</td></tr>
<tr><td>#</td><td>270</td><td colspan="2">1/2 2400</td><td>3/4 4000</td><td>NA</td></tr>
<tr><td>$</td><td>200</td><td colspan="2">2000</td><td colspan="2">NA</td></tr>
<tr><td>$</td><td>270</td><td colspan="2">2000</td><td>1/2 2600</td><td>NA</td></tr>
<tr><td rowspan="2">3.61° — 3.80°</td><td>★</td><td>200</td><td colspan="2">3/4 4000</td><td colspan="2">NA</td></tr>
<tr><td>#</td><td>200</td><td colspan="2">1/2 2400</td><td colspan="2">NA</td></tr>
<tr><td rowspan="4">3.81° — 4.20°</td><td>★</td><td>200</td><td>3/4 4000</td><td colspan="3">NA</td></tr>
<tr><td>★</td><td>250</td><td>3/4 4000</td><td>1 5000</td><td colspan="2">NA</td></tr>
<tr><td>#</td><td>200</td><td>1/2 2400</td><td colspan="3">NA</td></tr>
<tr><td>#</td><td>250</td><td>1/2 2400</td><td>3/4 4000</td><td colspan="2">NA</td></tr>
<tr><td rowspan="2">4.21° — 5.00°</td><td>★</td><td>250</td><td>3/4 4000</td><td colspan="3">NA</td></tr>
<tr><td>#</td><td>250</td><td>1/2 2400</td><td colspan="3">NA</td></tr>
<tr><td rowspan="2">5.01° — 5.70°</td><td>★</td><td>300</td><td>1 5000</td><td colspan="3">NA</td></tr>
<tr><td>#</td><td>300</td><td>3/4 4000</td><td colspan="3">NA</td></tr>
<tr><td rowspan="2">5.71° — 6.40°
AIRSPEED
NTE 80 KNOTS</td><td>★</td><td>350</td><td>1 ¼</td><td colspan="3">NA</td></tr>
<tr><td>#</td><td>350</td><td>1 5000</td><td colspan="3">NA</td></tr>
</table>

★= No Lights $ = # Plus TDZ/CL Lights

= MALSR, SSALR, ALSF NA = Not authorized

NOTE: For a HAT higher than the minimum, the visibility (prior to applying credit for lights) shall equal the distance MAP to threshold, or (a) 3/4 mile up to 5.00°, or (b) 1 mile 5.01° through 5.70°, or (c) 1 1/4 miles 5.71° through 6.40°, whichever is the greater.

Table 2-2C. Threshold Crossing Height Upper Limits For Allowing Visibility Credit For Lights

HAT (Feet)	GLIDEPATH ANGLE (Degrees)	TCH UPPER LIMIT (Feet)	HAT (Feet)	GLIDEPATH ANGLE (Degrees)	TCH UPPER LIMIT (Feet)
200	3.00 - 3.20	75	300	3.00 - 4.90	75
	3.21 - 3.30	70		4.91 - 5.00	71
	3.31 - 3.40	66		5.01 - 5.10	66
	3.41 - 3.50	63		5.11 - 5.20	61
	3.51 - 3.60	59		5.21 - 5.30	56
	3.61 - 3.70	55		5.31 - 5.40	52
	3.71 - 3.80	50		5.41 - 5.50	48
	3.81 - 3.90	47		5.51 - 5.60	43
	3.91 - 4.00	43		5.61 - 5.70	39
	4.01 - 4.10	39			
	4.11 - 4.20	35	350	3.00 - 5.60	75
				5.61 - 5.70	70
250	3.00 - 4.10	75		5.71 - 5.80	65
	4.11 - 4.20	71		5.81 - 5.90	60
	4.21 - 4.30	67		5.91 - 6.00	55
	4.31 - 4.40	62		6.01 - 6.10	50
	4.41 - 4.50	58		6.11 - 6.20	45
	4.51 - 4.60	54		6.21 - 6.30	40
	4.61 - 4.70	50		6.31 - 6.40	35
	4.71 - 4.80	45			
	4.81 - 4.90	41			
	4.91 - 5.00	37			
270	3.00 - 4.40	75			
	4.41 - 4.50	73			
	4.51 - 4.60	68			
	4.61 - 4.70	64			
	4.71 - 4.80	59			
	4.81 - 4.90	55			
	4.91 - 5.00	51			

2.7 THRESHOLD CROSSING HEIGHT (TCH).

Select the appropriate TCH from table 2-3. Publish a note indicating visual glide slope indicator (VGSI) not coincident with the procedure GPA when the VGSI angle is more than 0.2 degrees from the WAAS GPA, or when the VGSI TCH is more than 3 feet from the WAAS TCH.

Table 2-3. TCH Requirements

Representative Aircraft Type	**Approximate 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, 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-747/767/777, 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.).

2.8 GROUND POINT OF INTERCEPT (GPI).

Calculate GPI distance using the following formula:

$$GPI = \frac{TCH}{\tan(GPA)}$$

2.8.1 GPI distance less than 954 feet.

Whenever the GPI distance is less that 954 feet, an additive must be applied to the height of the obstructions when they are evaluated against the final approach OCS. Application of the additive yields the obstruction's effective height above ASBL. Determine the value of the adjustment by applying the following formula:

$$\text{Effective Height} = H + \text{adjustment}$$

Where H = the obstacle height in feet above ASBL

$$\text{adjustment} = \frac{GPA \times (954' - GPI)}{102}$$

Example: $H = 64'$, $GPA = 3$

$$\text{adjustment} = \frac{3 \times (954' - 867')}{102} = 2.56'$$

$$\text{Effective height} = 64' + 2.56' = 66.56'$$

2.9 DETERMINING FPAP COORDINATES

The positional relationship between the LTP and the FPAP determines the final approach ground track. Geodetically calculate the latitude and longitude of the FPAP

course is the runway bearing) as a forward azimuth value, and an appropriate distance. If an ILS or MLS serves the runway, the appropriate distance in feet is the

, or the distance between the LTP and the DER, whichever is greater

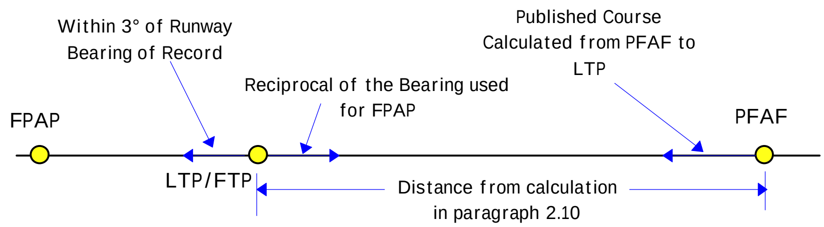
the appropriate distance for runways not served by an ILS or MLS.

Table 2-4. Runways not served by an ILS or MLS

	FPAP Distance from LTP		**± Width**
≤ 9,023'	9,023'	2.0°	350'
> 9,023' and ≤ 12,366'	to DER	$\tan^{-1}\left(\frac{350}{\text{RWY length} + 1000}\right)$	350'
> 12,366 and ≤ 16,185'	to DER	1.5°	$\tan(1.5) \times (\text{RWY length} + 1{,}000))$
> 16,185' (AFS or Appropriate Military Agency Approval)	to DER or as specified by approving agency	1.5°	$\tan(1.5) \times (\text{RWY length} + 1{,}000))$

2.10 DETERMINING PFAF/FAF COORDINATES. See figure 2-1.

Figure 2-1. Determining PFAF location



Geodetically calculate the latitude and longitude of the PFAF using the reciprocal (180°) of the desired final approach course, and the horizontal distance (D3) from the LTP or FTP to the point the glidepath intercepts the intermediate segment altitude. Determine D3 using the following formulae:

	Formula	Example
Step 1:	$B = A - F$	$1537.7 = 2100 - 562.3$
Step 2:	$D1 = \frac{B}{\text{Tan}(GPA)}$	$29341.06 = \frac{1537.7}{\text{Tan}(3)}$
Step 3:	$EC1 = \left(\frac{D1}{NM}\right)^2 \times 0.88466$	$20.63 = \left(\frac{29341.06}{6076.11548}\right)^2 \times 0.88466$
Step 4:	$D2 = \frac{B - EC1}{\text{Tan}(GPA)}$	$28947.42 = \frac{1537.7 - 20.63}{\text{Tan}(3)}$
Step 5:	$EC2 = \left(\frac{D2}{NM}\right)^2 \times 0.88466$	$20.08 = \left(\frac{28947.42}{6076.11548}\right)^2 \times 0.88466$
Step 6:	$D3 = \frac{B - EC2}{\text{Tan}(GPA)}$	$28957.91 = \frac{1537.7 - 20.08}{\text{Tan}(3)}$

Where:
D1 = Distance from LTP first iteration
D2 = Distance from LTP second iteration
D3 = Distance from LTP final iteration
A = FAF Altitude (example 2100)
B = Total altitude lost from FAF to RWT
F = LTP elevation + TCH (example 562.3)
EC1 = Earth Curvature for first iteration distance
EC2 = Earth Curvature for second iteration distance
GPA = Glidepath angle (example 3.0°)
NM = 6076.11548 feet

Determine the PFAF coordinates with the direct geodetic function, using the specified bearing and distance D3. If the procedure will provide nonprecision minima, locate the FAF coincident with the PFAF. LNAV is not authorized when the PFAF is more than 10 NM from RWT. FAF coordinates may require recalculation when WAAS is added to an existing LNAV procedure.

2.11 COMMON WAYPOINTS.

Design all procedures published on the same chart to use the same sequence of charted waypoints.

2.12 CLEAR AREAS AND OBSTACLE FREE ZONES (OFZ).

Airports is responsible for maintaining obstruction requirements in AC 150/5300-13, Airport Design. If approach lights are not installed or not planned, the inner approach OFZ does not apply. Penetration of the runway OFZ and the inner approach OFZ (see figures 2-2 and 2-3) may effect minimums. When obstacles penetrate either the runway or approach OFZ, TERPS paragraph 332 does not apply, visibility credit for lights is not authorized, and the lowest authorized HAT and visibility values are:

- For GPA ≤ 4.2°: 300-¾
- For GPA > 4.2°: 400-1

Figure 2-2. Inner Approach OFZ Approach Light Area

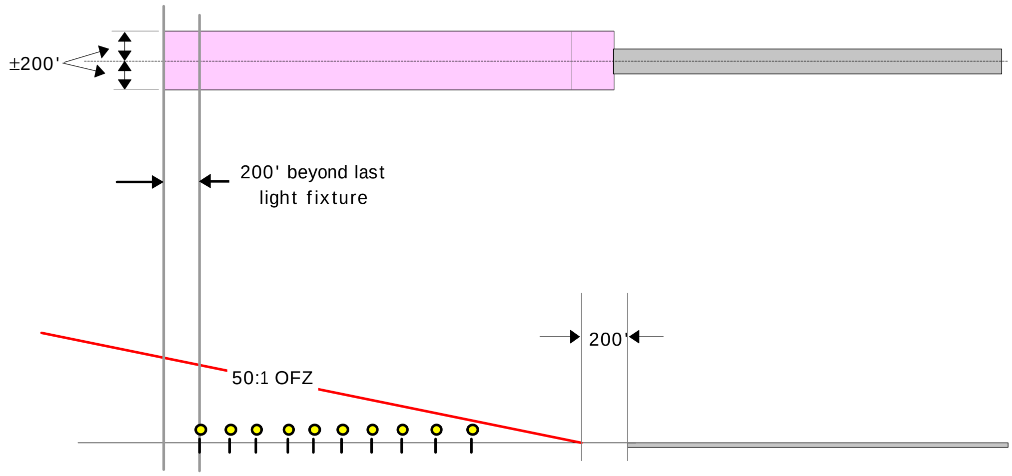
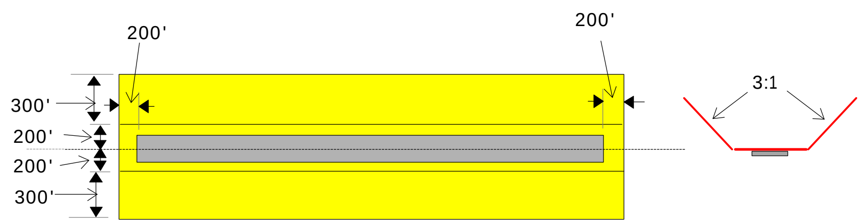


Figure 2-3. Inner Transitional OFZ



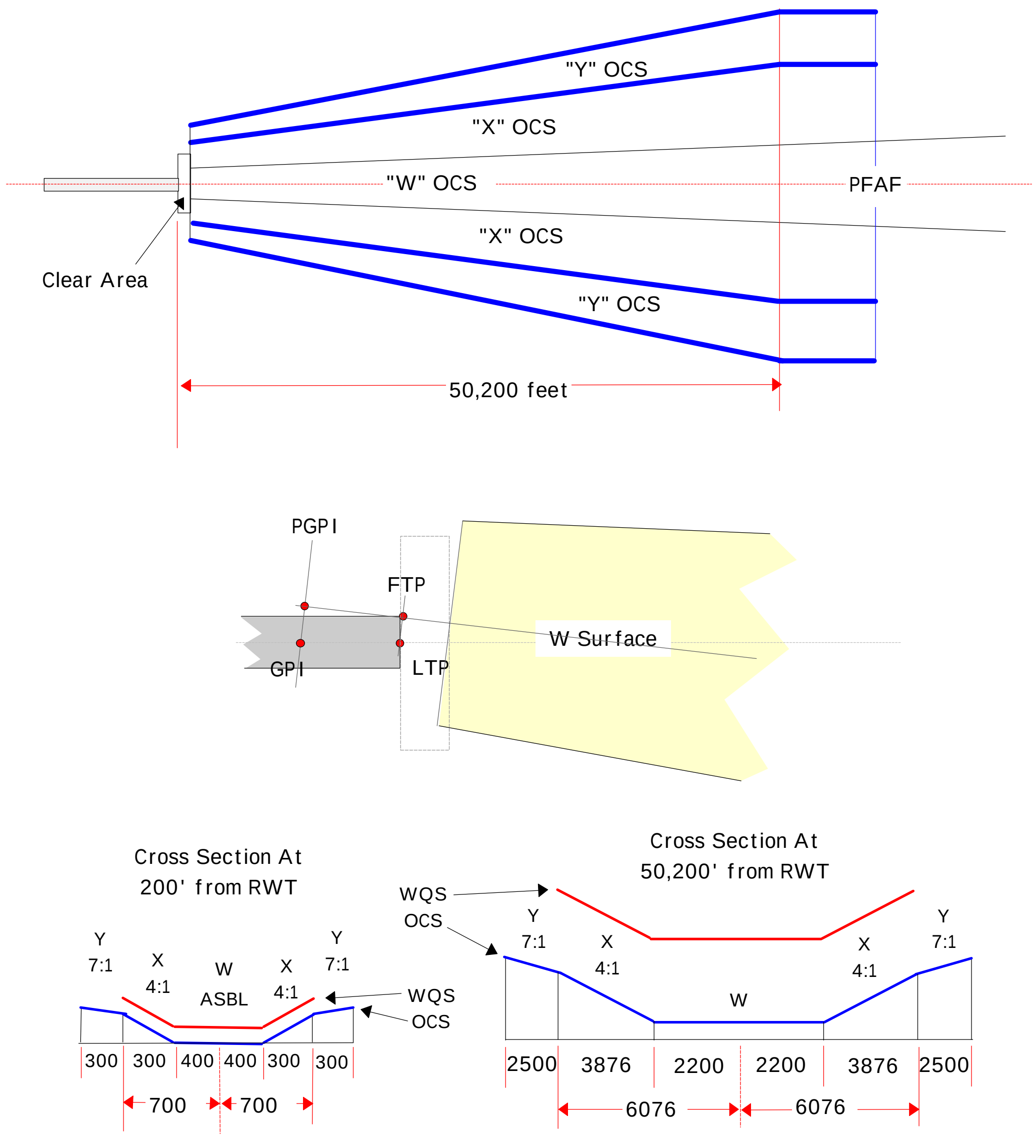
CHAPTER 3. FINAL & MISSED APPROACH SEGMENTS

SECTION 1. WIDE AREA AUGMENTATION SYSTEM (WAAS)

3.1 WAAS FINAL SEGMENT.

The WAAS final approach area begins at the PFAF and ends at a point 200 feet prior to the LTP or FTP (see figure 3-1). The primary area consists of the "W" and "X" OCS, and the secondary area consists of the "Y" OCS. When the PFAF is located beyond the 50,200-foot point, the OCS boundaries will parallel the course between the 50,200-foot point and the PFAF.

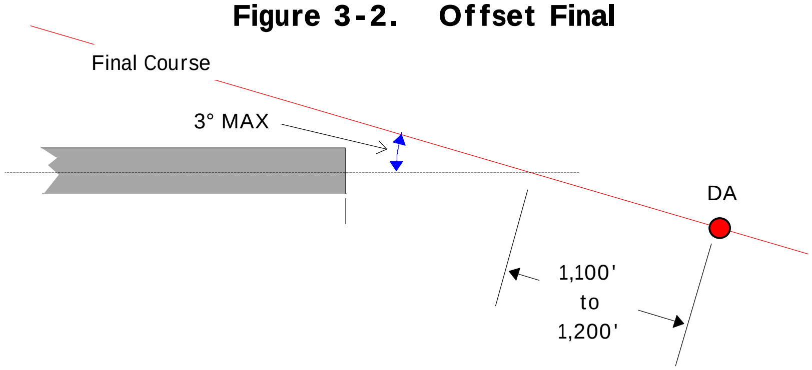
Figure 3-1. WAAS Obstacle Clearance Areas



3.1.1 Alignment.

The final course is normally aligned through the RWT. 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 RWT from the DA point on the glidepath and the angular divergence of the course does NOT exceed 3° (see figure 3-2).

Figure 3-2. Offset Final



3.1.2 Obstacle Clearance Surface (OCS) Slope (S).

Determine the OCS slope associated with a specific GPA using the following formula:

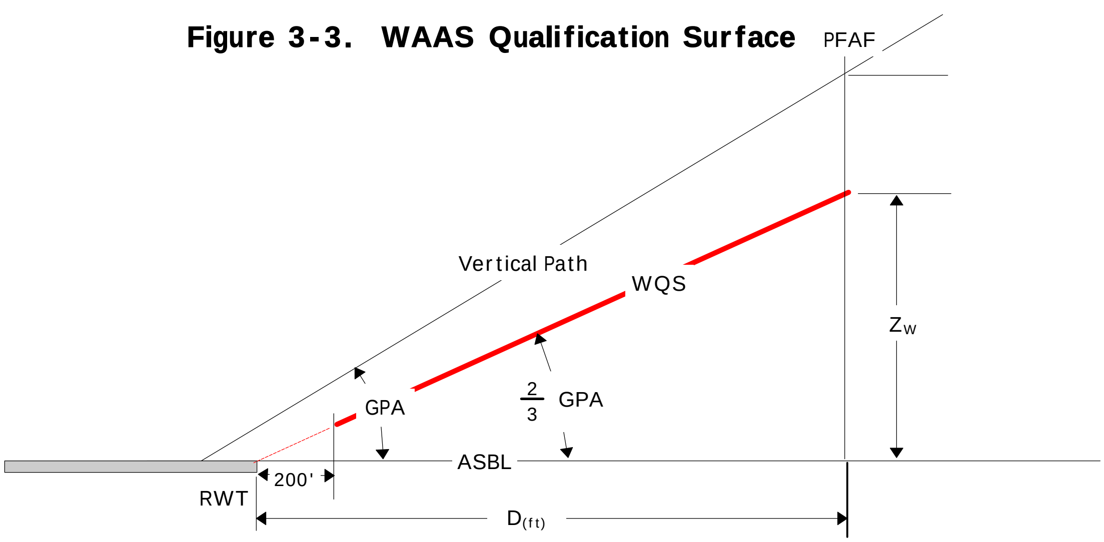
$$S = \frac{102}{GPA} \qquad \text{example: } \frac{102}{3} = 34$$

3.1.2.1 WAAS Qualification Surface (WQS).

Evaluate the WQS as an initial screening process to determine feasibility of the proposed procedure (see figure 3-3). If the WQS is penetrated, a WAAS procedure is not allowed.

NOTE: Penetrations of the OCS's result in higher minimums.

Figure 3-3. WAAS Qualification Surface



3.1.2.1.1 Length.

The WQS extends longitudinally from a point 200 feet outward from the LTP or FTP to the PFAF.

3.1.2.1.2 Width.

The WQS overlies the PRIMARY OCS's (w and x surfaces). See figure 3-1.

3.1.2.1.3 Height.

The WQS W surface (z_w) starts at the RWT and extends outward and upward at 2/3 the GPA value. Calculate the height of the WQS surface using the formula:

$$z_W = \tan\left(\frac{2 \times GPA}{3}\right) \times D$$

Where D = the distance in feet from RWT in feet

Calculate the height WQS X surface (z_x) of the x surface above ASBL using the formula:

$$z_X = z_W + \frac{b - D_W}{4}$$

Where:

b = the obstacle perpendicular distance in feet from centerline

D_W = *half* width of "W" OCS

3.1.2.1.4 WQS Penetrations.

Do NOT establish a WAAS procedure if the WQS is penetrated. Adjust obstruction height, raise the GPA, or displace the RWT to eliminate penetrations of the WQS.

3.1.2.2 Precision Object Free Area (POFA)

An area centered on the runway centerline extended, beginning at the RWT, 200 feet long, and ± 400 feet wide. Airports is responsible for maintaining POFA obstruction requirements in AC 150/5300-13 (see figure 3-4).

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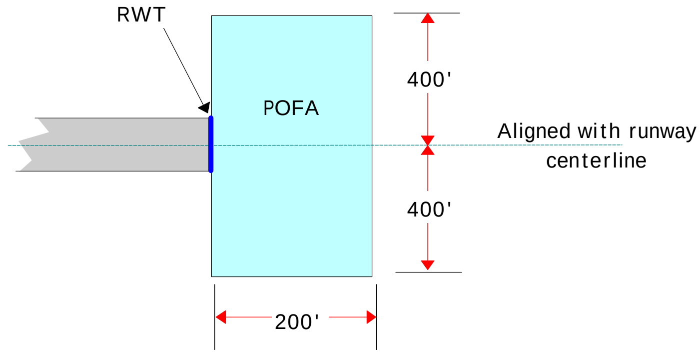
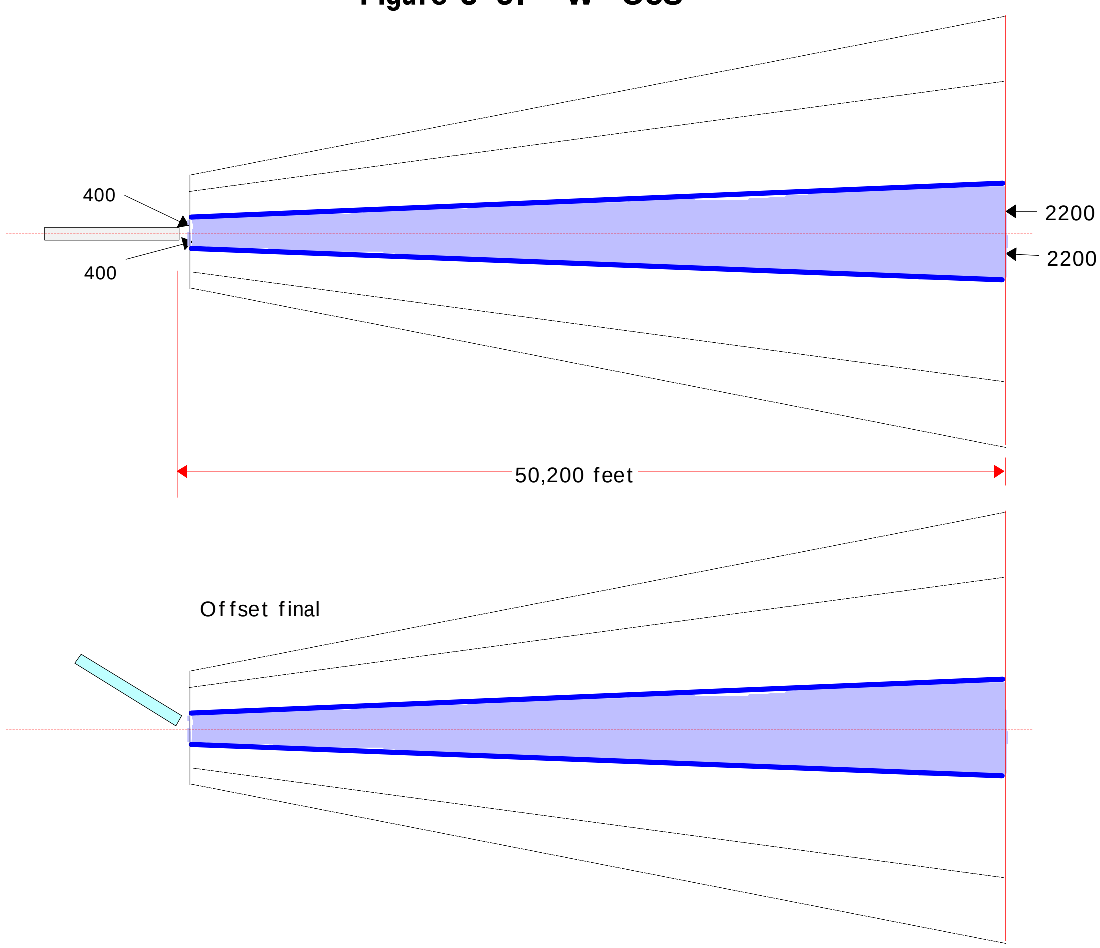
Figure 3-4. POFA



Scale exaggerated for emphasis

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

Figure 3-5. "W" OCS



3.1.2.3.1 Length.

The "W" OCS begins at 200 feet from LTP or FTP, measured along course centerline and extends to the PFAF.

3.1.2.3.2 Width.

The width is 400 feet either side of course at the beginning, and expands uniformly to 2,200 feet either side of course 50,200 feet from LTP or FTP, as defined by the formula:

$$D_W = 0.036 \times (D - 200) + 400$$

Where D = the distance in feet from LTP or FTP.

D_W = Perpendicular distance in feet from course to "W" surface outer boundary.

If the PFAF is more than 50,200 feet from LTP or FTP, the OCS maintains a constant width of 2,200 feet either side of course from 50,200 feet to the PFAF.

3.1.2.3.3 Height.

The height (Z_W) of the "W" OCS above ASBL is defined by the formula:

$$Z_W = \frac{D - 200}{S}$$

Where D = the distance in feet from RWT

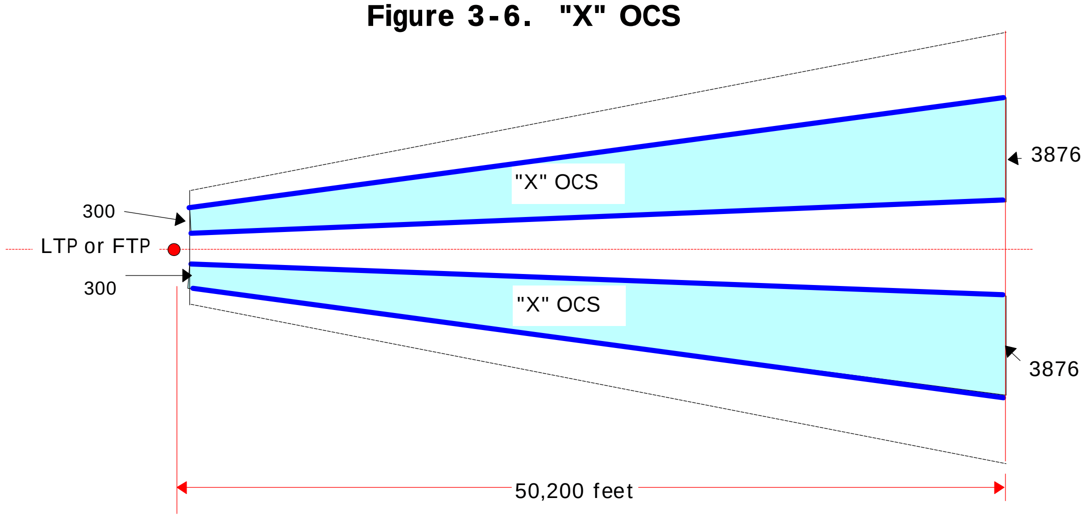
S = "W" surface slope

3.1.2.3.4 "W" OCS Penetrations.

Penetrations of the "W" surface are not authorized. Adjust obstruction height, raise the GPA, or displace the RWT to eliminate penetrations of the "w" surface.

3.1.2.4 "X" OCS. See figure 3-6.

Figure 3-6. "X" OCS



3.1.2.4.1 Length.

The "X" OCS originates 200 feet from the LTP or FTP and extends to the PFAF.

3.1.2.4.2 Width.

The perpendicular distance (D_X) from the course to the outer boundary of the "X" OCS is defined by the formula:

$$D_X = 0.10752 \times (D - 200) + 700$$

Where D = the distance in feet from LTP or FTP.

If the PFAF is more than 50,200 feet from LTP or FTP, the OCS maintains a constant width of 3,876 feet either side of course from 50,200 feet to the PFAF.

3.1.2.4.3 Height.

Determine the height (Z_X) above ASBL for a specific location the "X" OCS using the following formula:

$$Z_X = \frac{D - 200}{S} + \frac{D_O - D_W}{4}$$

Where D = the distance in feet from LTP or FTP,

D_O = the perpendicular distance in feet between course centerline and a specific point in the "X" surface

D_W = the perpendicular distance between course centerline and the "W" surface boundary.

$$S = \text{Slope associated with GPA} \left[\frac{102}{GPA}\right]$$

3.1.2.4.4 "X" OCS Penetrations.

Lowest minimums can be achieved when the "X" OCS is clear. To eliminate, avoid, or mitigate a penetration, take one of the following actions listed in the order of preference.

3.1.2.4.4.1 Remove or adjust the obstruction location and/or height.

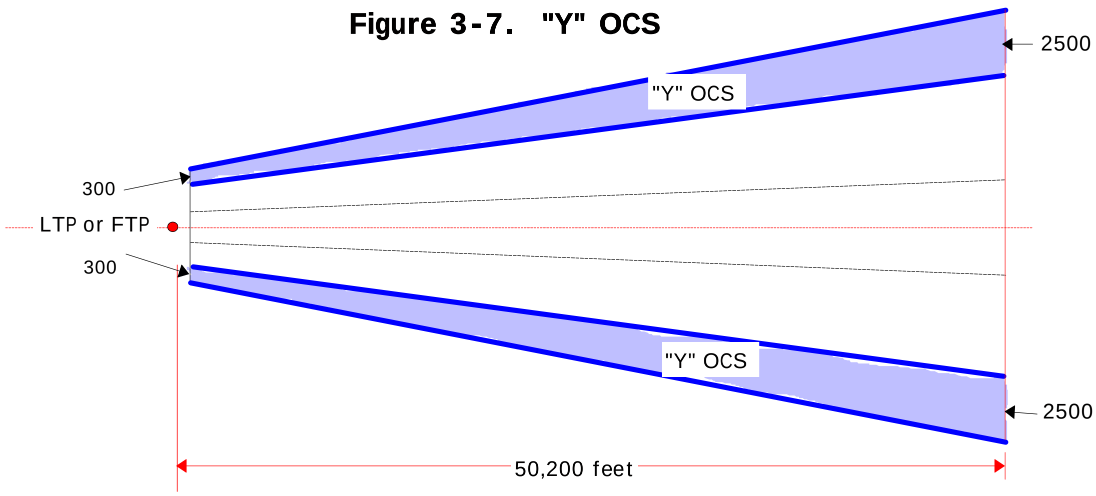
3.1.2.4.4.2 Displace the RWT.

3.1.2.4.4.3 Raise the GPA within the limits of table 2-2A.

3.1.2.4.4.4 Adjust DA. See paragraph 3.1.4.

3.1.2.5 "Y" OCS. See figure 3-7.

Figure 3-7. "Y" OCS



3.1.2.5.1 Length.

The "Y" OCS originates 200 feet from the LTP or FTP, as appropriate, and extends outward to the PFAF.

3.1.2.5.2 Width.

The perpendicular distance (D_Y) from the runway centerline extended to the outer boundary of the "Y" OCS is defined by the formula:

$$D_Y = 0.15152 \times (D - 200) + 1000$$

Where D is the distance in feet from the LTP or FTP.

If the PFAF is more than 50,200 feet from LTP or FTP, as appropriate, the OCS maintains a constant width of 2,500 feet either side of course from 50,200 feet to the PFAF.

3.1.2.5.3 Height.

The height (Z_Y) of the "Y" surface above ASBL is defined by the formula:

$$Z_Y = \frac{D - 200}{S} + \frac{D_X - D_W}{4} + \frac{D_o - D_X}{7}$$

Where D = the distance in feet from the LTP or FTP,

D_X = the perpendicular distance in feet between course centerline and "X" surface outer bondary,

D_0 = perpendicular distance in feet between course centerline and an obstruction in the "Y" surface.

3.1.2.5.4 "Y" OCS Penetrations.

Lowest minimums can be achieved when the "Y" OCS is clear. When the OCS is penetrated, remove the obstruction or reduce its height to clear the OCS. If this is not possible, consider the obstruction's physical nature, the amount of penetration, obstruction location with respect to the "X" surface boundary, and density of the obstruction environment to determine if the procedure requires adjustment.

- If an adjustment is required, take the appropriate actions from the following list:

  a. Adjust DA.

  b. Displace threshold.

  c. Offset final course.

  d. Raise GPA.

- If an adjustment is not required, or if the OCS is penetrated after adjustment is made, CHART the obstruction.

3.1.3 Decision Altitude (DA) and Height Above Touchdown (HAT).

The DA value may be derived from the HAT. The MINIMUM HAT for Category I operations is 200 feet. Calculate the DA using the following formula:

$$DA = HAT + TDZE$$

3.1.4 Adjustment of DA for OCS Penetrations.

The distance from GPI to the DA may be increased to ensure DA occurs at a height above ASBL providing sufficient obstruction clearance.

3.1.4.1 Determine the distance from GPI or PGPI to the adjusted DA point using the following formula:

$$D_{adjusted} = \frac{H \times 102}{GPA} + 200 + GPI$$

Where $D_{adjusted}$ = the adjusted distance in feet from GPI to the adjusted DA

H = the obstacle height in feet above ASBL

3.1.4.2 Calculate the adjusted HAT using the following formula:

$$HAT = \tan(GPA) \times D_{adjusted} - (TDZE - LTP \text{ or } FTP \text{ elevation})$$

Where d = adjusted distance value from above

3.1.4.3 Calculate the revised minimum HAT/maximum ROC using the following formula:

$$\text{Min Hat and Max ROC} = \frac{GPA}{3} \times 250$$

3.1.4.4 Compare HAT and Minimum HAT. Publish the higher of the two values. Calculate the DA value using the formula in paragraph 3.1.3.

3.1.4.5 Initiate action to mark and light obstruction(s) that would cause DH adjustment when they are located between the DA and the end of the final segment.

3.1.5 MISSED APPROACH.

The missed approach segment begins at DA and ends at the clearance limit. It is comprised of section 1 (initial climb) and section 2 (from end of section 1 to the clearance limit). Section 2 is constructed under criteria contained in Order 8260.44. The area beginning width is ± 0.5 NM. The 40:1 OCS begins at the elevation of section 1b at centerline. The MA procedure is limited to two turn fixes.

3.1.5.1 Section 1.

Section 1 is aligned with the final approach course. It is comprised of 3 subsections, beginning at DA and extending 1.5 NM.

3.1.5.1.1 Section 1a.

3.1.5.1.1.1 Area.

Section 1a begins at the DA point and overlies the final approach primary ("W" and "X" surfaces) OCS, extending 1,460 feet in the direction of the missed approach. This section is always aligned with the final approach course (see figure 3-8).

3.1.5.1.1.2 OCS.

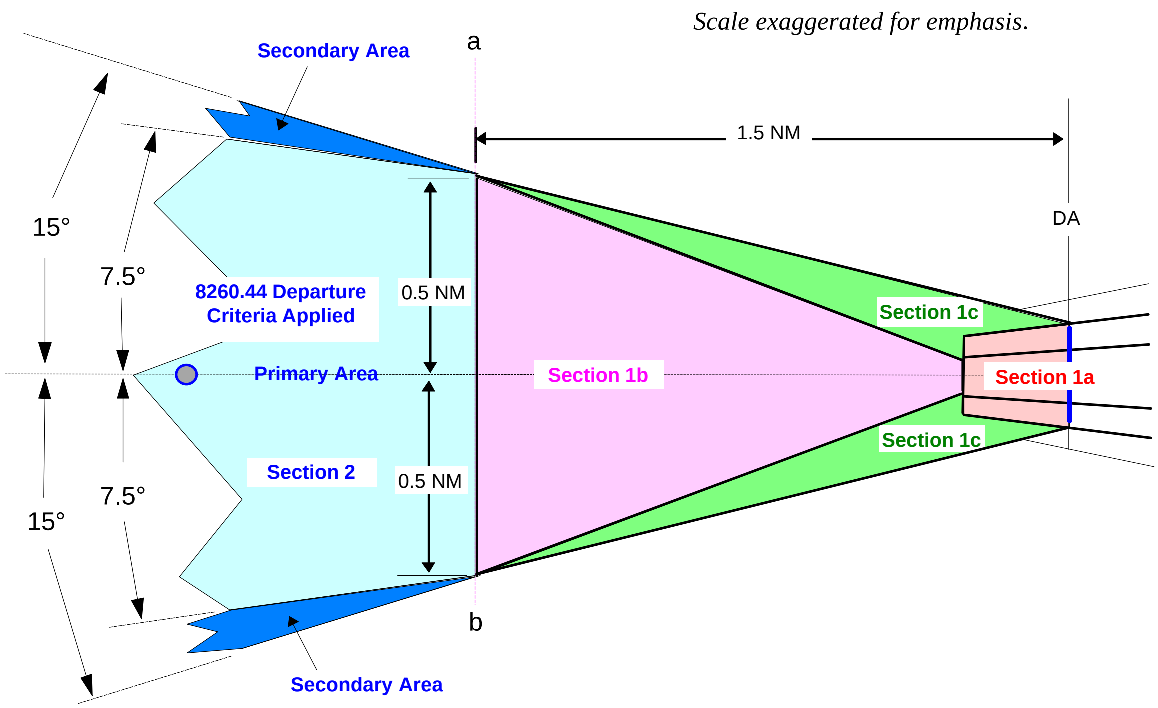
The height of the section 1a surface is equal to the underlying "W" or "X" surface as appropriate. Penetrations of this surface are not allowed.

3.1.5.1.2 Section 1b.

3.1.5.1.2.1 Area.

Section 1b begins at the end of section 1a, and splays along the extended final course to a total width of 1 NM. This section is always aligned with the final approach course (see figure 3-8).

Figure 3-8. Straight Missed Approach



3.1.5.1.2.2 **OCS.**

Section 1b OCS is a 28.26:1 inclined plane rising in the direction of the missed approach. The height of the beginning of section 1b is equal to the height of the "W" OCS at the end of section 1a. Evaluate obstructions using the shortest distance of the obstruction from the end of section 1a (see figure 3-8).

3.1.5.1.3 **Section 1c.**

3.1.5.1.3.1 **Area.**

These are 7:1 secondary areas which begin at the DA point. These sections splay to a point on the edge and at the end of section 1b. Obstacles in section 1c that are adjacent to the "X" surfaces are evaluated using the 7:1 surface, beginning at the elevation of the outer edge of the "X" surfaces. Obstacles in section 1c, adjacent to section 1b, are evaluated using the 7:1 surface beginning at the elevation of the outer edge of section 1b (see figure 3-8).

3.1.5.1.3.2 **OCS.**

An inclined plane starting at the DA point and sloping 7:1, perpendicular to the MA course. The inner boundaries originate at the elevation of the outer edges of the "W" surface at the beginning of section 1b. The outer boundaries originate at the elevation of the outer edges of the "X" surfaces at the DA point. These inner and outer boundaries converge at the end of section 1b (1.5 NM from the DA point).

Obstacles in section 1c, adjacent to the "X" surfaces, are evaluated with a 7:1 slope from the elevation of the outer boundaries of the "X" surfaces. Obstacles in section 1c, adjacent to section 1b, are evaluated using the 7:1 slope, beginning at the elevation at the outer edge of section 1 (see figure 3-8).

3.1.5.2 Section 2.

Apply Order 8260.44 criteria in this section. Instead of the departure trapezoid originating at DER altitude at the DER, it originates at the elevation of the end of section 1b OCS at centerline, with a width of ± 0.5 NM (along the ab line). It ends at the plotted position of the clearance limit. The primary and secondary widths shall be the appropriate width from the distance flown. Establish a fix on the continuation of the final approach course at least 0.5 NM from the end of section 1 (ab line). If the fix is a flyby turning waypoint, locate the fix at least DTA+0.5 NM from the ab line (see figures 3-9A and B). Use table 3-1 airspeeds to determine turn radii from Order 8260.44, table 2. Establish the outer boundary radius of a turning procedure based on the highest category aircraft authorized to use the approach.

Table 3-1

Category	***< 10,000' MSL***	***³ 10,000' MSL***
A, B	200 KIAS	200 KIAS
C, D, E	250 KIAS	310 KIAS

Figure 3-9A. Turning Missed Approach With Turning Fix At The Minimum Required Distance

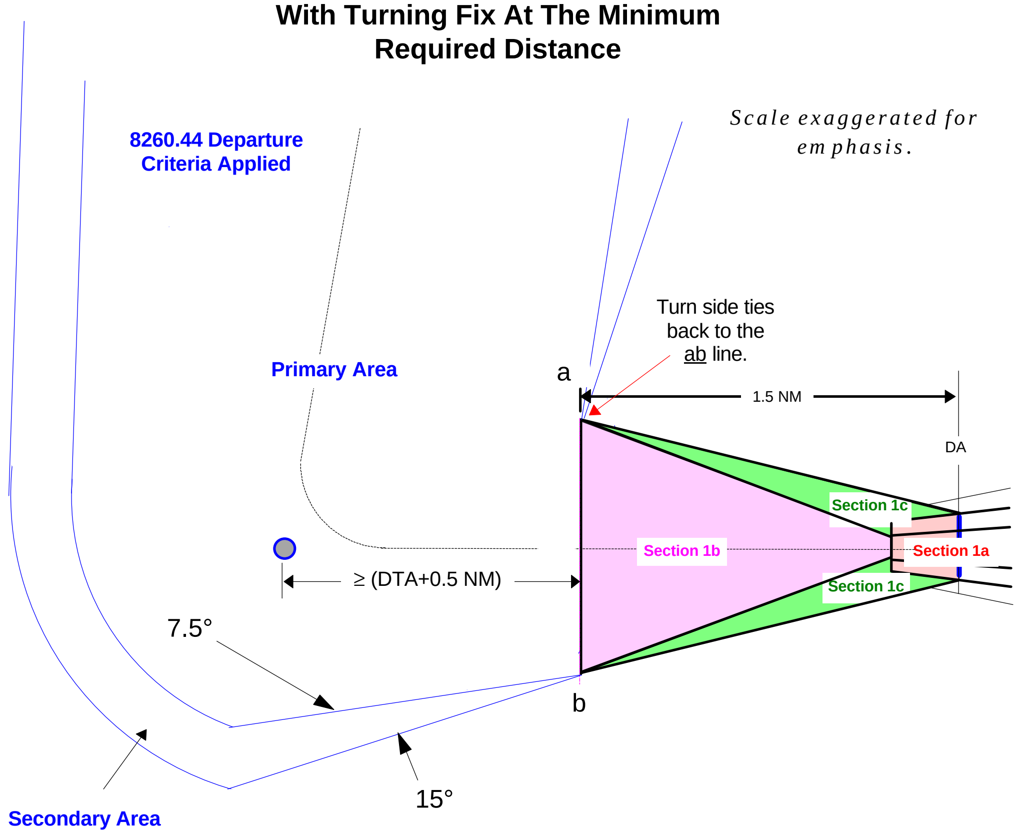
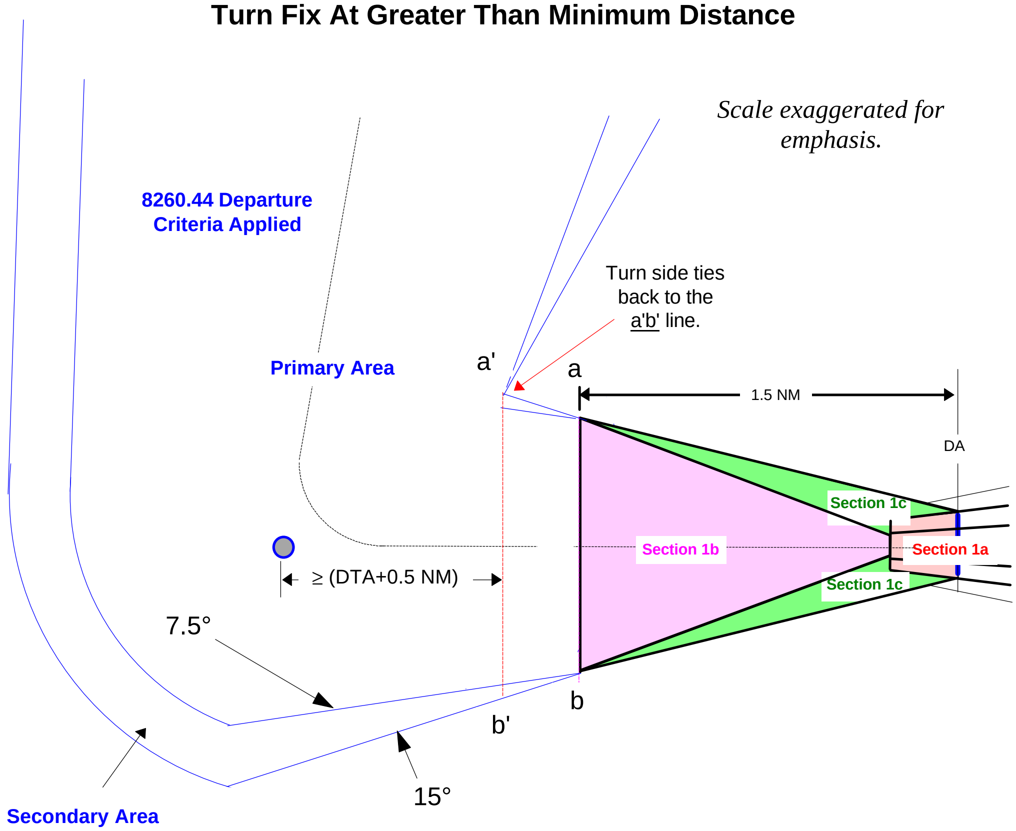


Figure 3-9B. Turning Missed Approach With Turn Fix At Greater Than Minimum Distance



3.1.5.3 Missed Approach Altitude.

3.1.5.3.1 Straight Missed Approach Procedures. Use TERPS paragraphs 274b and d to establish the charted missed approach altitude. Use TERPS paragraph 274c to determine if a climb-in-holding evaluation is required.

3.1.5.3.2 Combination straight-turning missed approach procedures. Use TERPS paragraphs 277d and f to establish the charted missed approach altitude. Use TERPS paragraph 277e to determine if a climb-in-holding evaluation is required.

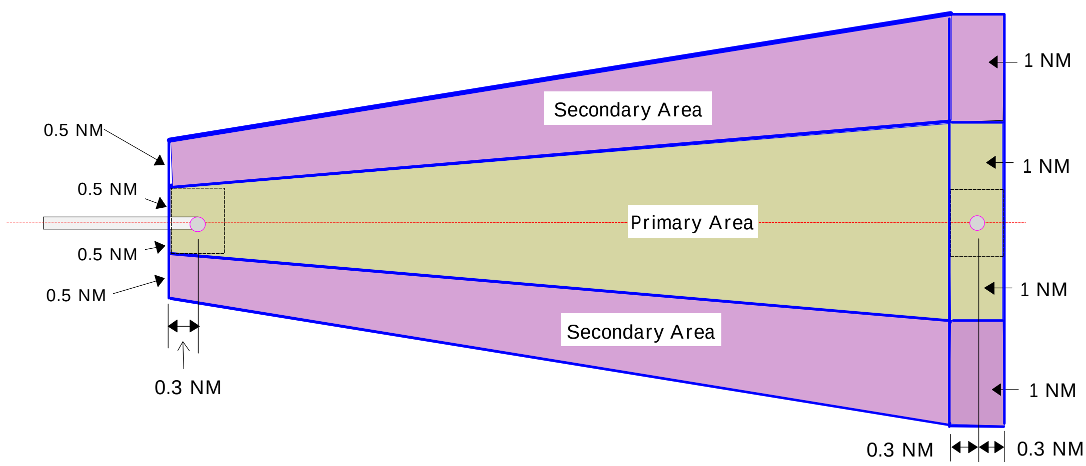
SECTION 2. INSTRUMENT PROCEDURE WITH VERTICAL GUIDANCE (IPV)

3.2 FINAL APPROACH SEGMENT.

The IPV TCH and GPA shall match the WAAS precision TCH and GPA. The IPV GPA is limited to angles between 2.75° and 3.5°. If the WAAS precision GPA is greater than 3.5°, do not publish IPV minimums. When minimums are based on remote altimeter settings, or the final segment overlies precipitous terrain, annotate the chart with a note to indicate BAROMETRIC VNAV is not authorized.

3.2.1 AREA. See figure 3-10.

Figure 3-10. IPV Primary and Secondary Areas



3.2.1.1 Alignment.

The IPV and WAAS courses shall be identical. Locate the FAF at the PFAF location.

3.2.1.2 Length.

The primary OCS begins at the earliest point the FAF can be received and extends 0.3 NM past the RWT or FTP.

3.2.1.3 Width.

3.2.1.3.1 Primary Area.

Calculate the perpendicular distance (D_Y) from the course extended to the outer boundary of the primary area for any distance (D) from RWT or FTP using the following formula:

$$D_Y = \frac{0.5\ NM}{L} \times (D + 1822.83) + 3038.06$$

Where D = the distance in feet from RWT or FTP along centerline

L = the final length in NM from plotted position of FAF to plotted position of RWT or FTP

3.2.1.3.2 Secondary Area.

The width of the secondary area is equal to the ½ width of the primary at any distance "D" from RWT or FTP. See paragraph 3.2.1.3.1.

3.2.2 Obstruction Clearance Surfaces.

3.2.2.1 IPV Qualification Surface (IQS).

Application of this surface determines the applicability of vertical guidance criteria to the specific obstruction environment.

3.2.2.1.1 Length.

The IQS extends from a point 200 feet outward from the RWT or FTP to the FAF.

3.2.2.1.2 Width.

The IQS overlies the PRIMARY Area (see figures 3-11 and 12).

Figure 3-11. IPV Qualification Surface (IQS)

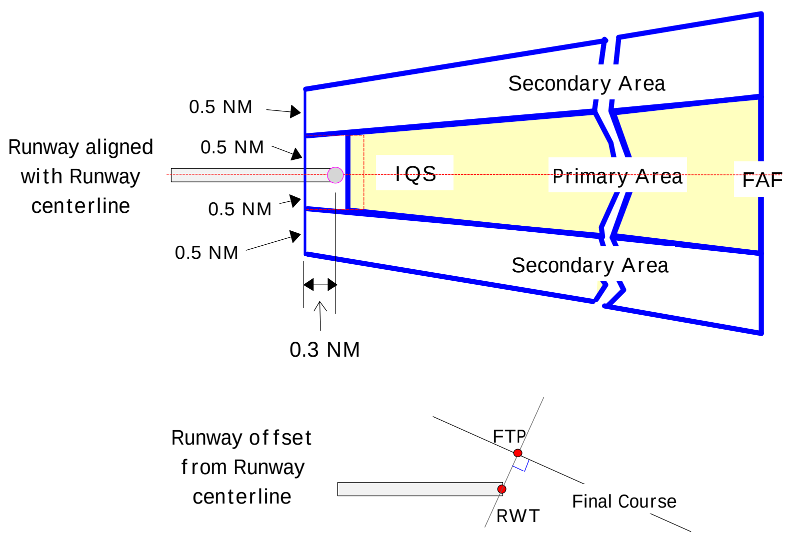
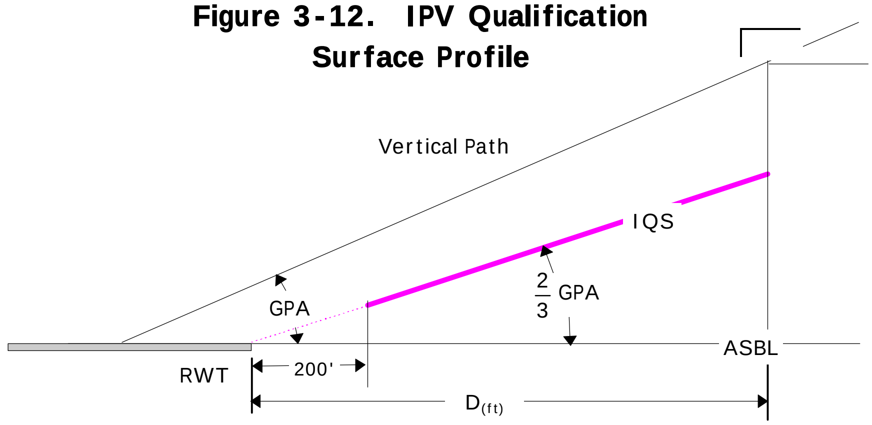


Figure 3-12. IPV Qualification Surface Profile



3.2.2.1.3 IQS Height.

Calculate the height (V_Z) of the IQS above ASBL assuming the origin point is at the RWT (see figure 3-12). The height is defined by the formula:

$$V_Z = \tan\left(\frac{2 \times GPA}{3}\right) \times D$$

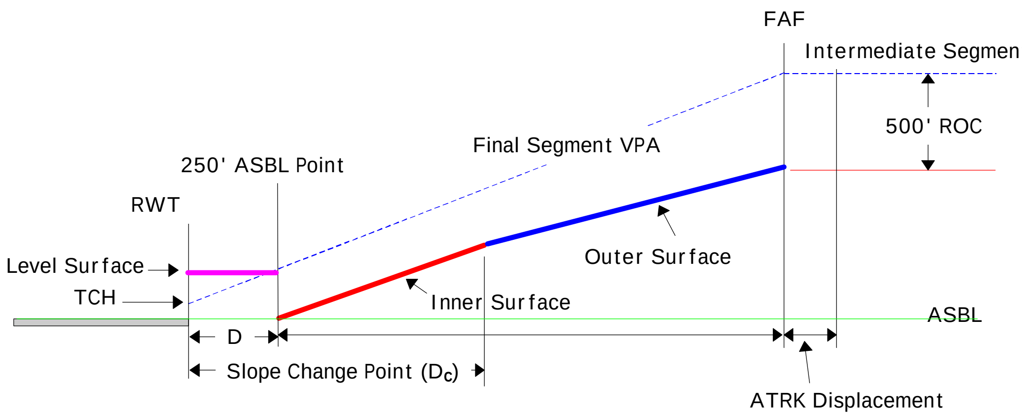
Where D is the distance from RWT or FTP

3.2.2.1.4 IQS Penetrations.

A penetration of the IQS disqualifies the proposed IPV approach procedure. Consider raising the GPA or displacing RWT to clear the penetrating obstruction. If the IQS is not clear, the IPV procedure is not allowed (see figure 3-12).

3.2.2.2 Primary OCS. See figure 3-13.

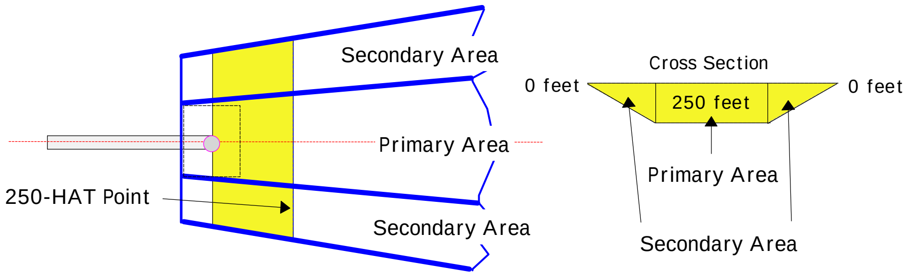
Figure 3-13. IPV OCS's



3.2.2.2.1 Obstruction Clearance Inside 250-foot DA Point.

The area between the RWT or FTP and the 250 feet above ASBL point consists of primary and secondary ROC areas. Apply ROC in the appropriate shaded area below to arrive at a preliminary DA (pDA) (see figure 3-14).

Figure 3-14. Obstacle Clearance Inside the 250 Feet Above ASBL Point



3.2.2.2.1.1 Primary Area.

Apply 250 feet ROC to the highest obstruction (see figure 3-14).

3.2.2.2.1.2 Secondary Area.

Calculate secondary area ROC using the following formulae:

$$D_P = \frac{3{,}038.06}{L} \times \left(D_X + 1{,}822.83\right) + 3038.06 \qquad \text{Example: } \frac{3{,}038.06}{28{,}557.74} \times \left(3{,}000 + 1{,}822.83\right) + 3{,}038.06 = 3{,}551.13$$

$$D_S = D_P$$

$$ROC_S = \frac{250}{D_S} \times \left(\left[2 \times D_S\right] - D_Y\right) \qquad \text{Example: } \frac{250}{3{,}551.15} \times \left(\left[2 \times 3{,}551.15\right] - 4{,}200\right) = 204.32$$

Where

L = final length in feet (plotted position of FAF to plotted position of RWT or FTP).

DP = the distance in feet from runway centerline to the primary area outer boundary.

D_S = the width of the secondary area at distance D_X.

D_X = the distance in feet from RWT or FTP to the obstacle measured along centerline.

D_Y = the perpendicular distance in feet from course centerline to the obstacle.

3.2.2.2.1.3 Preliminary DA (pDA).

Determine the pDA by adding the appropriate ROC value to the controlling obstruction height and round up to the next higher 20-foot increment.

3.2.2.2.2 Vertical OCS.

3.2.2.2.2.1 Inner Surface Slope (S_I).

The inner surface begins at the point on the ASBL corresponding to the location of the 250 feet above ASBL point (see figure 3-14). Calculate the distance (**D_{250}**) from RWT or FTP to the OCS origin using the following formula:

$$D_{250} = \frac{250 - TCH}{\tan(GPA)} \qquad \text{Example: } \frac{250 - 53}{\tan(3)} = 3{,}758.98'$$

Take the following actions to determine the S_I:

3.2.2.2.2.1.1 Obtain the mean low temperature of the coldest month of the year for the last five years of data. If the data is given in Fahrenheit (°f), convert the temperature to Celsius (°c) using the following formula:

$$^\circ c = \frac{5}{9} \times (^\circ f - 32^\circ f) \qquad \text{Example: } \frac{5}{9} \times (76^\circ f - 32^\circ f) = 24.4^\circ c$$

3.2.2.2.2.1.2 Convert the mean temperature into a deviation from ISA using the following formula:

$$\text{deviation} = ^\circ c - \left[15^\circ c - \left(\frac{\text{Airport Elevation}}{500}\right)\right] \qquad \text{Example: } -28 - \left[15^\circ c - \left(\frac{1{,}528}{500}\right)\right] = -39.9^\circ$$

3.2.2.2.2.1.3 Round deviation to the next lower 5°c increment. Use this rounded deviation or -15°c, whichever is lower, and the GPA to find the surface slope from table 3-2.

Table 3-2. S_I Considering GPA and International Standard Atmosphere (ISA) Temperature Deviation

ISA (C) DEV	2.7	2.8	2.9	3	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8
-10	23.2	22.4	21.7	21.0	20.4	19.8	19.3	18.8	18.3	17.8	17.4	17.0
-15	23.8	23.0	22.2	21.6	20.9	20.3	19.8	19.3	18.8	18.3	17.9	17.5
-20	24.4	23.6	22.9	22.2	21.5	20.9	20.3	19.8	19.3	18.8	18.4	18.0
-25	25.1	24.3	23.5	22.8	22.1	21.5	20.9	20.4	19.9	19.4	18.9	18.5
-30	25.8	25.0	24.2	23.4	22.8	22.1	21.5	21.0	20.5	20.0	19.5	19.1
-35	26.6	25.7	24.9	24.1	23.4	22.8	22.2	21.6	21.1	20.6	20.1	19.6
-40	27.4	26.5	25.7	24.9	24.2	23.5	22.9	22.3	21.7	21.2	20.7	20.3
-45	28.2	27.3	26.5	25.7	24.9	24.2	23.6	23.0	22.4	21.9	21.4	20.9
-50	29.1	28.2	27.3	26.5	25.8	25.0	24.4	23.8	23.2	22.6	22.1	21.6

3.2.2.2.2.2 **Outer Surface.**

The outer surface begins at point "c" and ends at the earliest point the FAF can be received (see figure 3-13). Calculate the distance (D_C) from RWT or FTP to point C using the following formula

$$D_C = \frac{(a \times S_W) - (200 \times S_V)}{(S_W - S_V)}$$

Where a=Distance from RWT or FTP to OCS origin (D_{250} from para 3.2.2.2.2.1)

$S_W = \frac{102}{VPA}$

S_V=Slope from table 3.2

3.2.2.2.3 Calculate the height of the OCS.

3.2.2.2.3.1 Inner OCS.

Calculate the height (I_Z) above ASBL of the inner surface using the following formula:

$$I_Z = \frac{D_O - D_{250}}{S_V}$$

Where D_O = the distance in feet from the RWT or FTP to the obstacle

D_{250} = the distance from the RWT or FTP origin to the inner surface origin

3.2.2.2.3.2 Outer OCS.

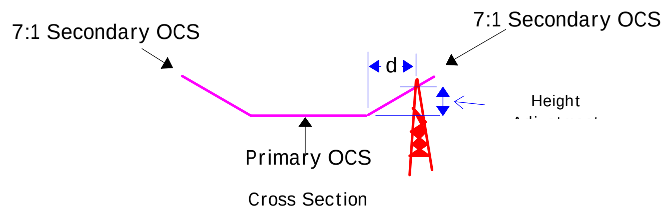
Calculate the height (O_Z) above ASBL of the outer OCS using the following formula:

$$O_Z = \frac{(D_O - 200) \times GPA}{102}$$

3.2.2.2.3.3 Secondary OCS.

The secondary OCS has a slope of 7:1 measured perpendicular to the segment centerline. To evaluate the height of a secondary OCS obstruction, reduce the obstruction height by the amount of secondary surface rise from the edge of the primary OCS (see figure 3-15). Then evaluate the revised height of the obstruction against the height of the primary OCS abeam the obstruction.

Figure 3-15. Secondary OCS Evaluation



$$\text{Height Adjustment} = \frac{d}{7}$$

Where d = distance in feet from edge of primary OCS measured perpendicular to the segment centerline.

3.2.2.2.3.4 OCS Penetrations.

Obstructions should not penetrate the OCS. If the OCS is clear, publish the pDA value. If the OCS is penetrated, take one of the following actions. These actions are listed in order of preference.

3.2.2.2.3.4.1 **Remove or adjust** the obstruction location and/or height.

3.2.2.2.3.4.2 **Enter table 3-3 with the deviation value** from paragraph 3.2.2.2.2.1.2 and the height of the penetrating obstruction measured above ABSL and determine the ROC value. Add this value to the obstruction MSL value to arrive at a revised DA value. Publish the higher of the revised DA or the PDA controlled by the evaluation of the area between RWT or FTP and the 250-HAT point. The published HAT shall be 250 feet or greater.

Table 3-3. IPV Required Obstruction Clearance (ROC, Feet)
Altitude Above Station (feet)

Below ISA at Station	**250**	**500**	**750**	**1000**	**1250**	**1500**	**1750**	**2000**
-15	250	250	250	250	250	250	250	250
-20	250	250	250	250	250	250	250	250
-25	250	250	250	250	250	250	250	275
-30	250	250	250	250	250	250	275	310
-35	250	250	250	250	250	270	305	345
-40	250	250	250	250	255	295	340	380
-45	250	250	250	250	280	325	370	410
-50	250	250	250	260	305	355	400	445

3.2.3 Missed Approach Segment.

Height loss is assumed after DA. The missed approach area begins at the cd line prior to the DA point. Apply RNAV departure criteria (FAA Order 8260.44) from the segment origin to the missed approach holding fix. Locate the first fix encountered after DA at least 9,000 feet from DA. If a turn is associated with a fly-by fix, the minimum distance is 9,114+DTA (see figures 3-16 and 3-17A and B).

Figure 3-16. Straight Missed Approach

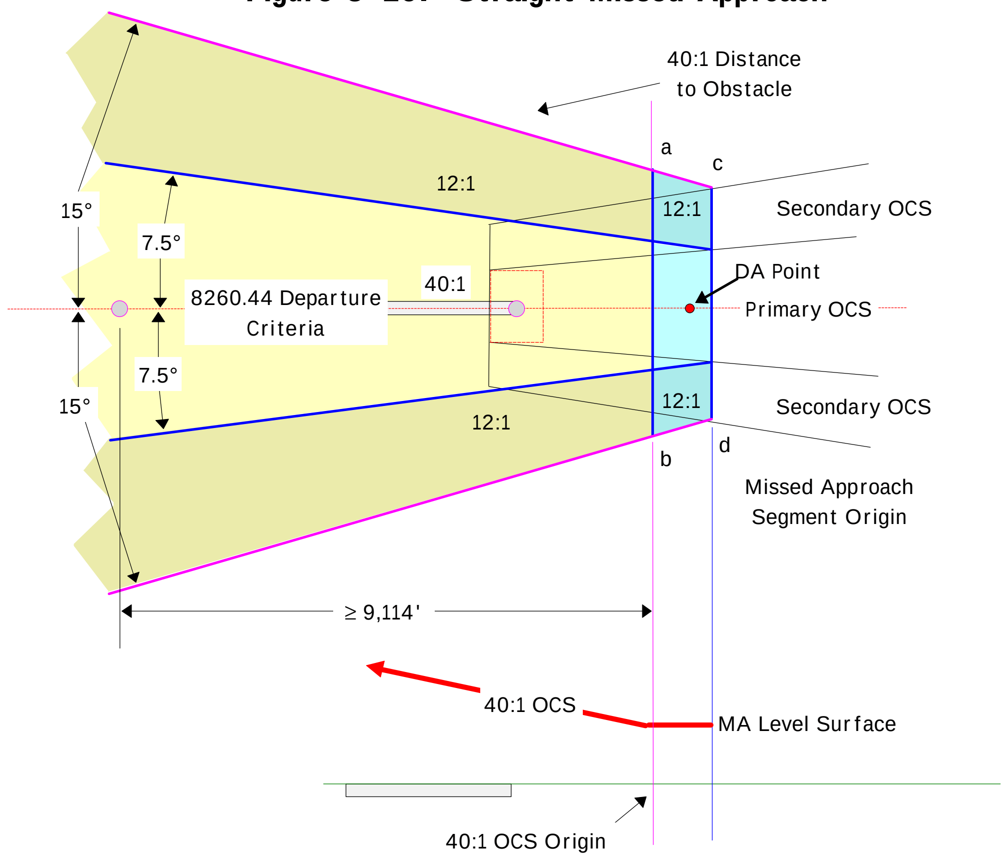


Figure 3-17A. Turning Approach Surfaces Minimum Distance from DA to Turn Fix

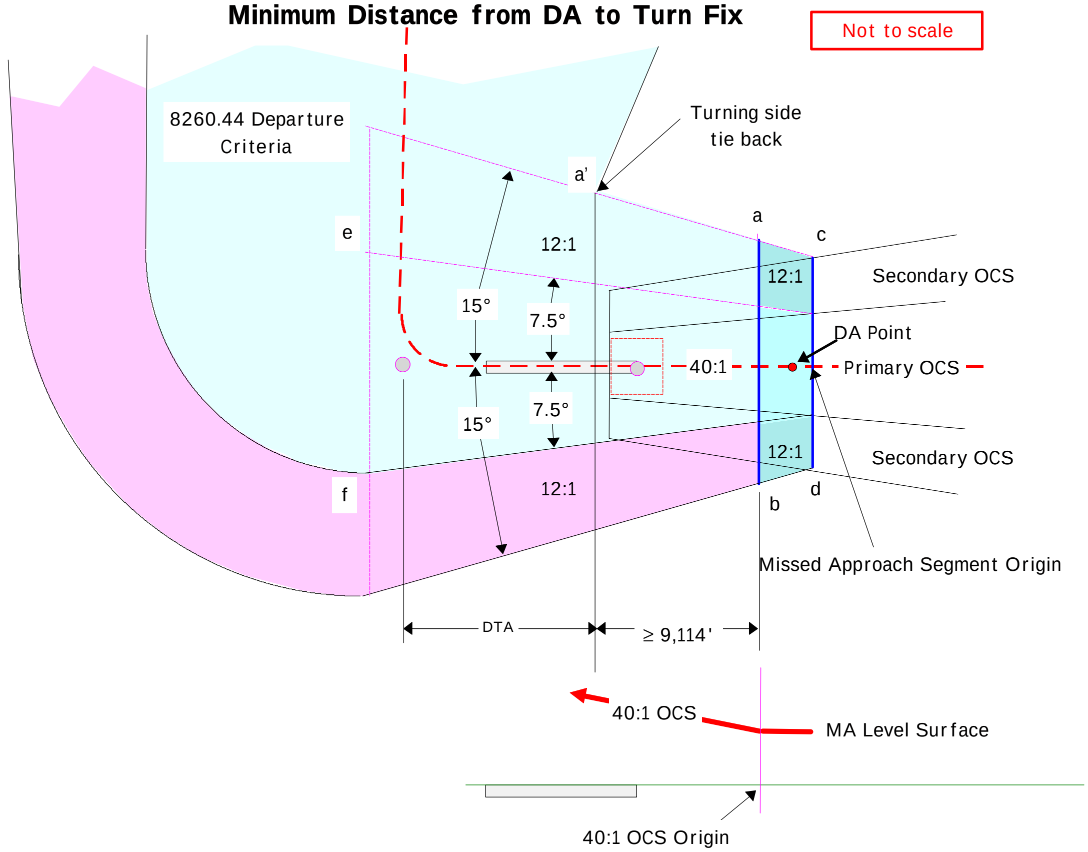
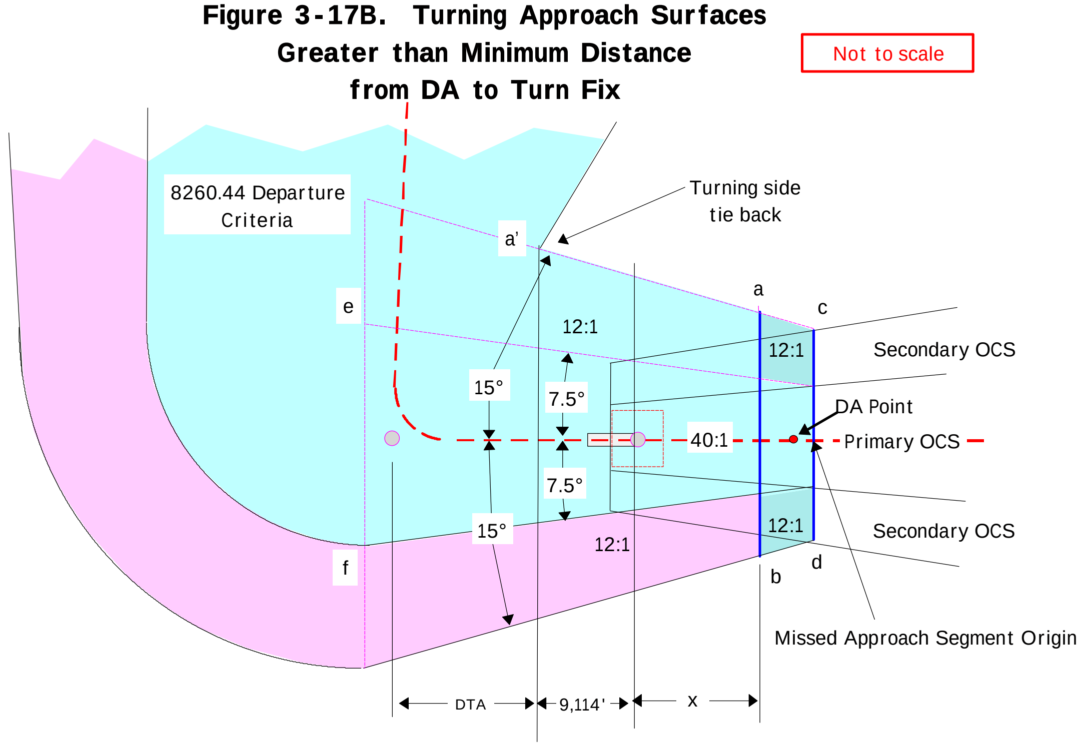


Figure 3-17B. Turning Approach Surfaces Greater than Minimum Distance from DA to Turn Fix



3.2.3.1 Area.

3.2.3.1.1 Level Surface.

The level surface accounts for possible along track errors inherent with barometric altimetry and allows an aircraft to lose (dip down) 50 feet prior to commencing climb.

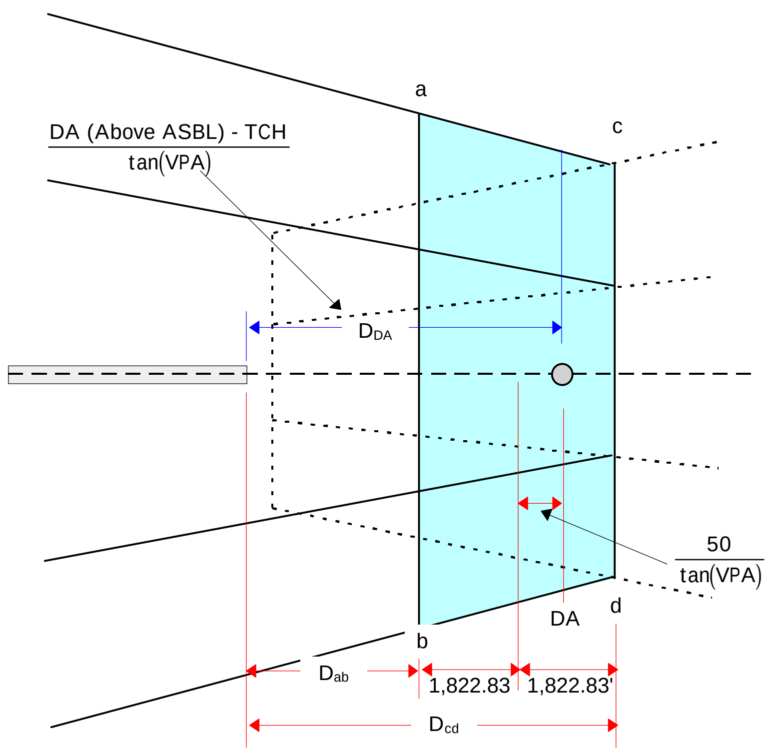
3.2.3.1.1.1 Length.

Calculate the distance (D_{cd})from RWT to the **origin** of the MA segment (cd line), and the distance (D_{ab}) from RWT to the end of the level surface (ab line), using the following formulae:

$$D_{cd} = \frac{DA(\text{above ABSL}) - TCH}{\tan(VPA)} - \frac{50}{\tan(VPA)} + 1{,}822.83$$

$$D_{ab} = D_{cd} - 3038.06$$

Figure 3-18. Level Surface



3.2.3.1.1.2 Width.

The primary area splays at 7.5° relative to the MA course beginning at the final primary outer boundary at the cd line. The secondary area splays at 15° relative to the MA course beginning at the secondary outer boundary at the cd line (see figure 3-18).

3.2.3.1.1.3 OCS.

A level surface overlies the area. Where obstructions penetrate the OCS, increase the DA by the value of the penetration. The height of the MA LEVEL OCS is determined by the formula:

$$h = DA(\text{above ASBL}) - (\text{ROC} + \text{Adustments} + 50)$$
$$\text{Where h is the height of the OCS above ASBL}$$

3.2.3.1.2 40:1 Surface. (Application of Order 8260.44 criteria)

3.2.3.1.2.1 Length.

The 40:1 surface begins at the ab and extends along the MA course until the clearance limit.

3.2.3.1.2.2 Width.

The primary area splays as specified in Order 8260.44 relative to the MA course beginning at the final primary outer boundary at the cd line (See figure 3-19).

3.2.3.1.2.3 OCS.

Where obstructions penetrate the OCS, increase the DA by the value ($DA_{adjustment}$) calculated by the following formula:

$$DA_{adjustment} = \frac{(40 \times p) \times VPA}{102}$$
$$\text{Where p = amount of penetration in feet}$$

3.2.3.1.3 Missed Approach Altitude.

3.2.3.1.3.1 Straight Missed Approach Procedures. Use TERPS paragraphs 274b and d to establish the charted missed approach altitude. Use TERPS paragraph 274c to determine if a climb-in-holding evaluation is required.

3.2.3.1.3.2 Combination straight-turning missed approach procedures. Use TERPS paragraphs 277d and f to establish the charted missed approach altitude. Use TERPS paragraph 277e to determine if a climb-in-holding evaluation is required.

SECTION 3. LATERAL NAVIGATION (LNAV)

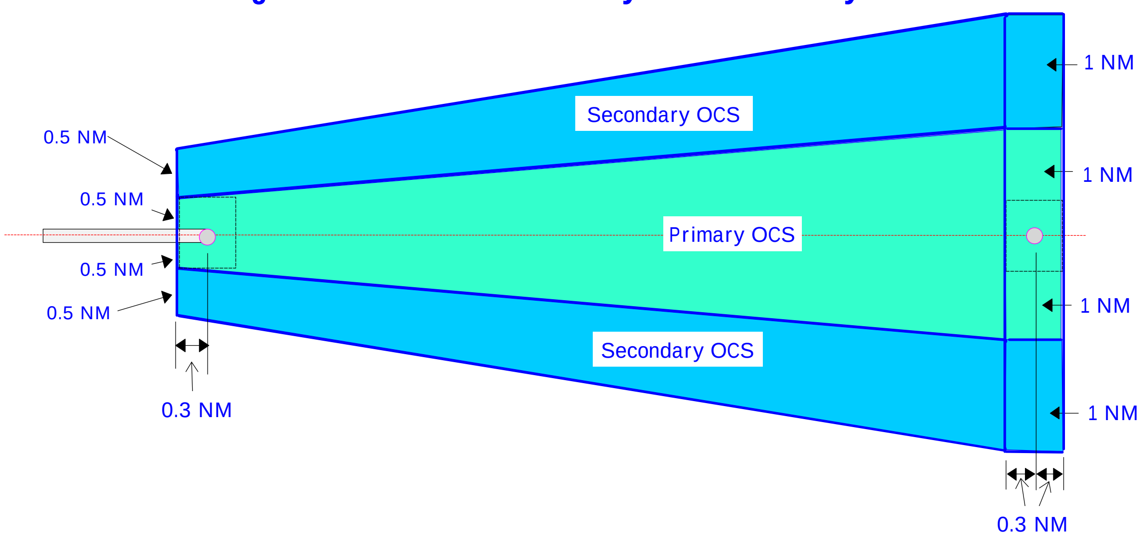
3.3 FINAL APPROACH SEGMENT.

The LNAV final approach segment is based on the capabilities of TSO C-129 receivers. Use guidance contained in this section to design LNAV procedures intended for publication with WAAS and/or IPV approach procedures. Use Order 8260.38A to design "stand-alone" LNAV procedures, e.g., intended for publication separate from WAAS or IPV.

3.3.1 Area.

The LNAV final approach segment begins at the earliest point the FAF/PFAF can be received and ends 0.3 NM (1,822.83 feet) beyond the RWT (see figure 3-19).

Figure 3-19. LNAV Primary and Secondary OCS



3.3.1.1 Alignment.

The WAAS, IPV and LNAV courses shall be identical. Locate the LNAV FAF at the PFAF location.

3.3.1.2 Length.

The primary OCS begins at the earliest point the FAF can be received and extends to 0.3 NM past the RWT (see figure 3-19). If FAF to RWT distance exceeds 10 NM, LNAV minimums are not authorized.

3.3.1.3 Width.

3.3.1.3.1 Primary Area.

The primary area half width (½ W_p), (the perpendicular distance (p) from the runway centerline extended to the outer boundary of the primary area), is defined by the formula:

$$\tfrac{1}{2}W_p = \frac{0.5\ \text{NM}}{fl} \times (D + 1{,}822.83) + 3{,}038.06$$

Where D = the distance in feet from RWT along centerline

fl = the final length in NM from plotted position of FAF to plotted position of RWT.

3.3.1.3.2 Secondary Area.

The width of the secondary area is equal to the ½ width of the primary at any distance "D" from RWT. See paragraph 3.3.1.3.1.

3.3.1.4 Obstruction Clearance.

Apply at least 250 feet of ROC to the highest obstruction in the primary area. Apply the following formula to calculate the ROC at any point in the secondary area.

$$W_s = \frac{0.5\ \text{NM}}{\text{fl (NM)}} \times (D + 1{,}822.83) + 3{,}038.06$$

$$ROC_S = \frac{250}{W_s} \times \left((1/2W_P + W_S) - Dy \right)$$

Where: fl = final length in NM, W_s is the width of the secondary area.

D = the distance in feet from RWT to the obstacle measured along centerline.

Dy = the perpendicular distance in feet from centerline to the obstacle.

Add the ROC from this order and adjustments from Order 8260.3, chapter 3, to the MSL value of the controlling obstruction and round the sum to the next higher 20-foot increment. When stepdown fixes are necessary to achieve acceptable minimums, publish a stand-alone LNAV procedure.

3.3.1.5 Descent Gradient/Angle.

The designed TCH and VPA values shall match the WAAS and IPV values.

3.3.1.6 VDP.

Publish a VDP for the LNAV final approach except as follows:

- Do not publish a VDP based on part-time or full-time remote altimeter settings unless the Remote Altimeter Setting Source (RASS) adjustment is zero.
- Do not publish a VDP If the difference between the WAAS/IPV GPA and the VGSI angle is greater than ± 0.20°.

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

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

3.3.1.6.2 **For runways NOT served by a VGSI**, establish the distance from THR to a point where the WAAS/IPV GPA segment reaches the MDA. Use the following formula:

$$\text{VDP Distance} = \frac{\text{MDA} - (\text{TCH} + \text{RWT Elevation})}{\text{Tan}(\text{WAAS GPA})}$$

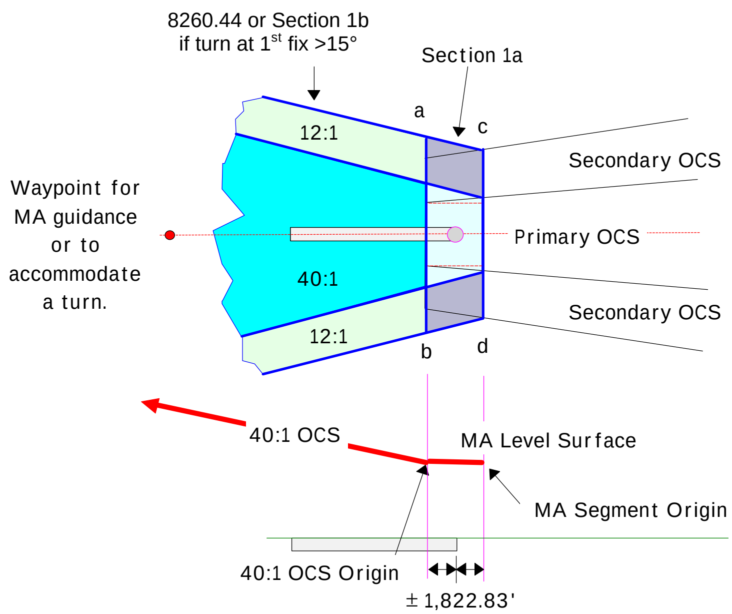
3.3.1.6.3 **Marking VDP Location.** Mark the VDP location as an along track distance (ATD) fix to the MAP. Maximum fix error is ± 0.5 NM.

3.3.2 **Missed Approach Segment.**

3.3.2.2 **Area.**

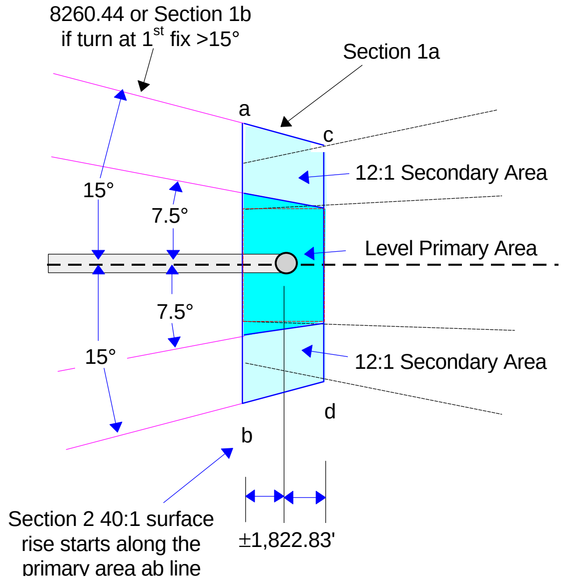
The LNAV missed approach segment consists of a level surface evaluation in section 1a, and a rising surface evaluation in section b if a turn >15° is required at the first fix after the MAP, otherwise it is a 40:1 rising surface under guidance in Order 8260.44 (see figure 3-20).

Figure 3-20. LNAV Missed Approach Surfaces



3.3.2.2.1 **Section 1a.** (Level Primary Surface & 12:1 Secondary Surface). See figure 3-21.

Figure 3-21. LNAV MA Section 1a



3.3.2.2.1.1 Length.

The OCS extends from a point 1,822.83 feet prior to the MAP (cd line) to a point 1,822.83 feet beyond the MAP (ab line).

3.3.2.2.1.2 Width.

3.3.2.2.1.2.1 Primary Area.

The primary area boundary splays outward at 7.5° relative to the MA course from the point of intersection of the edge of the final segment primary area and the cd line. (see figure 3-21).

3.3.2.2.1.2.2 Secondary Area.

The secondary outer boundary splays outward at 15° relative to the MA course from the point of intersection of the edge of the final segment secondary area and the cd line (see figure 3-21). The secondary area rises from the edge of the primary area perpendicular to the MA course at a rate of 12:1.

3.3.2.2.1.2.3 OCS Application.

The level surface shall not be penetrated. Where penetrations exist, raise the MDA the amount of penetration and round to the next higher 20-foot increment. The height (h) of the MA LEVEL OCS is determined by the formula:

$$h = \text{MDA} - (\text{Final ROC} + \text{Adustments})$$

3.3.2.2.2 Section 2. (40:1 OCS).

The 40:1 surface begins at the end of the level surface along the ab line and extends along the MA course. Apply Order 8260.44 criteria for area construction and obstruction measurement.

3.3.2.2.2.1 Minimum Fix Distance.

Establish the first fix following the MAP at least 6,076 feet from the MAP (see figure 3-22). If a turn is associated with a fly-by fix, the minimum distance is 6,076+DTA, if necessary, from the MAP (see figure 3-23).

Figure 3-22. MA Minimum Distance to First Fix

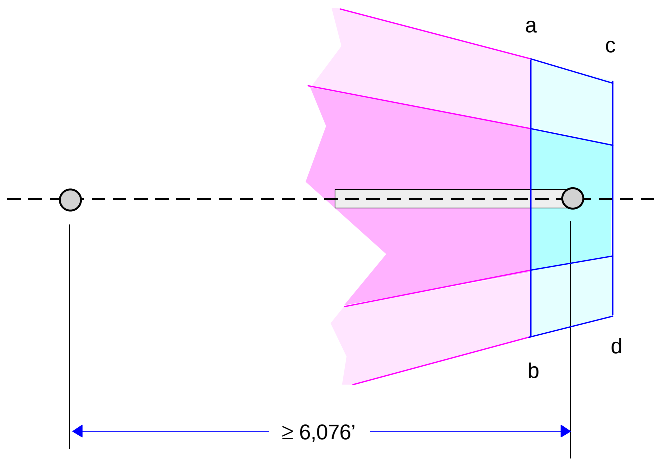
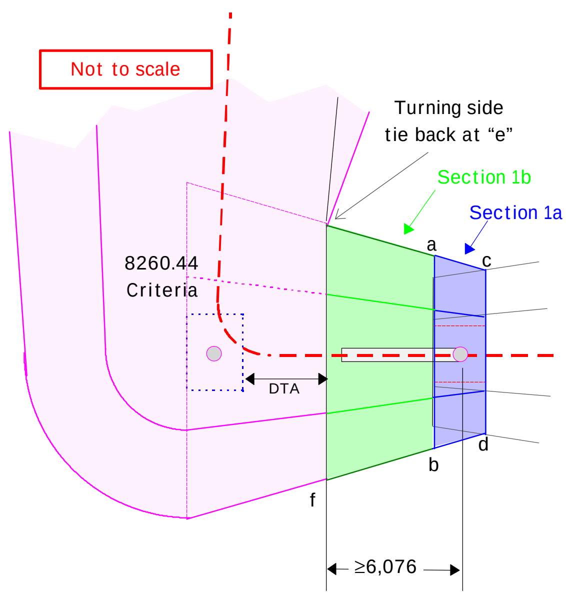


Figure 3-23. Turning Missed Approach, Fly-by Turn Fix



3.3.2.2.2.2 OCS Penetrations.

Select one of the following options when obstructions penetrate the OCS:

- Increase the final MDA by the magnitude of penetration and round the result to the next higher 20-foot increment.

- Consider publishing as a stand-alone procedure and move the MAP a sufficient distance away from threshold for the 40:1 surface to clear the obstruction.

3.3.2.2.3 Determining Missed Approach Altitude.

3.3.2.2.3.1 Straight Missed Approach Procedures. Use TERPS paragraphs 274b and d to establish the charted missed approach altitude. Use TERPS paragraph 274c to determine if a climb-in-holding evaluation is required.

3.3.2.3.3.2 Combination straight-turning missed approach procedures. Use TERPS paragraphs 277d and f to establish the charted missed approach altitude. Use TERPS paragraph 277e to determine if a climb-in-holding evaluation is required.

U.S. Department
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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 8260.48, Area Navigation (RNAV) Approach Construction Criteria

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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