ORDER

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.44A

3/23/00

SUBJ: CIVIL UTILIZATION OF AREA NAVIGATION (RNAV) DEPARTURE PROCEDURES

1.1 PURPOSE. This order, in conjunction with Orders 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS); 8260.38A, Civil Utilization of Global Positioning System (GPS); 8260.40B, Flight Management System (FMS) Instrument Procedures Development; 8260.46, Instrument Departure Procedure (DP) Program; and 8260.48, Area Navigation (RNAV) Approach Construction Criteria, provides criteria for constructing instrument flight rules (IFR) RNAV departure procedures.

2.1 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.

3.1 CANCELLATION. Order 8260.44, Civil Utilization of Area Navigation (RNAV) Departure Procedures, dated October 20, 1997, is canceled.

4.1 EFFECTIVE DATE: May 12, 2000.

5.1 EXPLANATION OF CHANGES.

5.1.1 Paragraph 6.1.11. Describes RNAV leg types.

5.1.2 Paragraph 7.1. Divides new levels of criteria into three classifications.

5.1.3 Paragraphs 9.1 –9.11. Clarifies criteria for waypoint (WP) substitution and charting instructions, provides WP definition and WP course changes with illustrations, and modifies minimum leg length. Adds fix displacement values for Level 2 criteria and a new table for fly-over WP minimum turn distance.

5.1.4 Paragraph 10.1. Modifies initial climb area, and adds criteria for a WP less than 2 nautical miles (NM) from departure end of runway (DER).

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

Initiated by: AFS-420

5.1.5 **Paragraphs 12.3 –12.4.** Modifies expansion of Level 1 criteria 30 NM from the airport reference point (ARP). Clarifies criteria for turns 90° or greater, successive fly-over WP's with turns less than 90°, "direct to fix" legs, and "fly-by to fly-over" WP's. Adds criteria for "direct to fix" leg of more than 120°.

5.1.6 **Paragraph 13.2**. Clarifies criteria when departure merges with airways.

5.1.7 **Paragraphs 15.2 –15.4.** Clarifies obstacle evaluation criteria and adds illustrations.

5.1.8 **Paragraph 16.1.** Provides criteria for climb gradients in excess of 200 feet per NM, a new formula for computing climb gradients (this increases the ROC and provides a greater margin of safety), and an example showing computation of the new gradient formula.

6.1 **DEFINITIONS.**

6.1.1 **Baseline.** A line perpendicular to the course line at the latest position of the fix displacement tolerance area, used for construction of turn area expansion arcs.

6.1.2 **Climb-in-Hold (CIH).** Climbing in holding pattern.

6.1.3 **Departure Altitude.** An altitude at the end of the departure evaluation area that satisfies the requirements for en route operations. This term is similar in concept to the "missed approach altitude."

6.1.4 **Departure End of Runway (DER).** The end of runway declared available for the ground run of an aircraft departure.

6.1.5 **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 of the next segment.

6.1.6 **Fly-By WP.** A waypoint where a turn is initiated prior to reaching it.

6.1.7 **Fly-Over WP.** A waypoint over which an aircraft is expected to fly before the turn is initiated.

6.1.8 **Initial Climb Area (ICA).** A segment starting at the DER which allows the aircraft sufficient distance to reach an altitude of 400 feet above the DER.

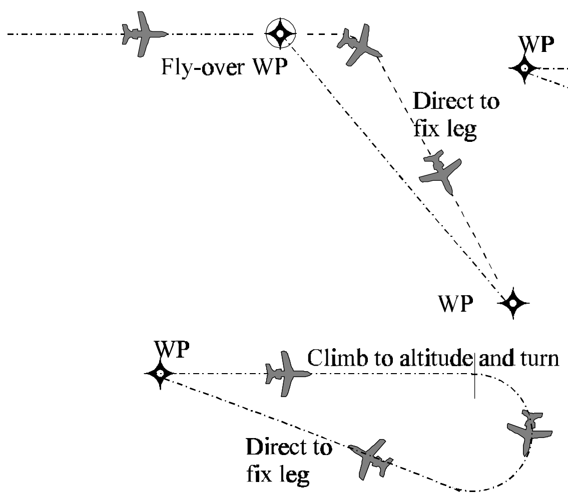
6.1.9 **Initial Course.** The course established initially after take-off beginning at the DER.

6.1.10 **Initial Course Waypoint (ICWP).** A waypoint established on the initial course denoting the start of positive course guidance (PCG).

6.1.11 RNAV Leg (Segment) Types.

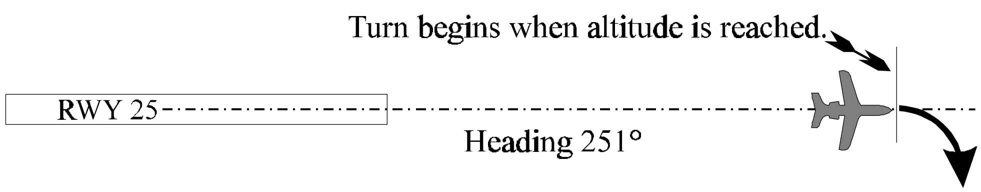
6.1.11 a. Direct to Fix (DF). A segment following a fly-over WP, climb to altitude, or radar vector, in which the aircraft's track is direct to the next WP (see figure 1).

Figure 1. DF Legs



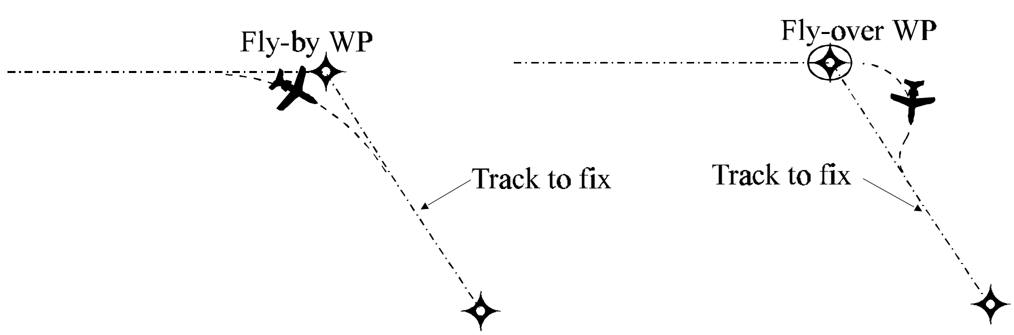
6.1.11 b. Heading to an Altitude (VA). After departing the runway, a segment allowing the aircraft to climb to an altitude on a specified heading (see figure 2).

Figure 2. VA Leg



6.1.11 c. Track to Fix (TF). A course between WP's which is intercepted and acquired as the flight track to the following WP. Applies to fly-by and fly-over WP's and shown individually in figure 3.

Figure 3. TF Legs



6.1.11 **d. Obstacle Clearance Surface (OCS).** A surface where obstacle penetrations are not allowed.

6.1.11 **e. Reference Line.** A line parallel to the course line, following a turn waypoint (TWP), used to construct a second set of expansion arcs.

6.1.11 **f. Reference Waypoint.** A point of known location used to geodetically compute the location of another WP.

6.1.11 **g. Turn Anticipation.** The capability of RNAV airborne equipment to determine the location of the point along a course, prior to a "fly-by waypoint" which has been designated a TWP, where a turn is initiated to provide a smooth path to intercept the succeeding course.

6.1.11 **h. TWP.** A waypoint, Fly-by, or Fly-over denoting a course change. Synonymous with turning waypoint.

7.1 **LEVELS OF CRITERIA AND STANDARD REQUIRED NAVIGATION PERFORMANCE (RNP) LEVELS.** These criteria are divided into three classifications: Levels 1, 2, and 3. Each level is associated with an RNP value: 1.0, 2.0, and 0.3 respectively. Use the appropriate aircraft equipment suffixes defined in the Aeronautical Information Manual (AIM), along with the standard values of RNP and supporting RNAV routes and procedures, to specify the following criteria:

7.1.1 **Level 1 (RNP 1.0) applies to equipment suffixes /E and /F,** with navigation system update at a known position 30 minutes prior to takeoff. It also applies to /G equipped aircraft whose selectable course deviation indicator (CDI) is set to terminal sensitivity of 1 nautical mile (NM). Without a selectable CDI, the aircraft must be equipped with a flight director. Level 1 criteria is an option and shall be used only under the following conditions:

7.1.1 **a. Environmental conditions or offending obstacles** warrant the use of more restrictive criteria than "Level 2" and thus excludes some RNAV-equipped aircraft.

7.1.1 **b. The procedure applies only to /G equipped aircraft** with the restrictions noted in paragraph 7.1.1.

7.1.l **c. Level 1 departure criteria** shall be applied as the missed approach criteria for Order 8260.48.

7.1.2 **Level 2 (RNP 2.0) applies to equipment suffixes /E, /F, and /G**, as defined in the AIM and IFR global positioning system (GPS) equipment. Level 2 criteria shall be applied, unless environmental or obstacle considerations require the use of the more restrictive Levels 1 or 3.

7.1.3 **Level 3 (RNP 0.3) applies to equipment suffixes /E and /F,** with navigation system update at runway prior to departure. Do not use the criteria in this order. Apply Order 8260.40. Special authorization for a Level 3 procedure is required through Flight Standards Service.

SECTION 1. GENERAL CRITERIA

8.1 APPLICATION.

8.1.1 **Apply diverse departure criteria** contained in Order 8260.3 to determine if RNAV departure procedures are required to avoid obstacles.

8.1.2 **Develop RNAV departure procedures** to satisfy operational, air traffic, or environmental requirements.

9.1 **THESE CRITERIA ESTABLISH DESIGN STANDARDS** for development of RNAV instrument departure procedures and provide flexibility so the procedures designer can select an appropriate level of criteria, waypoint type (fly-by, fly-over), and leg types (DF, TF, and VA). The procedures designer should work closely with user groups and air traffic to ensure that appropriate design tools (i.e., levels, WP types, leg types) are selected to meet user requirements.

9.1.1 **Waypoint Substitution.** Existing fixes/navigational aids (NAVAID's) should be substituted for an RNAV WP where conveniently located. For purposes of simplicity in these criteria, the term WP will be used to denote a fix.

9.1.2 **Fix Displacement Tolerance (FDT).** Terminal FDT applies to Level 1 criteria. Use where the plotted position of the WP is at or within 30 NM straight-line measurement of the departure airport's reference point (ARP). Level 1 en route FDT applies beyond 30 NM from the ARP, including succeeding WP's that may lie within 30 NM of the ARP should the route return to the area. En route FDT applies to Level 2 criteria throughout the procedure. The FDT area shall not contain an adjacent WP. Use table 1 for application of the appropriate FDT.

TABLE 1

FIX DISPLACEMENT TOLERANCE (NM)		
LEVEL 1 CRITERIA		
	EN ROUTE	**TERMINAL**
XTRK	**2**	**1**
ATRK	**0.5**	**0.5**
LEVEL 2 TWO CRITERIA		
	EN ROUTE	**TERMINAL**
XTRK	**2.8**	**N/A**
ATRK	**2**	**N/A**

9.1.3 **Waypoints (WP).** " Fly-by waypoints" are preferred in most situations. Use "fly-over waypoints" when operational requirements dictate or an advantage is achieved. Document the fix use and status of a waypoint as "fly-by" or "fly-over" on the associated FAA Form 8260-15B in accordance with Order 8260.19. Establish WP's to designate course restrictions/changes and altitude restrictions/changes when necessary.

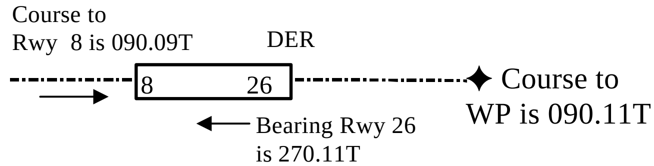
9.2 **CHARTING INSTRUCTIONS. Chart** all RNAV departures graphically. Place a note on the departure graphic describing a specific criteria level:

9.2.1 **Level 1:** "For use by /E, /F, and /G-equipped aircraft. (1) /E and /F aircraft are required to update navigation system at a known location within 30 minutes prior to takeoff. (2) /G aircraft with selectable course deviation indicator (CDI) must set CDI to 1 NM terminal sensitivity. Aircraft without selectable CDI must use flight director."

9.2.2 **Level 2:** "For use by /E, /F, and /G-equipped aircraft."

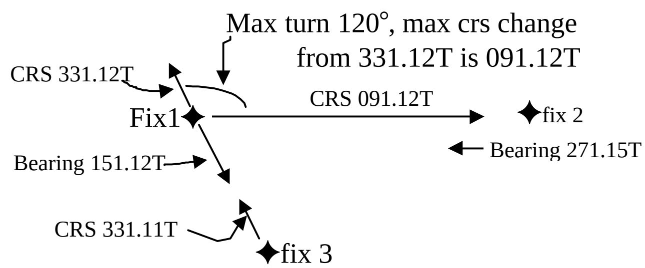
9.3 **WAYPOINT DEFINITION.** Define departure WP's on runway centerline extended by establishing coordinates using the reciprocal of the opposite direction runway true bearing and the appropriate distance applied from the DER (reference point). Where two or more segments are aligned along a continuous geodetic line, align and construct all succeeding WP's based on a true bearing and distance from the first reference waypoint in the sequence. Where turns are established, use the TWP as the reference WP to construct succeeding WP's and segments aligned on a continuous geodetic line following the turn (see figure 4).

Figure 4. Waypoint Definition



9.4 COURSE CHANGE AT WAYPOINTS. The departure course at a particular WP is the bearing from that WP to the following WP. The arrival course at a particular WP is the reciprocal of the course from that WP to the preceding WP. The difference between the departure course and the arrival course at a WP equals the amount of turn at that WP (see figure 5).

Figure 5. Course Change



9.5 NAMING RNAV INSTRUMENT DEPARTURE PROCEDURES. Refer to Order 8260.46 for naming computer codes and naming and coding transition routes.

9.6 ROUTE DESCRIPTION. Specify the magnetic courses using the magnetic variation of the departure airport until the departure route joins the en route airway system. Document the names of all WP's or fixes in the order flown with any turns or altitude crossing requirements specified at these points.

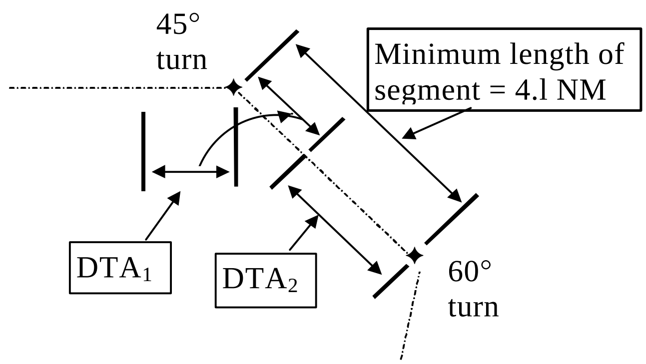
9.7-9.10 RESERVED.

9.11 DEPARTURE ROUTE SEGMENTS.

9.11.1 **The length of a segment** is measured between plotted positions of the WP's. Except for the ICA, the length of a segment shall be sufficient to encompass all turn anticipation and outside turn expansion requirements. Compute values using hundredths or greater, round final computation to the next higher tenth NM.

9.11.1 **a. In the case of two successive fly-by turning WPs̊,** the minimum segment length is the DTA of the first waypoint plus DTA of the second waypoint. The DTA's are measured from plotted positions of the fixes (see figure 6). For obstacle protection area (see figure 15).

Figure 6. Two Successive Fly-By WP's



Example steps of computation:

Given:

Aircraft Speed: 250 KIAS

Altitude: Below 10,000'MSL

First turn angle: 45°

Second turn angle: 60°

Step 1. Determine the radius of turn from table 3: 4.2 NM

Step 2. Determine DTA of first turn:

$DTA_1 = 4.2 \times \text{tangent } (45° \div 2) = 4.2 \times .41 = 1.74$ NM

Step 3. Compute the DTA of the second turn:

$DTA_2 = 4.2 \times \text{tangent } (60° \div 2) = 4.2 \times .58 = 2.42$ NM

Step 4. Determine minimum total distance between waypoints by adding the dimension in Step 2 to the dimension in Step 3.

Total distance waypoint to waypoint =
Minimum length of segment = $DTA_1 + DTA_2 = 1.74 + 2.42 = 4.16$ NM
(rounded to next higher tenth) 4.2 NM.

9.11.1 **b. In the case of two successive fly-over WPš,** select the minimum segment length as specified in table 2 (see figure 7). For obstacle protection area (see figure 21).

Using table 2, select applicable airspeed and turn angle.

Example steps of computation:

Given:

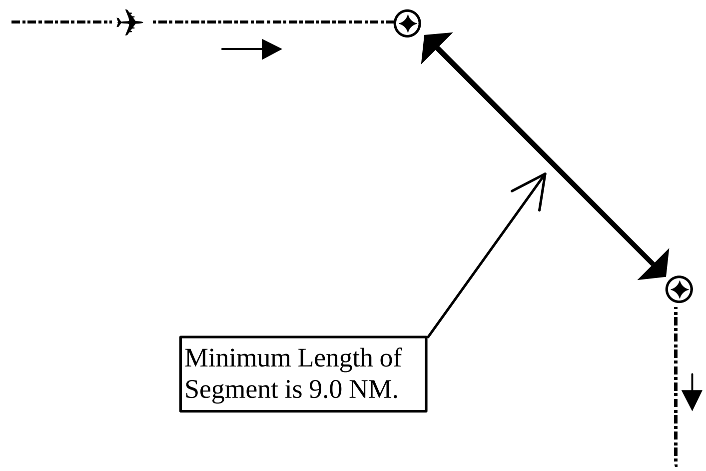
Aircraft speed: 250 KIAS

First turn angle: 45°

Second turn angle: (not applicable)

Step 1. Use table 2 and select distance from column under 250 KIAS and row opposite 45° = 8.96

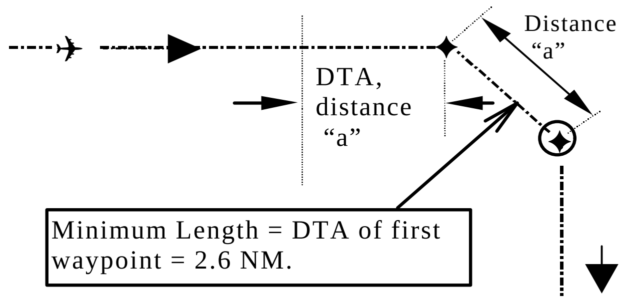
Figure 7. Two Successive Fly-Over WP's



Minimum length of segment = 8.96 NM (rounded to next higher tenth) **9.0**

9.11.1 c. **In the case of a fly-by to a fly-over WP,** the minimum segment length is the DTA of the first WP (see figure 8). For obstacle protection area (see figure 22).

Figure 8. Fly-by to Fly-Over WP



Example steps of computation:

Given:

Aircraft Speed: 250 KIAS

First turn angle: 50°

Second turn angle NA.

Altitude: More than 10,000'MSL

Step 1. Determine the turning radius from table 3: 5.5 NM

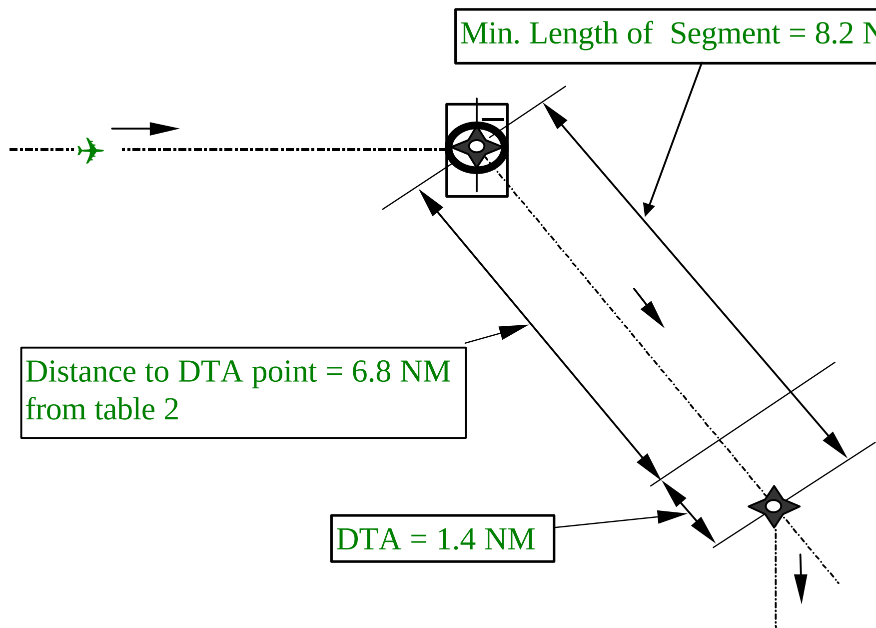
Step 2. Determine DTA of first turn:

DTA = 5.5 × Tangent (50°÷2) = **2.56 NM**

Minimum length of segment = 2.6 NM (rounded to next higher tenth)

9.11.1 **d. In the case of a fly-over to a fly-by WP,** the minimum segment length is the minimum distance specified in table 2 plus the DTA for the fly-by WP (see figure 9). For obstacle protection area (see figure 23).

Figure 9. Fly-Over to Fly-By WP



Example steps of computation:

Given:

Aircraft Speed: 200 KIAS

First turn angle: 35°

Second turn angle: 50°

Altitude: Below 10,000'MSL

Step 1. Use table 2 and select distance from column under 200 KIAS and row opposite 35° = 6.79

Step 2. Determine radius of second turn from table 3: 2.9 NM

Step 3. Determine DTA of second turn:

DTA = 2.9 × Tangent (50°÷2) = 2.9 × 0.46 = 1.35 NM

Step 4. Determine minimum total distance between waypoints by adding the dimension in step 1 to the dimension in step 3:

Total distance waypoint to waypoint =
Minimum length of segment = 6.79 + 1.35 = 8.14 NM. (rounded to next higher tenth) 8.2 NM.

TABLE 2. Fly-Over Waypoint Minimum Turn Distance

	140 KIAS	**160 KIAS**	175 KIAS	**200 KIAS**	220 KIAS	**250 KIAS**	310 KIAS	**350 KIAS**
				Distance NMś Use 10° line for turns less than 10°				
TURN ANGLE (degree)								
10	3.95	**4.33**	4.63	**5.16**	5.60	**6.31**	9.20	**10.51**
15	4.37	**4.83**	5.19	**5.83**	6.36	**7.20**	10.66	**12.22**
20	4.65	**5.15**	5.55	**6.25**	6.84	**7.77**	11.57	**13.27**
25	4.82	**5.36**	5.78	**6.52**	7.15	**8.13**	12.13	**13.91**
30	4.93	**5.49**	5.93	**6.69**	7.34	**8.35**	12.45	**14.28**
35	5.00	**5.56**	6.01	**6.79**	7.44	**8.47**	12.60	**14.48**
40	5.03	**5.59**	6.04	**6.82**	7.48	**8.50**	13.61	**16.05**
45	5.03	**5.59**	6.04	**6.87**	7.66	**8.96**	14.84	**17.54**
50	5.09	**5.77**	6.32	**7.31**	8.18	**9.59**	16.00	**18.95**
55	5.33	**6.06**	6.65	**7.72**	8.65	**10.18**	17.08	**20.25**
60	5.55	**6.33**	6.95	**8.10**	9.09	**10.72**	18.07	**21.46**
65	5.75	**6.57**	7.23	**8.44**	9.49	**11.21**	18.98	**22.56**
70	5.93	**6.79**	7.49	**8.75**	9.85	**11.65**	19.79	**23.54**
75	6.09	**6.98**	7.71	**9.02**	10.17	**12.04**	20.51	**24.41**
80	6.23	**7.15**	7.90	**9.26**	10.44	**12.38**	21.13	**25.16**
85	6.34	**7.29**	8.06	**9.45**	10.67	**12.66**	21.64	**25.78**
90	6.43	**7.40**	8.18	**9.61**	10.85	**12.88**	22.06	**26.29**
95	6.52	**7.50**	8.30	**9.76**	11.02	**13.09**	22.45	**26.75**
100	6.63	**7.64**	8.47	**9.96**	11.26	**13.38**	22.97	**27.39**
105	6.74	**7.77**	8.61	**10.13**	11.46	**13.63**	23.44	**27.96**
110	6.82	**7.88**	8.73	**10.28**	11.64	**13.85**	23.84	**28.44**
115	6.90	**7.97**	8.84	**10.41**	11.78	**14.03**	24.17	**28.84**
120	6.96	**8.04**	8.92	**10.51**	11.90	**14.17**	24.43	**29.16**
				Table may be interpolated or use next higher value.				

9.12 BASIC WIDTHS OF SEGMENTS.

9.12.1 Level 1 criteria.

9.12.1 **a. Within and including 30 NM** from the ARP.

9.12.1 **a. (1) Primary area:** 2 miles on each side of the segment centerline.

9.12.1 **a. (2) Secondary area:** 1 mile each side of the primary area.

9.12.1 **b. Beyond 30 NM from the ARP.**

9.12.1 **b. (1) Primary Area:** 3 miles on each side of the segment centerline.

9.12.1 **b. (2) Secondary Area:** 3 miles on each side of the primary area.

9.12.2 **Level 2 criteria.**

9.12.2 **a. Primary Area:** 4 miles on each side of the segment centerline.

9.12.2 **b. Secondary Area:** 2 miles on each side of the primary area.

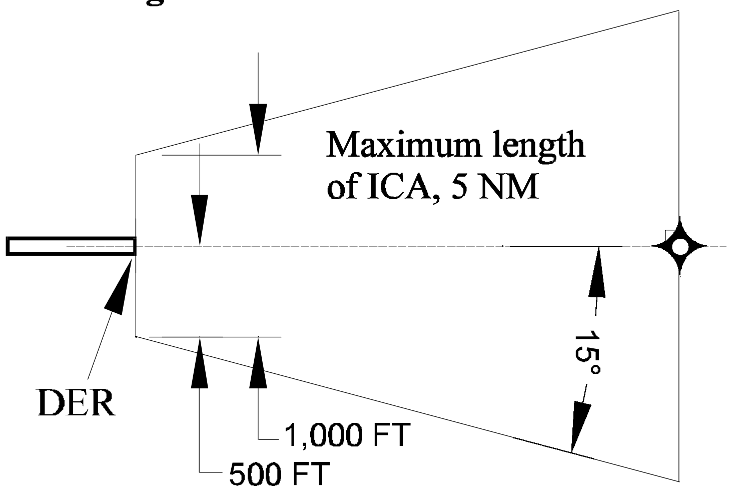
10.1 **INITIAL AREAS.**

10.1.1 **Initial Climb Area.** See figure 10. This segment starts at the DER and proceeds along runway centerline extended to allow the aircraft to reach an altitude of 400 feet above DER and allow establishment of positive course guidance by all navigation systems. Optimum length of the ICA for a fly-over WP is 2 NM and for a fly-by WP is 2 NM plus the DTA distance. Within the ICA, use 2.9 NM for any necessary turn radius (or less as allowed in table 3) to compute a DTA. **The maximum length is 5 NM.** Exception: When a VA leg is used for the initial climb, maximum length of the ICA does not apply. **Specify a WP at the end of its area** (except when para-graph 10.1.1c or 12.4.1 is applied (see figures 11 and 26 respectively) to denote the beginning of PCG.

10.1.1 **a. Splay the ICA area 15°** relative to the course from a point 500 feet each side of runway centerline.

10.1.1 **b. To shorten the ICA to less than 2 NM from the DER,** publish a fly-over WP, a minimum distance of 1 NM from DER, and specify a climb gradient to that WP.

Figure 10. Initial Climb Area

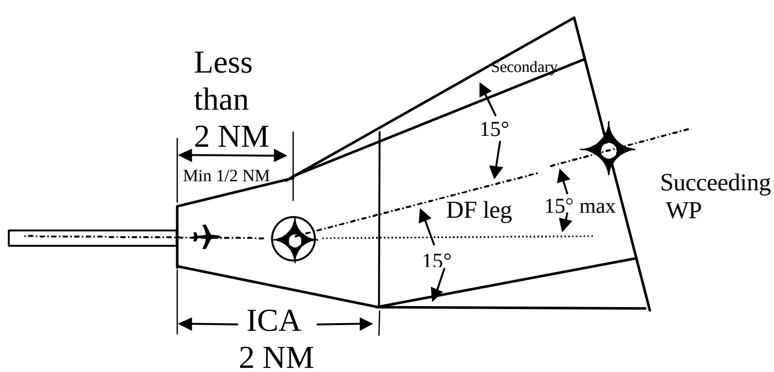


10.1.1 **c. To allow a WP less than 2 NM from the DER** without a climb gradient imposed**,** a fly-over WP may be used and published. No turn greater than 15° is permitted at this WP, and a succeeding WP must be established for a DF leg. Locate the WP a minimum distance of ½ NM from DER (see figure 11).

10.1.1 **c. (1) Establish a segment** aligned with runway centerline a minimum distance of 2 NM from DER to provide an area for the initial climb to 400 feet. A turn for a new course may occur at the first WP. A maximum turn of 15°, relative to runway centerline extended, is permitted and may be used to establish the next WP. No distance limitation is required for the next WP.

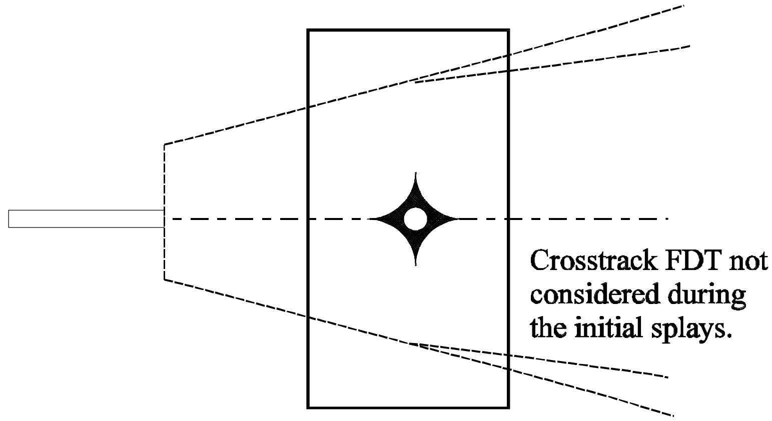
10.1.1 **c. (2) A secondary area** may begin at the first WP provided no turn exists at that WP. If a turn is involved, a secondary area may begin at the first WP on the inside of the turn. Secondary area consideration for the outside area of the turn is not allowed until the end of the 2-mile ICA.

Figure 11. WP Less than 2 NM from DER, without a Climb Gradient Imposed



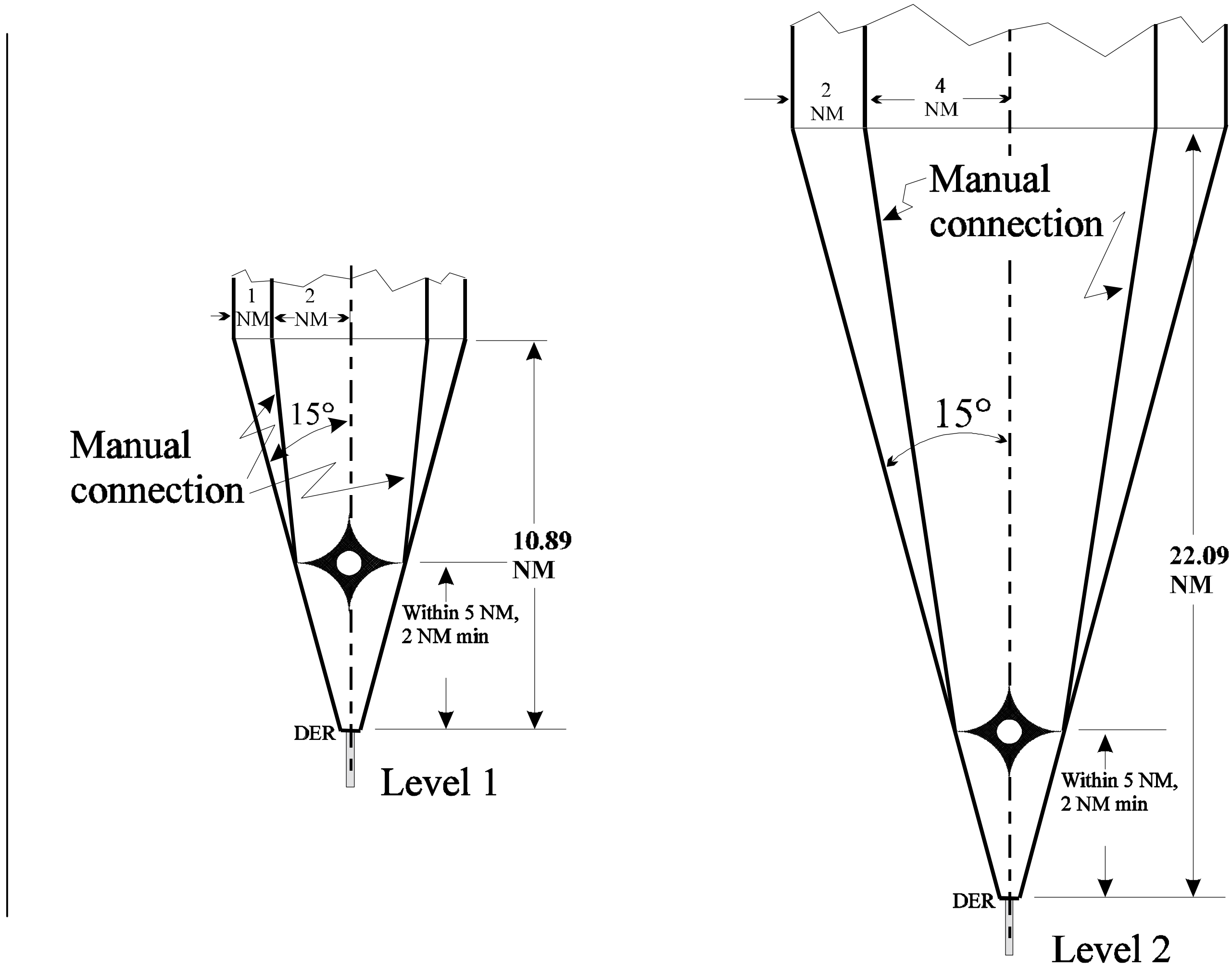
10.1.2 **Crosstrack fix displacement tolerances** need not be considered during the initial splay boundaries (see figure 12).

Figure 12. Crosstrack FDT in Initial Splay Area



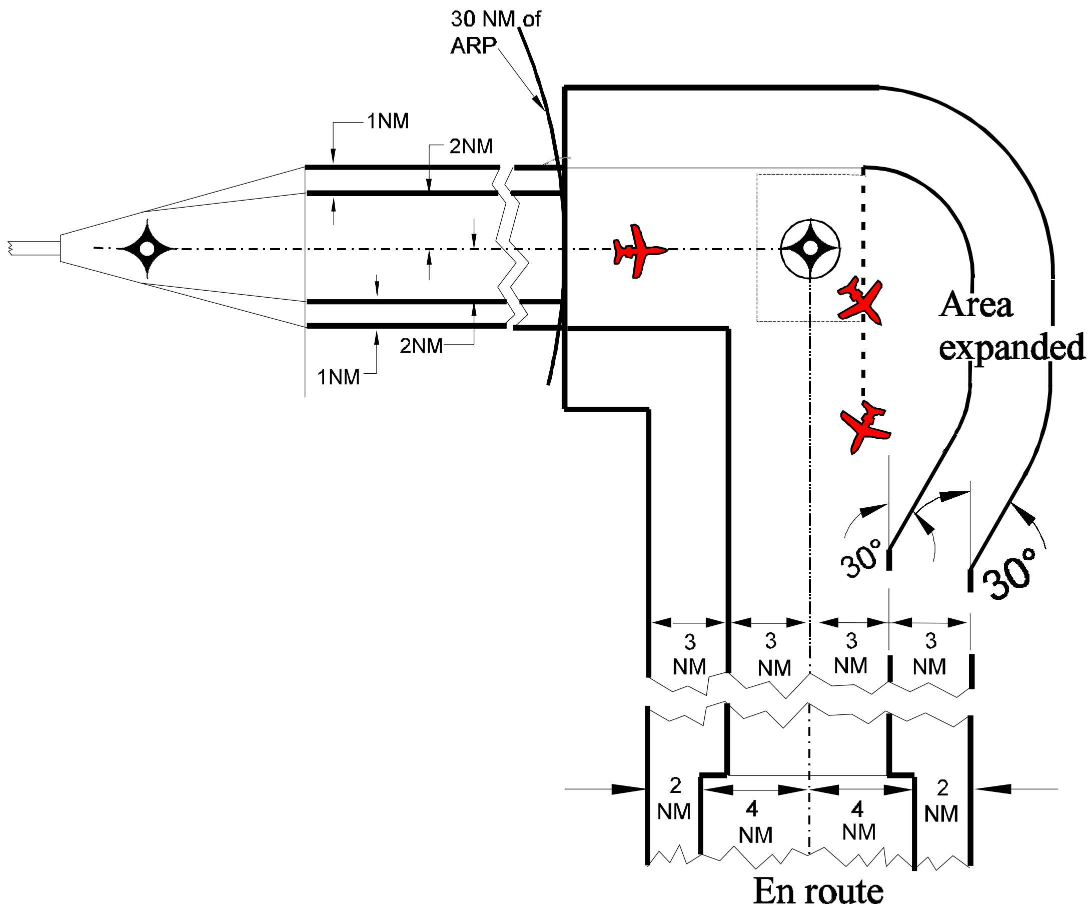
10.2 **AREAS BEYOND THE ICA. The 15° splays continue** until reaching the total width of the basic primary and secondary areas. This distance from DER is 10.89 NM for Level 1 and 22.09 NM for Level 2. Secondary areas are not designated until the establishment of the first WP. At the first WP, the primary area is manually established by connecting lines from the edges of the area abeam that waypoint to points on a line perpendicular to the course where the width of the basic primary area is reached (see paragraph 9.12 and figure 13).

Figure 13. Area Splays to Basic Widths



10.2.1 Once the departure segment splays to the respective primary and secondary area widths, the area widths remain constant except for the following: expansion of areas when a turn is involved; a course in Level 1 criteria reaches a point 30 NM from ARP; and the course in Level 1 reaches the en route structure (see figure 14).

Figure 14. 90° Turn, Fly-Over at more than 30 NM from ARP



10.2.2 **DEVELOP A ROUTE** using Level 1 or Level 2 basic primary and secondary areas as outlined in paragraph 9.12. Specify WP's as common fixes (see figure 14).

11.1 **AIRCRAFT SPEEDS AND ALTITUDES.** Refer to table 3.

11.1.1 **For all turns below 10,000 feet MSL,** use 250 knots indicated KIAS unless a lower speed has been authorized by air traffic. If a lower speed is used, the speed restriction shall be noted on the procedure. Do not use a speed less than 200 KIAS for Category C or 230 KIAS for Category D aircraft.

11.1.2 **For turns at 10,000 feet MSL and above**, use 310 KIAS, unless a higher airspeed has been authorized by air traffic. If a lower speed is used, a speed restriction not less than 250 KIAS above 10,000 through 15,000 feet shall be noted on the procedure for that turn. Above 15,000 feet, no speed reduction below 310 KIAS is permitted.

11.1.3 **Where less than the 250 or the 310 KIAS is required,** publish a speed restriction. Example: "Do not exceed (a designated speed from table 3) KIAS," or "Do not exceed (a designated speed from table 3) KIAS until CHUCK WP."

11.1.4 **When an airspeed greater than 250 KIAS** is authorized below 10,000 feet MSL or greater than 310 KIAS, 10,000 feet MSL and above, publish that speed from table 3, as appropriate.

TABLE 3. Waypoint Turn RADII, NM, According to Aircraft Speeds, (KIAS), (R1)

(Use next higher airspeed for speeds not given.)				
Aircraft Speeds	**140**	**160**	**175**	**200**
Turn radii:				
Below 10,000′ MSL	1.7	2.1	2.4	2.9
10,000′ MSL and above	2.4	2.9	3.3	4.0
Aircraft Speeds	**220**	**250**	**310**	**350**
Turn radii:				
Below 10,000′ MSL	3.4	4.2	6.0	7.3
10,000′ MSL and above	4.6	5.5	7.7	9.3
R2 = R1 plus (1 NM, 2 NM, or 3 NM) of secondary area width as applicable: 1 NM for Level 1, 2 NM for Level 2, or 3 NM for Level 1 beyond 30 NM from ARP.				

12.1 **TURNS and AREA EXPANSION.** For turns up to and including 15°, an expansion of the area is not required. The inside and outside boundaries of the segments prior to and after the turn may be connected with no arcs.

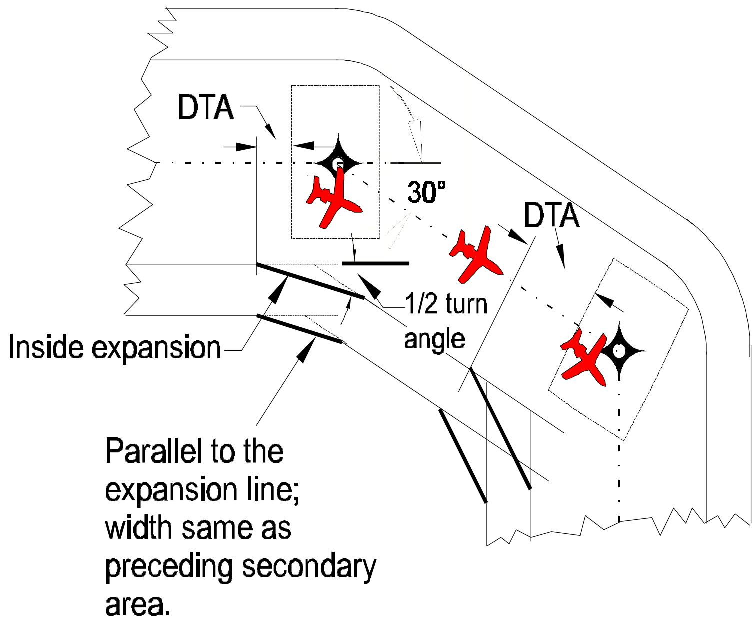
12.1.1 **For Turns Greater Than 15°,** an expansion of the departure area is required. Establish inside expansion area for fly-by WP's. Outside expansion is not required for fly-by WP's. Establish outside expansion areas for fly-over WP's. Inside expansion is

12.1.2 **Maximum Course Change Allowable for TF Legs is 120°.** No maximum course change is required for DF legs.

12.2 **INSIDE EXPANSION AREA FOR A FLY-BY WP**.

12.2.1 **Expand the primary area** by an angle equal to one-half of the course change (see figure 15).

Figure 15. Fly-By WP's



12.2.1 **a. Locate a point on the primary area boundary** on the inside of a turn a distance equal to the DTA measured back from the earliest point of the FDT area parallel to the course. The length of the DTA is determined by the following formula and it applies to turns of more than 15°.

DTA = R1 x tan (turn angle / 2)

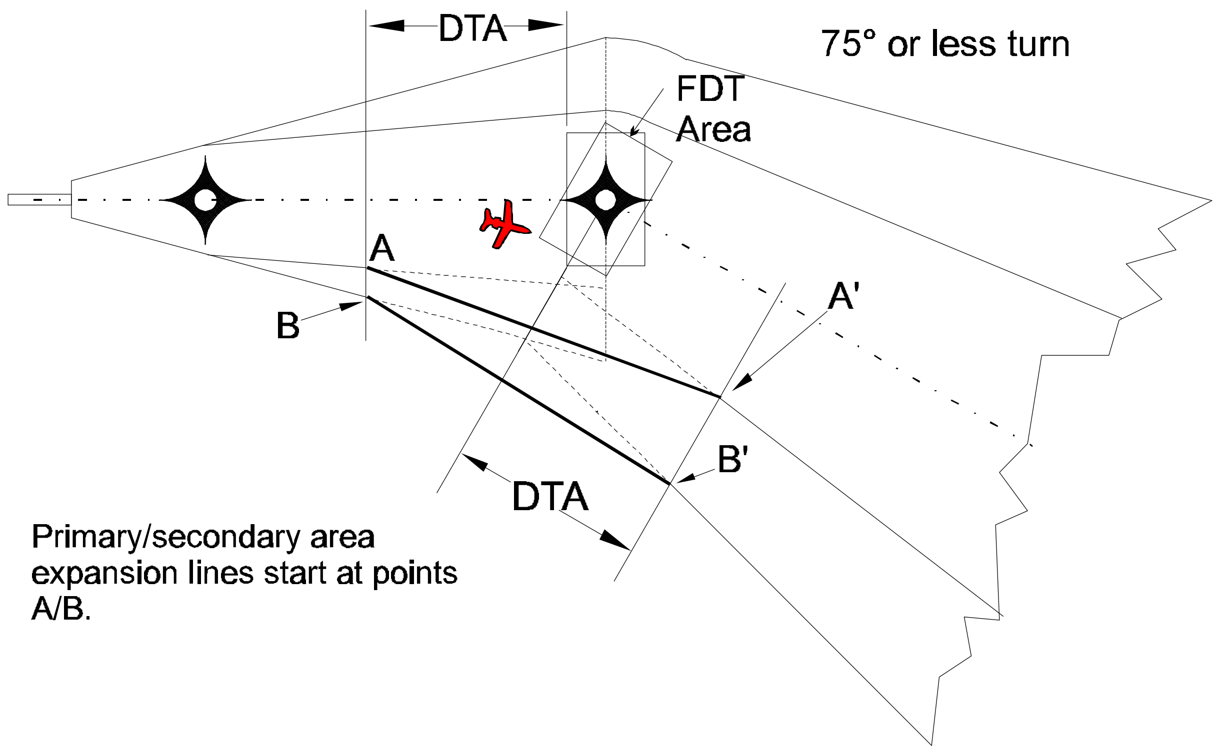
See table 3 for R1.

12.2.1 **b. Construct the secondary area boundary**, parallel with the primary expansion boundary, using the width of the preceding segment secondary area.

12.2.2 **Where turns occur during the initial splays**, the width of the segment following the TWP begins at the same width the preceding segment ended, and the splays continue as described in paragraph 10.1, except for turn expansion area indicated as follows:

12.2.2 **a. Locate point A** on the primary area boundary on the inside of the turn as prescribed in paragraph 12.2.1a (see figure 16).

Figure 16. Fly-By WP, Turn 75° or Less



12.2.2 **b. Locate point A′** on the edge of the primary area at the DTA distance, measured parallel to the course following the plotted position of the WP after completing the turn. Construct the primary boundary area by connecting point A with A′ (see figure 16).

12.2.2 **c. Locate point B** on the edge of the secondary area abeam point A. Locate point B′ on the edge of the secondary area abeam point A′. Construct the secondary area boundary by connecting point B with B′ (see figure 16).

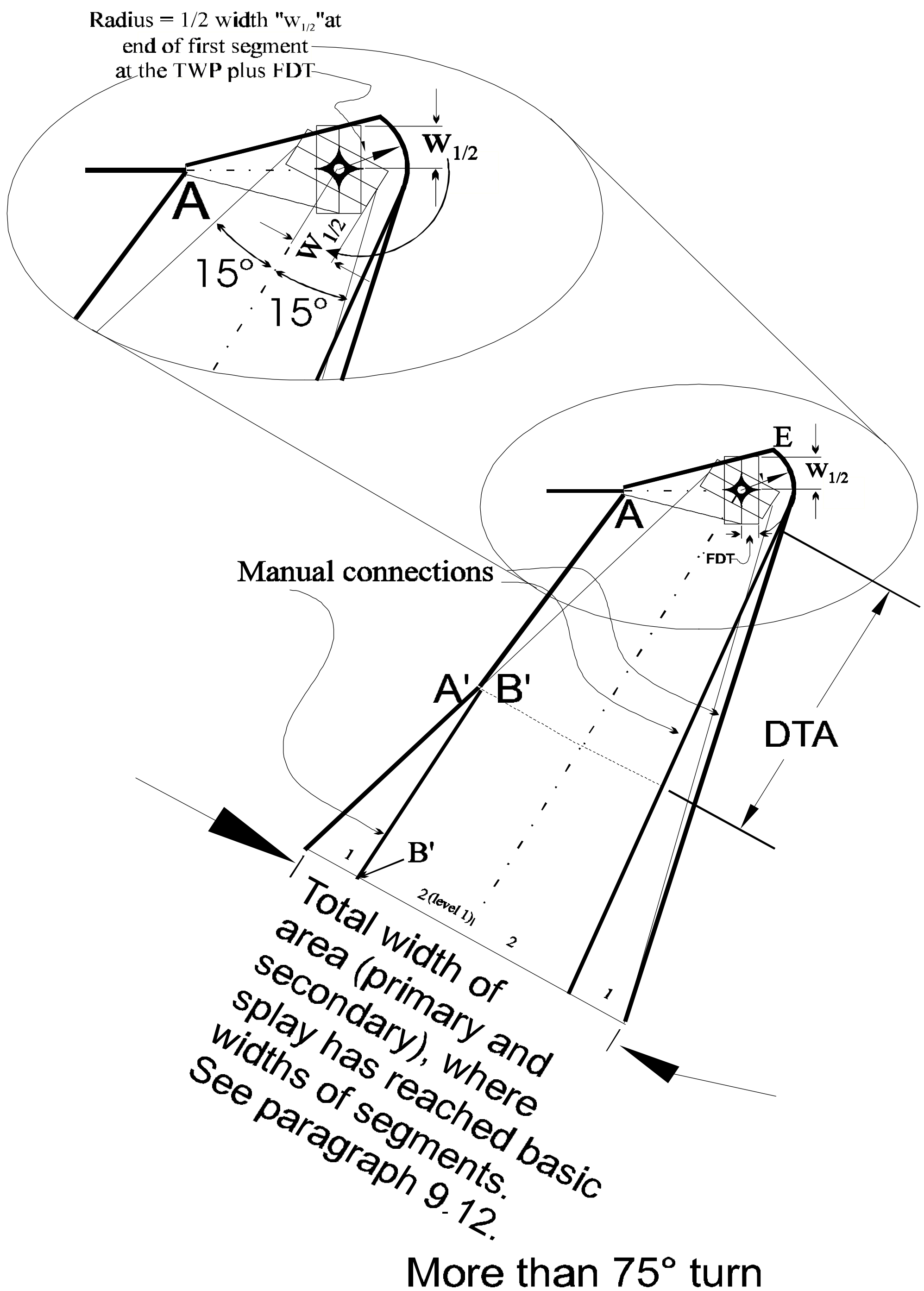
12.2.2 **d. For turns 75° less**, the resulting gap on the outside boundaries of the turn is closed by appropriate radii equal to the distance from the plotted position of the TWP to the edge of the primary or secondary area abeam the TWP (see figure 16).

12.2.2 **e. For turns greater than 75°,** continue the splay past the TWP and construct an arc from the center of the TWP and connect it to the splay at point E. The radius of this arc is equal to the width of the area at the end of the segment, abeam the plotted position of the fix plus the alongtrack FDT (see figure 17).

12.2.2. **e. (1) Using tangent lines,** join the arc to the points where the splay of the following segment reaches basic dimensions. The beginning width at the TWP, for the splay after the turn, is the width transferred from the TWP's plotted position for the previous segment.

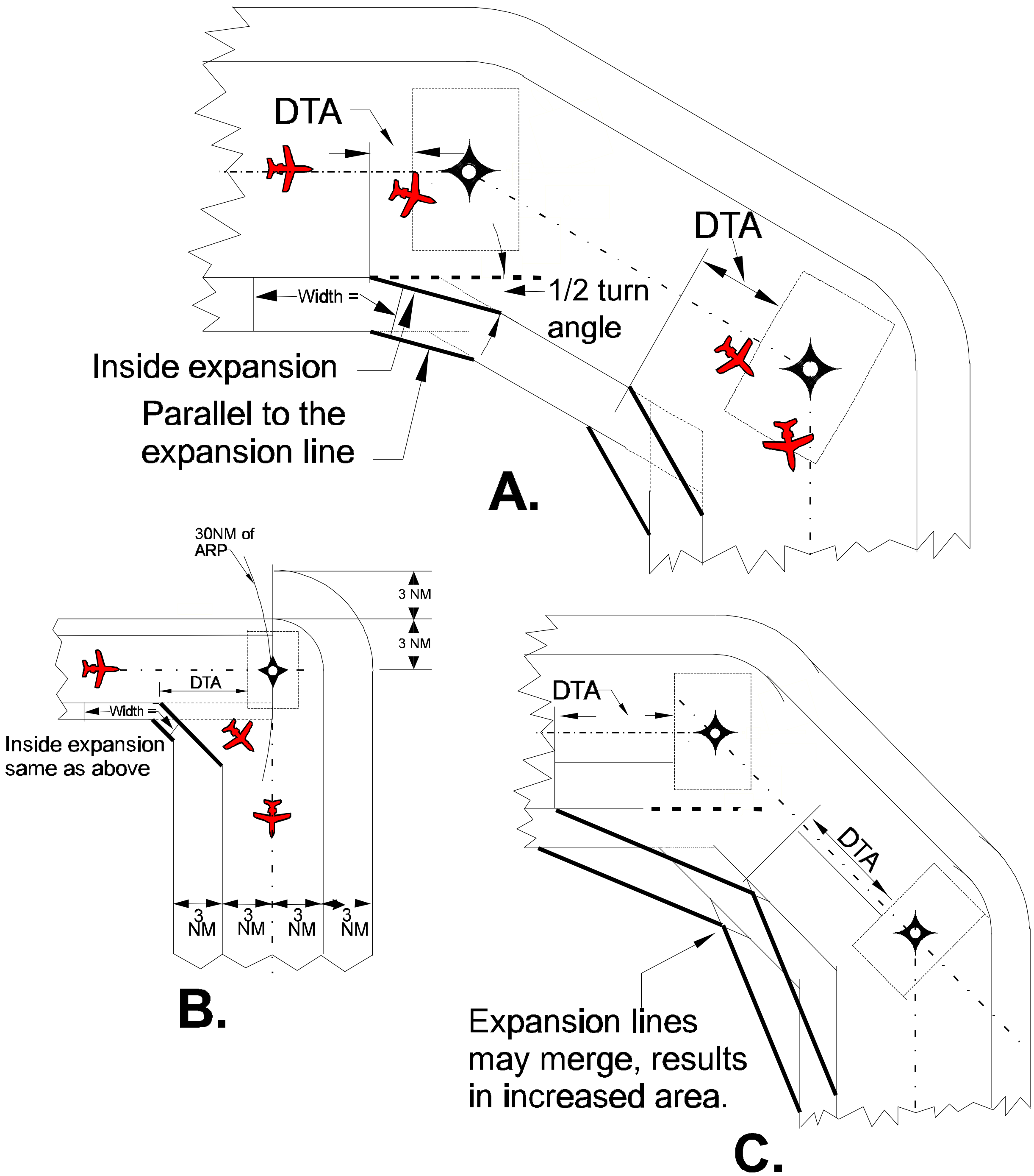
12.2.2 **e. (2) The inside area is formed** by connecting the beginning of the ICA, point A, to the edge of the splay at a distance equal to the DTA of the turn, point A′. Manually connect the point A′ to the point where the basic dimensions are reached at point B′ to establish the secondary area (see figure 17).

Figure 17. Fly-By WP, more than 75° Turn



12.2.3 Inside expansion area, two successive fly-by WP's, TF legs. Construct inside expansion as prescribed in paragraphs 12.2.1a and 12.2.1b for obstacle clearance areas when boundaries of the segments preceding and following the WP's are parallel with the course centerline. In some cases, example C, the DTA distances may cause the expansion lines to merge, increasing the size of the expanded areas. This construction is permissible (see figures 18A, B, and C).

Figure 18. Fly-By WP's, TF Legs.



12.3 OUTSIDE EXPANSION TURNS. Area for a fly-over WP. Track to fix legs.

12.3.1 Aircraft Departure Outer Boundary Radius. Select the outer boundary radius for construction of turning areas from table 3. These radii apply for the primary area boundaries. Use the boundary radius for the airspeed. Radius for the secondary area boundaries adds the applicable secondary width to R1, i.e., 1, 2, 3 NM.

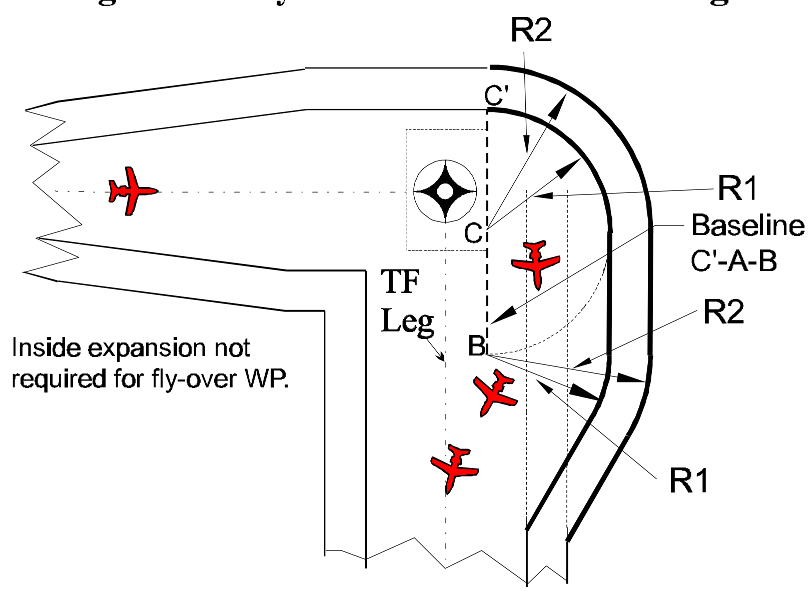
12.3.2 When the first TWP is within 5 NM of DER, use an outer boundary radius of 2.9 NM (or less as allowed in table 3 with the speed restriction) for that area; for any turns thereafter, apply paragraph 11.1. To determine the elevation for application of table 3, use the flight track distance to the WP applying the 200 feet per mile and/or published climb gradient where applicable.

12.3.3 At the latest point of the FDT, construct a baseline, for points C′-C-B. Use this baseline to construct a set of arcs to establish boundaries of the outside expansion areas (see figures 19 and 20).

12.3.3 a. Locate point C at a distance of R1 from the edge of the primary area along the baseline. Using point C on the baseline as a center point, draw an arc with radius R1 on the outside edge of the primary area of the turn. (R1 is a boundary radius selected from table 3.) Draw a second arc with radius R2 (see table 3), using C as a center point, from the outer edge of the secondary area on the outside of the turn (see figures 19 and 20).

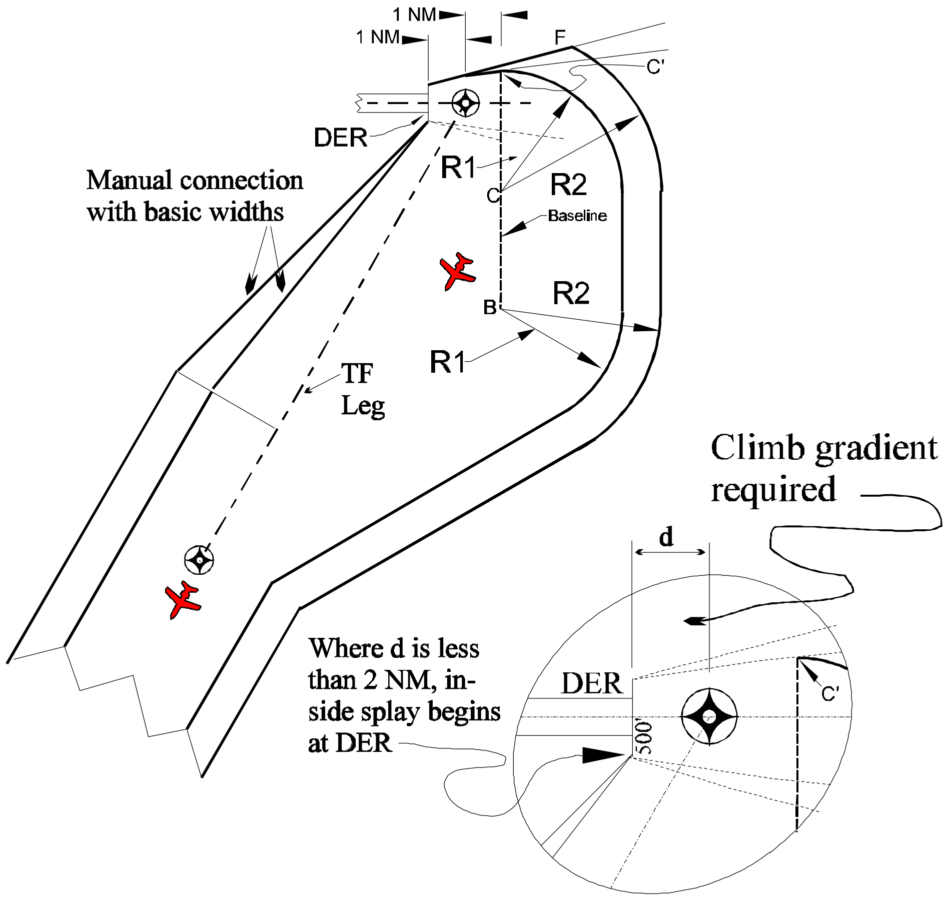
12.3.3 b. For turns 90° or greater, locate point B on the baseline at a distance R1 from point C**.** Draw another set of arcs as outlined in paragraph 12.3.3a. Connect the outside arcs with tangent lines to form the expanded area. The arcs of point B connect tangentially with lines 30° relative to the succeeding course centerline that join with the primary and secondary area boundaries (see figures 19 and 20).

Figure 19. Fly-Over WP Track to Fix Leg.



12.3.4 **Turns 90° or greater inside 5 NM** are illustrated in figure 20. Secondary areas begin abeam the fly-over WP. Where "d" is less than 2 NM, inside splay begins abeam DER as well as secondary area. Locate point "F" on the extended 15° splay using radius R2 from point C. C′ is located on the edge of the primary splay and point of intersection with the baseline.

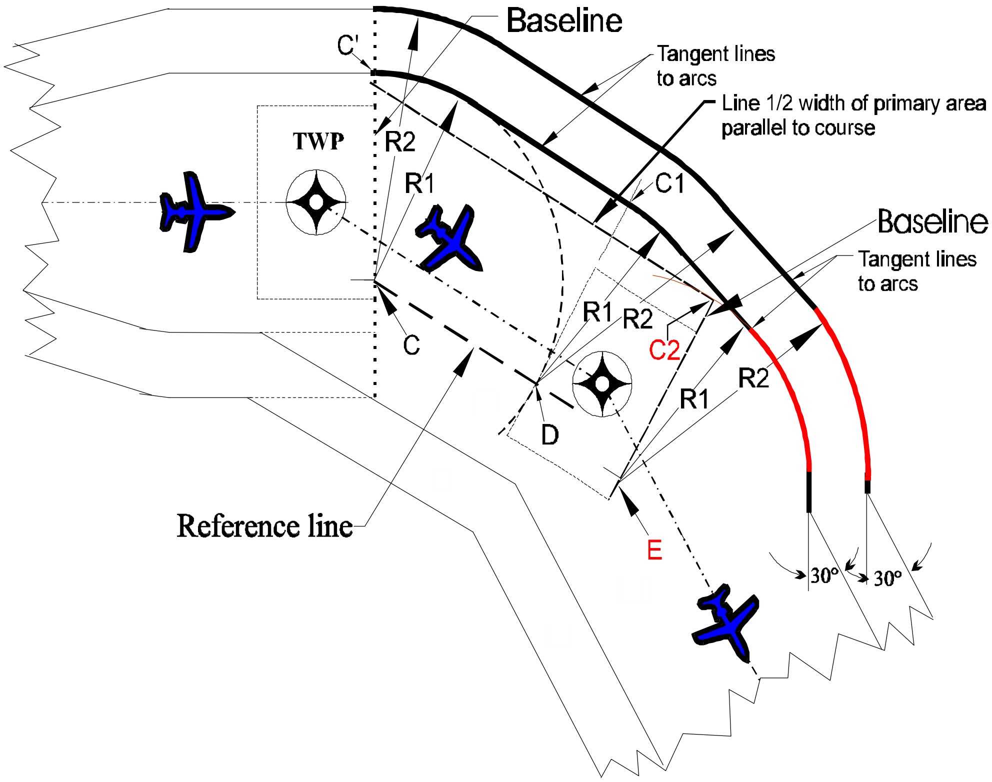
Figure 20. 90° or more Turn, Fly-Over WP Less 2 NM from DER



12.3.5 **For turns less than 90°,** construct a reference line from point C, parallel to the course centerline following the TWP. Locate point D on the reference line at a distance R1 from C and C1 (see figure 21).

12.3.5 **a. Using point D as a center point,** draw two arcs with radius R1 and R2, respectively. Radius R1 and R2 arcs define the primary and secondary expansion areas, respectively. Connect arcs with tangent lines.

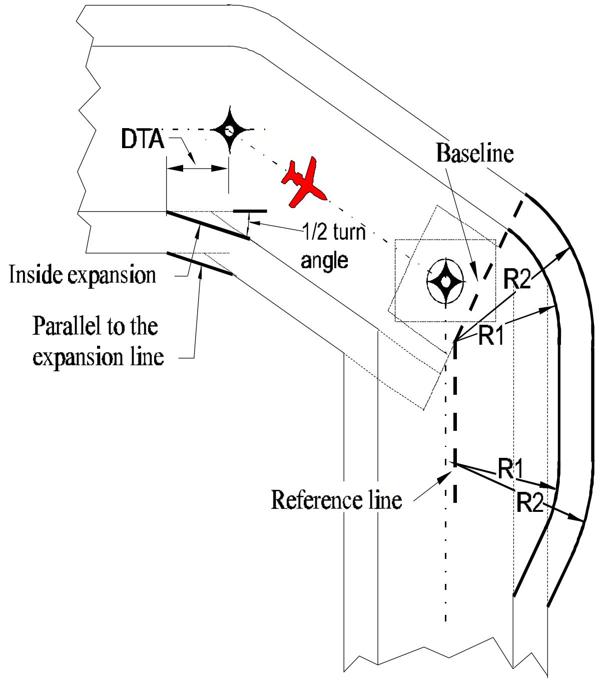
Figure 21. Successive Fly-Over WP's



12.3.5 **b. Locate E in same manner as locating C in paragraph 12.3.3a** (see figure 21). Construct a line on the outside of the turn, parallel to the course line, offset by a distance one-half the segment width. Locate C2 at the intersection of this line and the baseline of this segment. Locate E, a distance of R1 from C2. Using E as a center point, draw arcs R1 and R2. Connect, via tangents, the arcs centered at C, D, E respectively. The arcs of point E connect tangentially with lines 30° relative to the succeeding course centerline that join with the primary and secondary area boundaries.

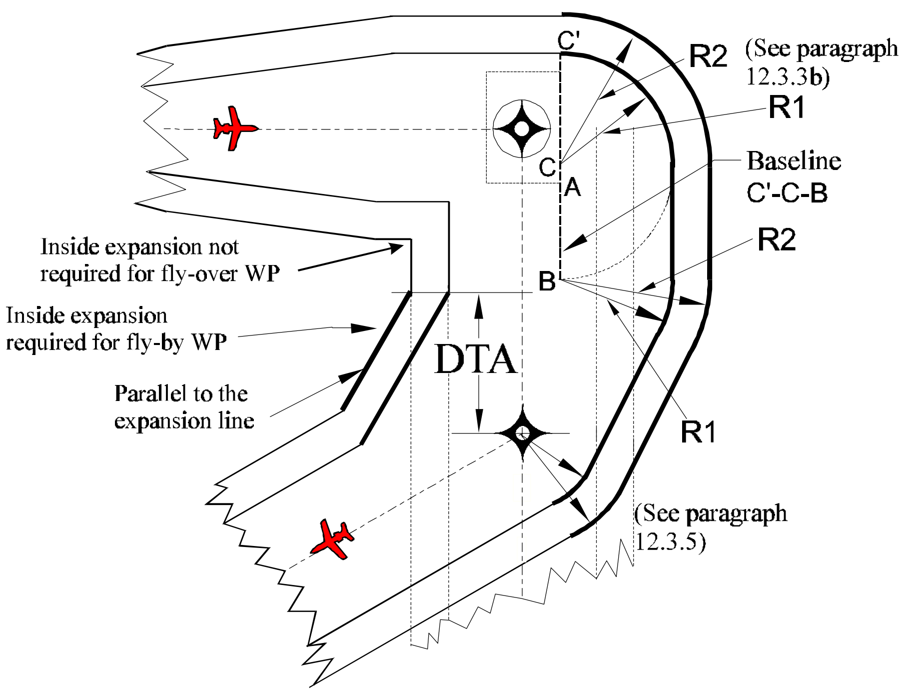
12.3.6 **Expansion Areas for Fly-By to Fly-Over WP's.** Apply paragraph 12.2.1 for the inside expansion area required for the fly-by WP. Apply paragraph 12.3.5 for the outside expansion required for the fly-over WP (See figure 22).

Figure 22. Fly-By to Fly-Over WP's



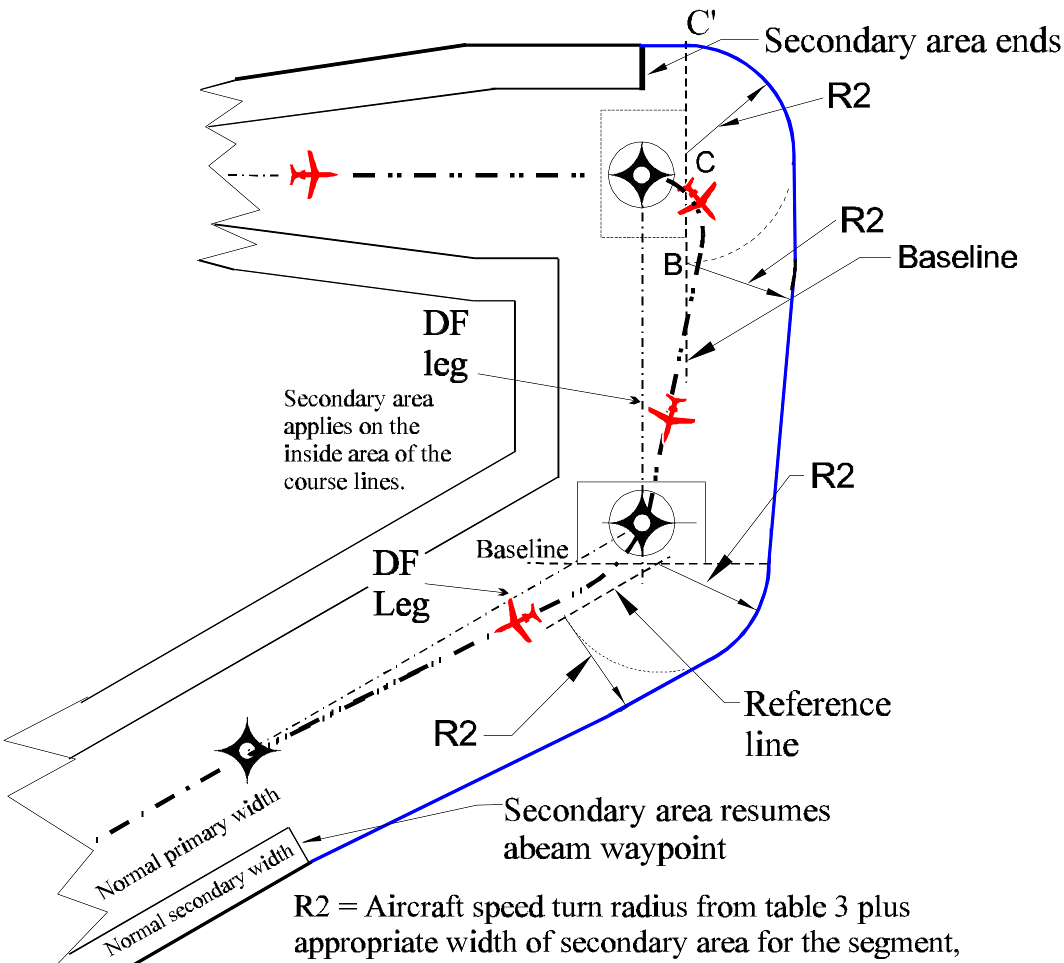
12.3.7 Expansion Areas for Fly-Over to Fly-By WP's. Apply paragraph 12.2.1 for the inside expansion area required for the fly-by. Apply paragraph 12.3.3b for the outside expansion area, 90° turn or greater, and 12.3.5 turn less than 90°, required for the fly-over WP's (see figure 23).

Figure 23. Fly-Over to Fly-By WP's



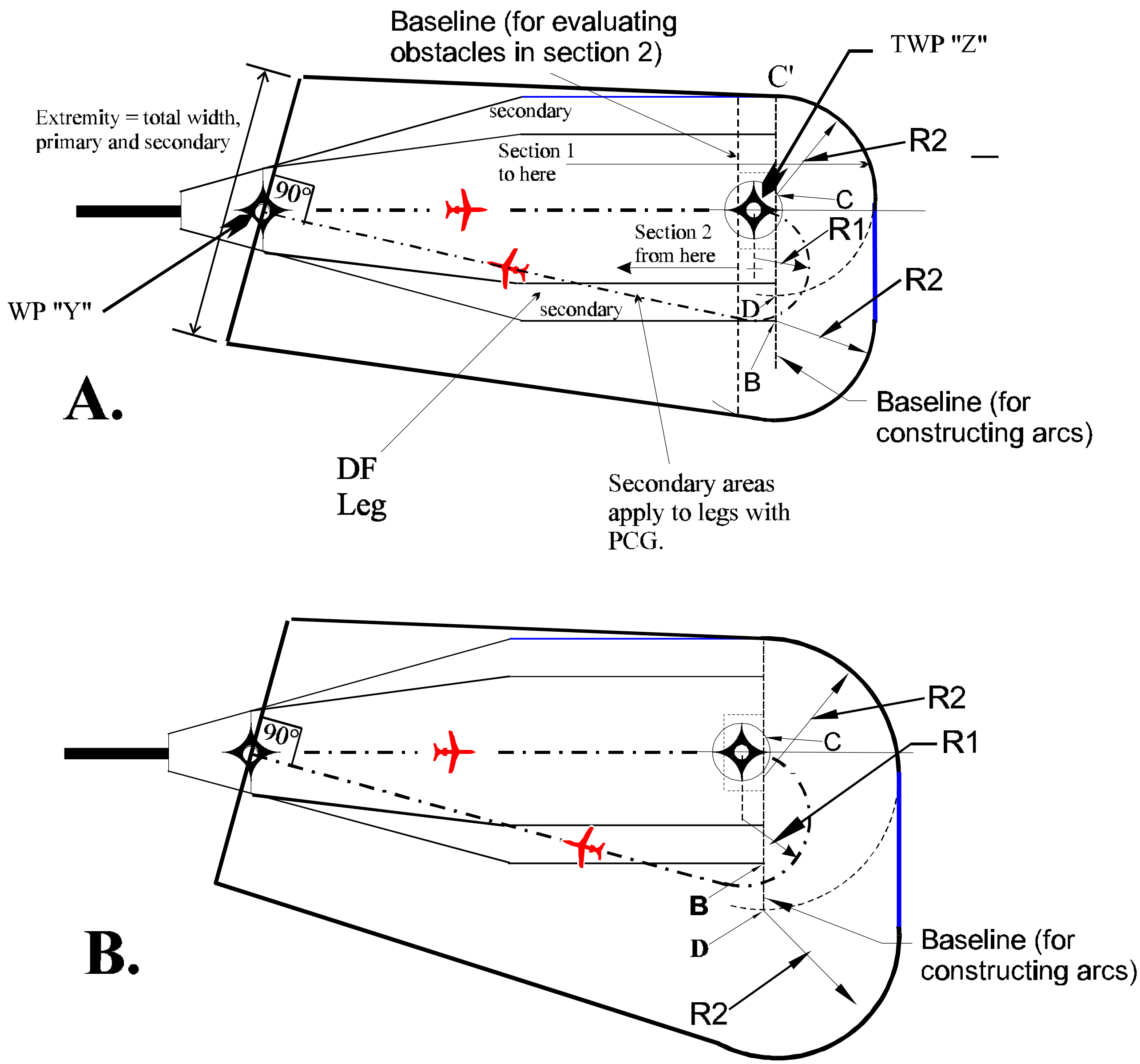
12.3.8 Direct to Fix Leg, Turns up to 120°. After turning at a fly-over WP, obstacle clearance is provided as if the aircraft rolls out and flies direct from the rollout point to another WP, either fly-by or fly-over. Specify the course change and plot the next WP. A secondary area is not allowed on the outside area of turns abeam the first fly-over WP to abeam the last WP where normal primary and secondary areas can resume. The all-primary area on the outside of the turns encompasses areas of successive fly-over WP's. The dimensions of the arc, to form the outside boundaries of the turning areas, are radii selected from table 3. Add the appropriate secondary dimension width to formulate R2. Baselines and/or reference lines are necessary to construct the outside boundary arcs. Locate C on the baseline from C′ on the outside of the secondary area's normal boundary width. Swing an arc from C to locate B. Swing an arc from B to form a second expansion arc. Use this expansion method for any successive fly-over WP's (see figure 24).

Figure 24. Fly-Over to Fly-Over WP, to a Fly-By WP



12.3.9 Direct to Fix Leg, Turns more than 120°, Fly-Over WP. After turning at a fly-over WP, obstacle clearance is provided as if the aircraft rolls out and flies direct from the rollout point to another WP, either fly-by or fly-over. Specify the course change and plot the next WP. A secondary area is not allowed from the TWP to the succeeding WP, but a secondary area is allowed to the TWP. The all-primary area, after the TWP, is made up of primary and secondary width dimensions combined. The dimensions of the arc, to form the outside boundaries of the turning areas, are radii selected from table 3 and adding the appropriate secondary dimension width to formulate R2. In figure 25A, R1 is applied to form the course line that returns to the WP "Y" from TWP "Z." A perpendicular line is then constructed at the end of the segment. Construct a baseline at latest point of the FDT, TWP "Z" to locate vertices to draw the outside obstacle area arcs. Construct an "evaluation" baseline at the earliest point of the FDT, TWP "Z," to evaluate the obstacles in section 2. Locate C on the baseline using R2 from C′ on the outside of the secondary area's normal boundary width. Swing an arc from C to construct a boundary arc. Continue this arc to form an intersection with the baseline at point D. D might fall short of "B" or overlap it on an extension of the baseline as shown in figure 25B. Point B is at the corner of the secondary area intersecting the baseline. Swing an arc from B (D if it overlaps B as shown in figure 25B) to form a second expansion arc. Join the two arcs by tangents forming the end of section 1 area (see figures 25A and B).

Figure 25. DF, More than 120° Turn, Fly-Over WP

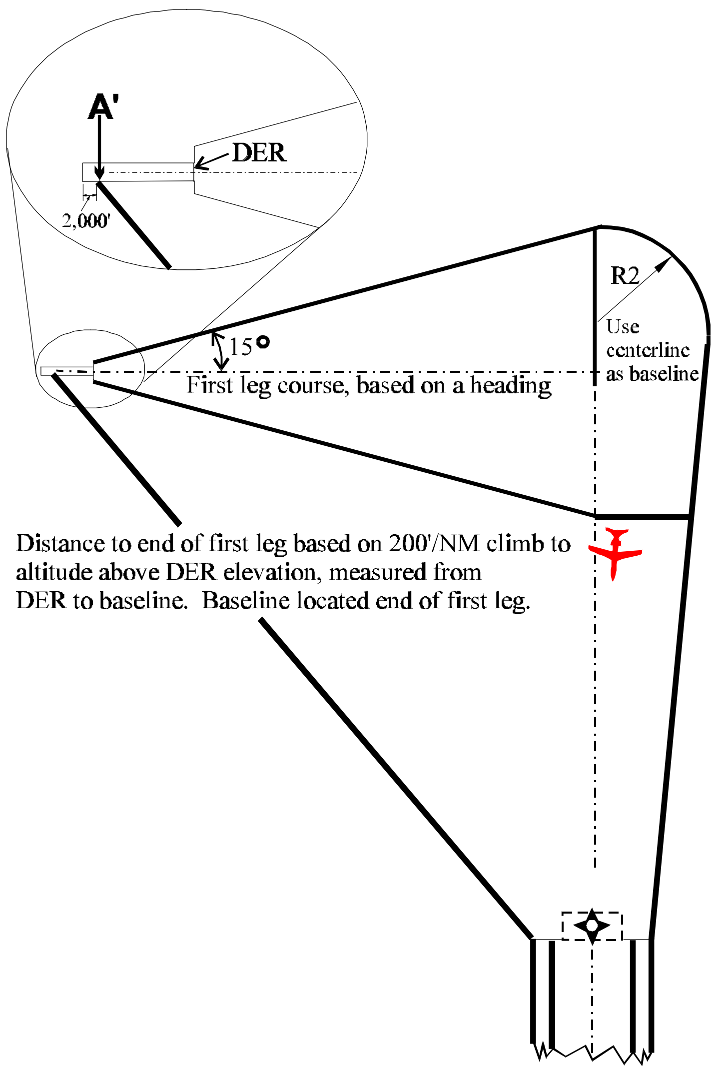


12.4 CLIMB TO ALTITUDE AND TURN. Use 200 feet per NM to determine distance required from DER to a point on runway centerline extended as the initial course where the turning altitude can be reached. Publish the extended runway centerline starting at the DER as the departure course. The distance measured from the DER to the point shall be sufficient enough to allow the aircraft to reach the designated turning altitude. Publish a climb gradient if a shorter distance is required.

12.4.1 Heading to an Altitude (VA), (Dead Reckoning). Expand the area for the climb by constructing a line 15° relative to the extended runway centerline each side of the course to a point where the altitude for the turn is reached. Select a course and distance to the next waypoint as desired. Expansion of the area is required beyond the first turn similar to the expansion methodology outlined in paragraph 12.3.9. The entire departure area including expanded portion is primary area. Use R2 radius value to construct the turning area around the point where the altitude specified to "climb to" has been reached (see figure 26).

12.4.1. a. **For turns 90° or less, construct an inside boundary** starting on the edge of the runway at a point 2,000 feet from the take-off roll end of runway, point A' (see figure 26). Extend a line directly to the inside edge of the secondary area abeam the latest point of the FDT area of the waypoint where PCG can be resumed (see figure 26).

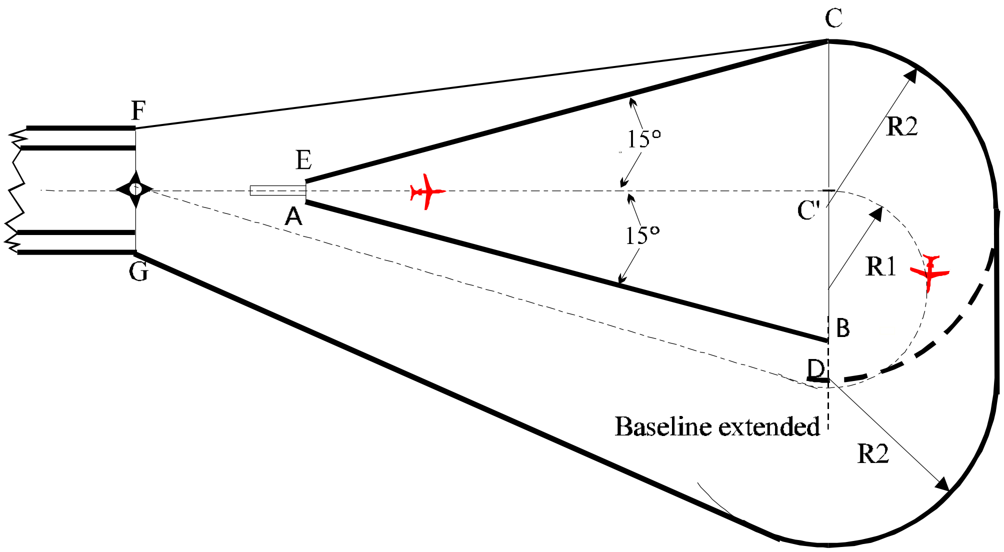
Figure 26. VA



12.4.2 **VA Followed by Turn More Than 90°.** Construct the initial course and area in accordance with paragraph 12.4.1. Use R1 (table 3) as the turn radius to construct a course to the next waypoint. Select distance based on 200 feet/NM to altitude desired. Climb gradient permitted. Expansion of the area is required beyond the first turn, using the wide construction methodology. The entire departure area is primary area (see figure 27).

12.4.2 **a. Use R2 at the end of the segment** where the turn begins for boundary arcs. Locate point D outside of turn area, construct boundary arc from point D, and join with tangent line to boundary arc for point C′. Connect boundary arc of point D to point G abeam the waypoint at the edge of the secondary area where the PCG resumes. Connect point C to point F.

Figure 27. VA, Followed by Turn More Than 90°

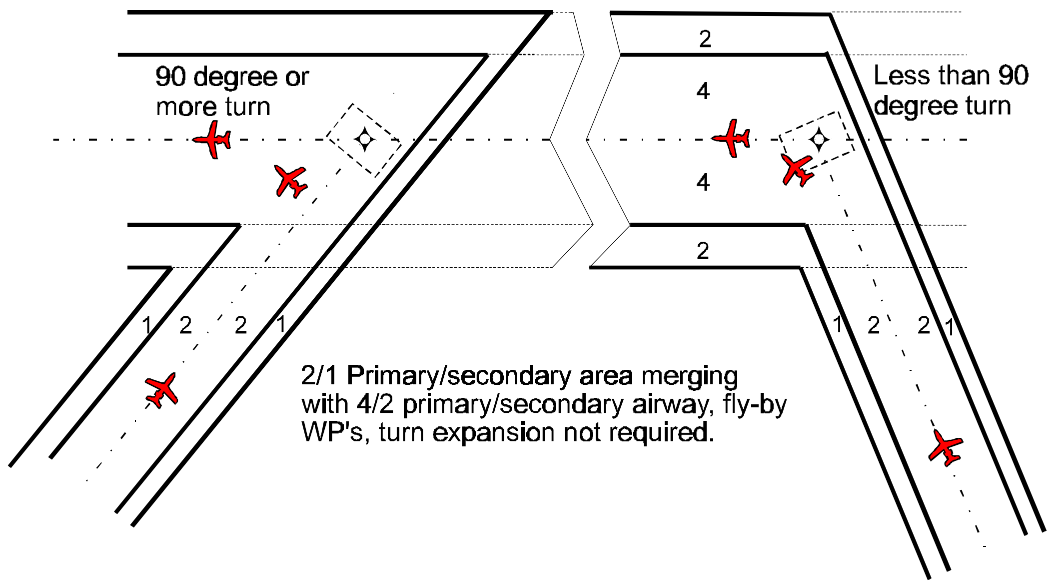


13.1 **DEPARTURE AREAS MERGING WITH EN ROUTE AIRWAY STRUCTURE.**

13.2 **Fly-by WPs.** Inside expansion is not required when departure areas are 4 and 2 NM primary and secondary respectively.

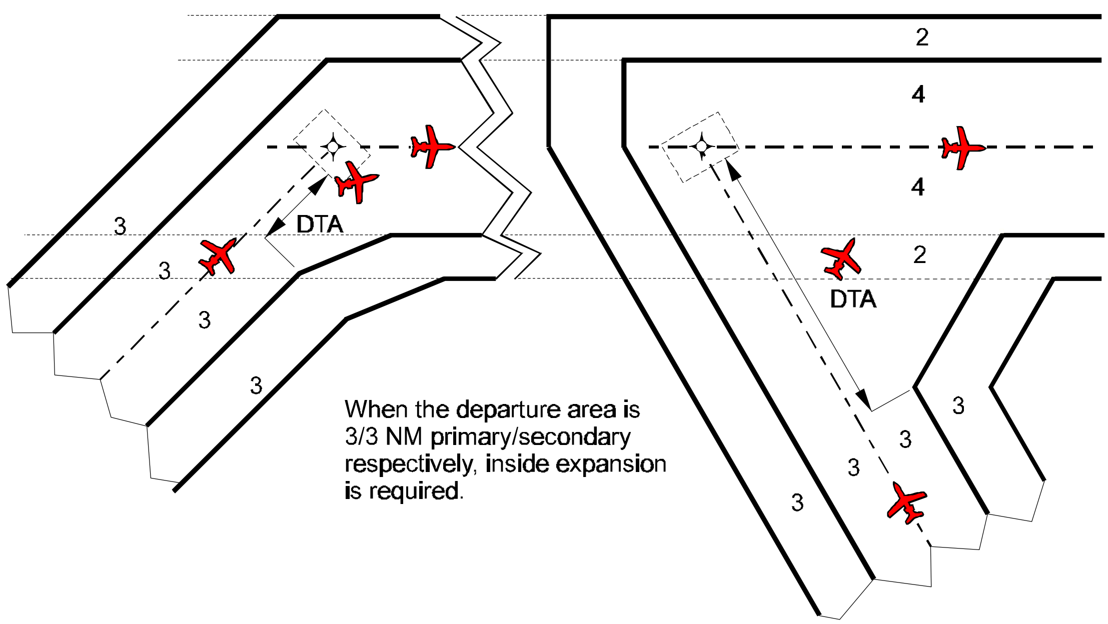
13.2.1 **When the departure** merges with an airway and departure areas are 2 and 1 NM primary and secondary respectively, the areas do not require any turn expansion (see figure 28).

Figure 28. Fly-By WP's, TF Legs



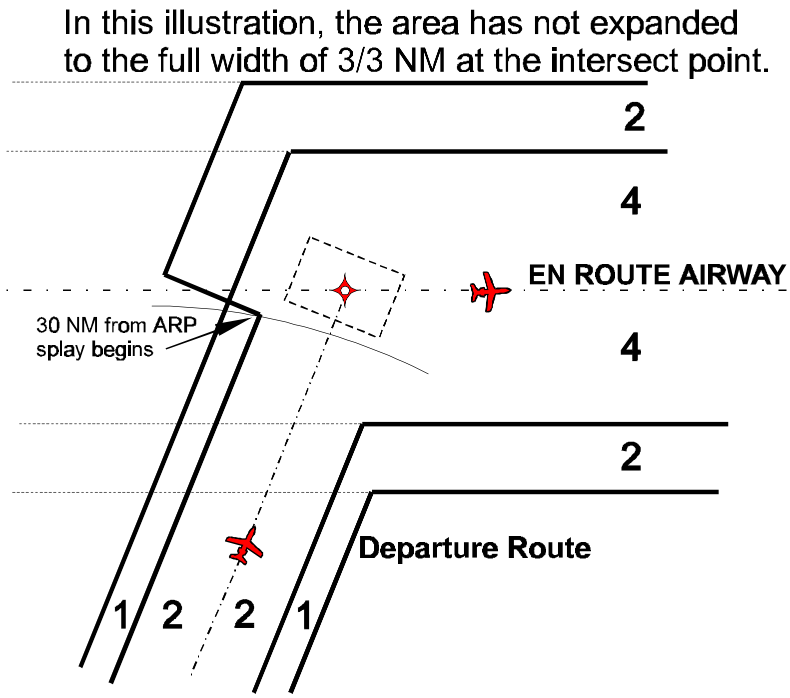
13.2.2 **When the departure** merges with an airway and the departure areas are 3 and 3 NM primary and secondary respectively, they require inside turn expansion (see figure 29). Paragraph 12.2 provides criteria.

Figure 29. Fly-By WP's, TF Legs.



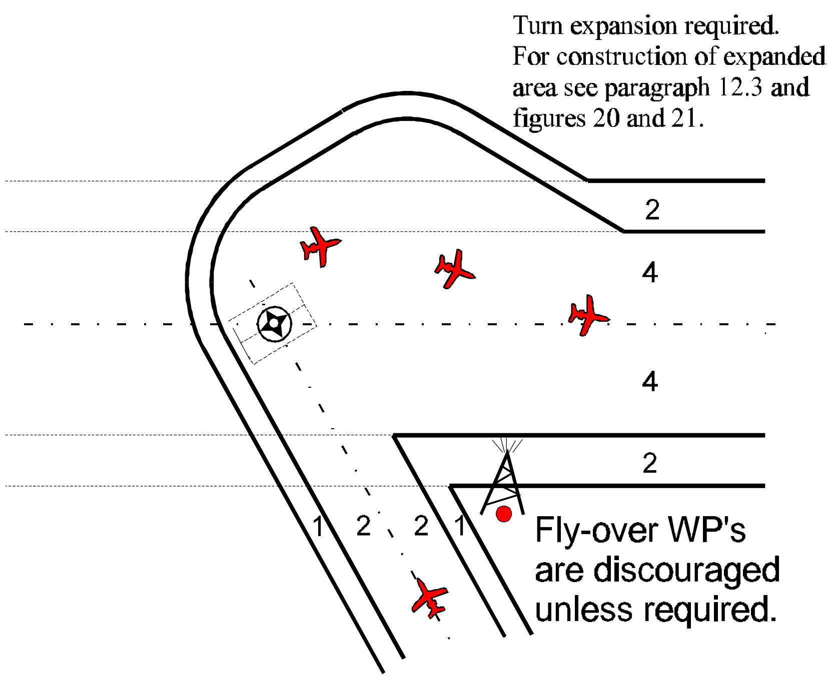
13.2.3 **When the departure** merges with an airway and departure areas are splaying from 2 and 1 NM areas to 3 and 3 primary and secondary areas respectively, the splay of the outside boundary ends where the two courses intersect. Inside expansion is not required (see figure 30).

Figure 30. RNAV Departure Joining En Route Airway



13.3 **FLY-OVER WPS.** When the departure area merges with an airway, outside turn expansion is required for all departure areas; i.e., 2 and 1 NM or 3 and 3 NM, primary and secondary areas (see figure 31). Paragraph 12.3 provides criteria.

Figure 31. Fly-Over WP, TF Leg.



13.3.1 When the departure areas are 4 and 2 NM primary and secondary respectively, use the criteria in Order 8260.3B, paragraph 1715b, for outside area expansion for turning areas.

14.1 DEPARTURE ALTITUDE. Establish a departure altitude, which is the highest altitude of: joining an existing airway, off-airway termination, or an air traffic control requirement.

14.2 JOINING AN EXISTING AIRWAY:

14.2.1 A level surface evaluation. See paragraph 15.9.

14.2.2 The appropriate MEA or MCA for the direction of flight.

14.3 OFF-AIRWAY TERMINATION:

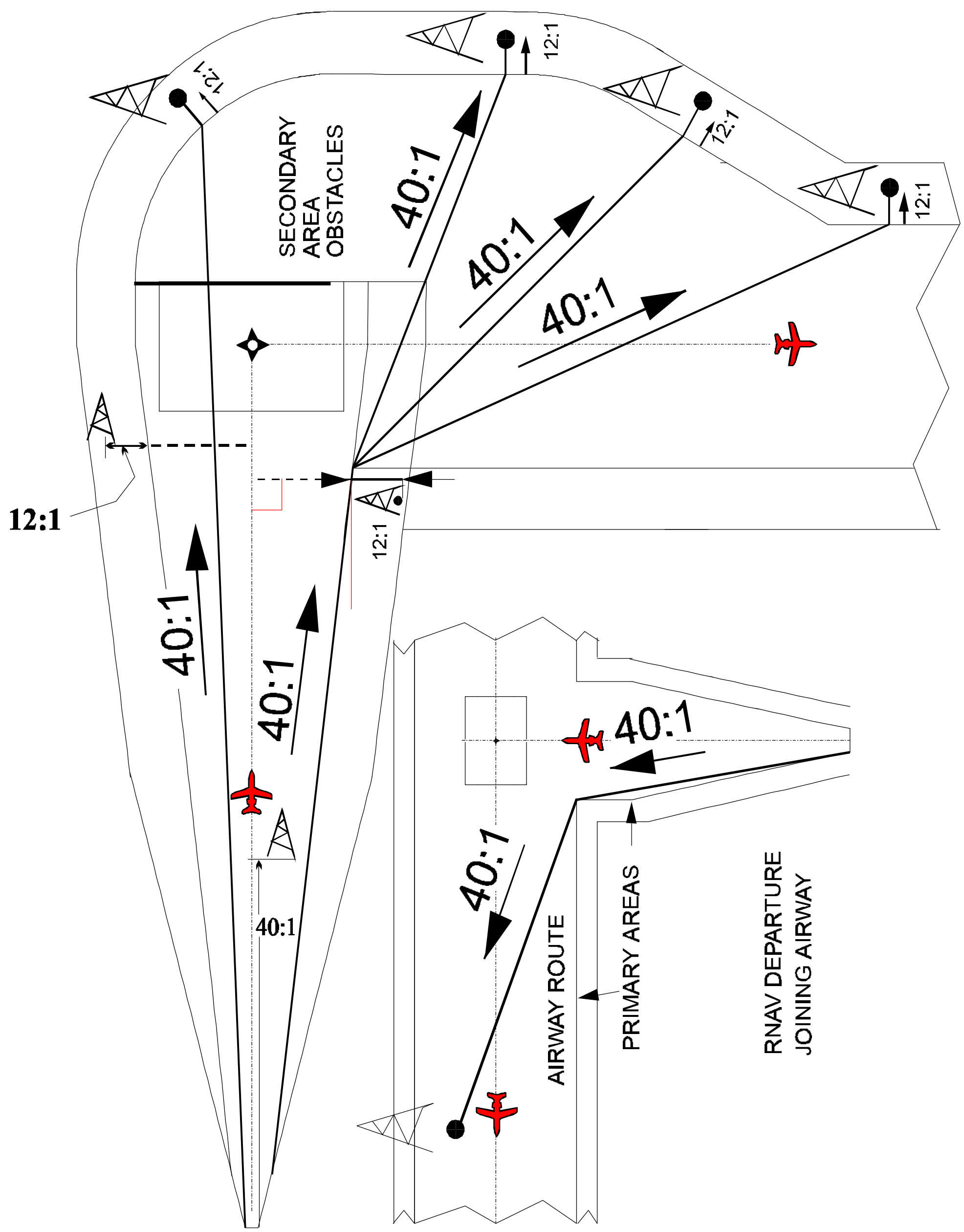
14.3.1 A level surface evaluation.

14.3.2 Altitude where radar services can be provided.

15.1 OBSTACLE EVALUATION. The area considered for obstacle evaluation begins at the departure area, and ends at a point or a WP/FIX/NAVAID defining the end of the departure (see paragraph 18.1). The maximum required obstacle clearance (ROC) for level flight is 1,000 feet in non-mountainous areas and 2,000 feet in designated mountainous areas, except when Order 8260.3B, paragraph 1720, is applied. Do not compute a climb gradient above an altitude that satisfies these ROC's.

15.2 PRIMARY AREA. No obstacle shall penetrate a 40:1 OCS that begins at the DER at DER elevation. Exception: Increase the origin height up to 35′ above DER as necessary to clear existing obstacles. The OCS rises above the shortest distance in the primary area from its beginning to the obstacle. For turns, evaluate obstacles on the turning side of the initial climb area by measuring back, within the primary area, the shortest distance to the beginning of the departure area (see figure 32).

Figure 32. Evaluation of Obstacles



15.2.1 Secondary Area. No obstacle shall penetrate a 12:1 OCS which rises from the edge of the primary area perpendicular to the segment course. In a turn expansion area, the 12:1 OCS rises perpendicular to the edge of the primary area (see figure 32). Determine the height of an equivalent obstacle on the edge of the primary area, and then evaluate the equivalent obstacle relative to the 40:1 OCS at that point.

Example: A 9,840' MSL obstacle is located in the secondary area, 2,700' from the edge of the primary area.

Step 1. Determine the elevation of an equivalent obstacle (E_E) on the edge of the primary area:

Rise of 12:1 slope to edge of primary area:	$\frac{2{,}700'}{12} = 225'$
Elevation of obstacle (E_O)	9,840'
Less 12:1 rise	- 225'
E_E	9,615'

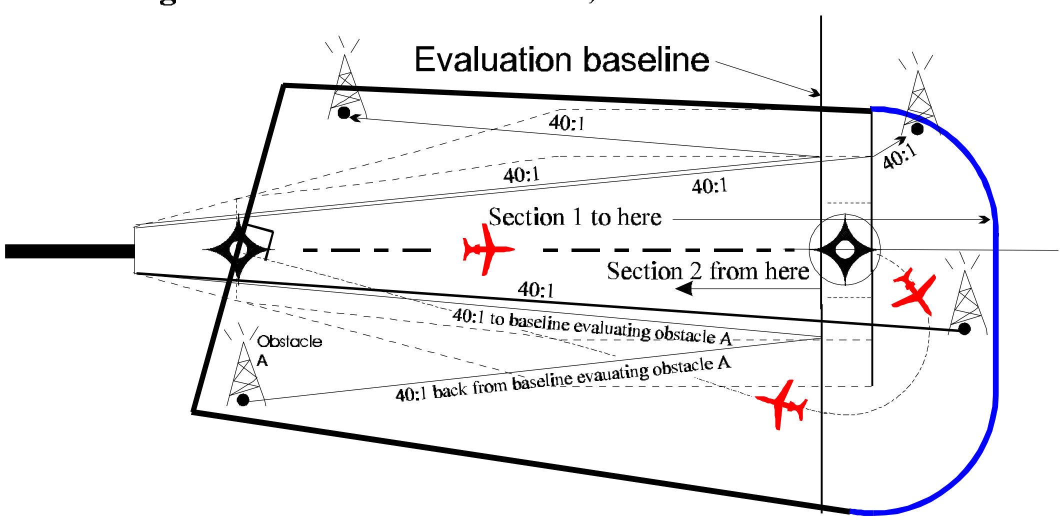
Step 2. Determine the 40:1 OCS elevation at equivalent obstacle:

D = distance (feet) from beginning of departure area measured along the shortest distance within the primary area = 21,344'

Plus 40:1 rise:	$\frac{21{,}344'}{40} = 533.6'$
DER elevation	7,640.0'
40:1 rise	+ 533.6'
40:1 OCS elevation at equivalent obstacle	8,173.6'

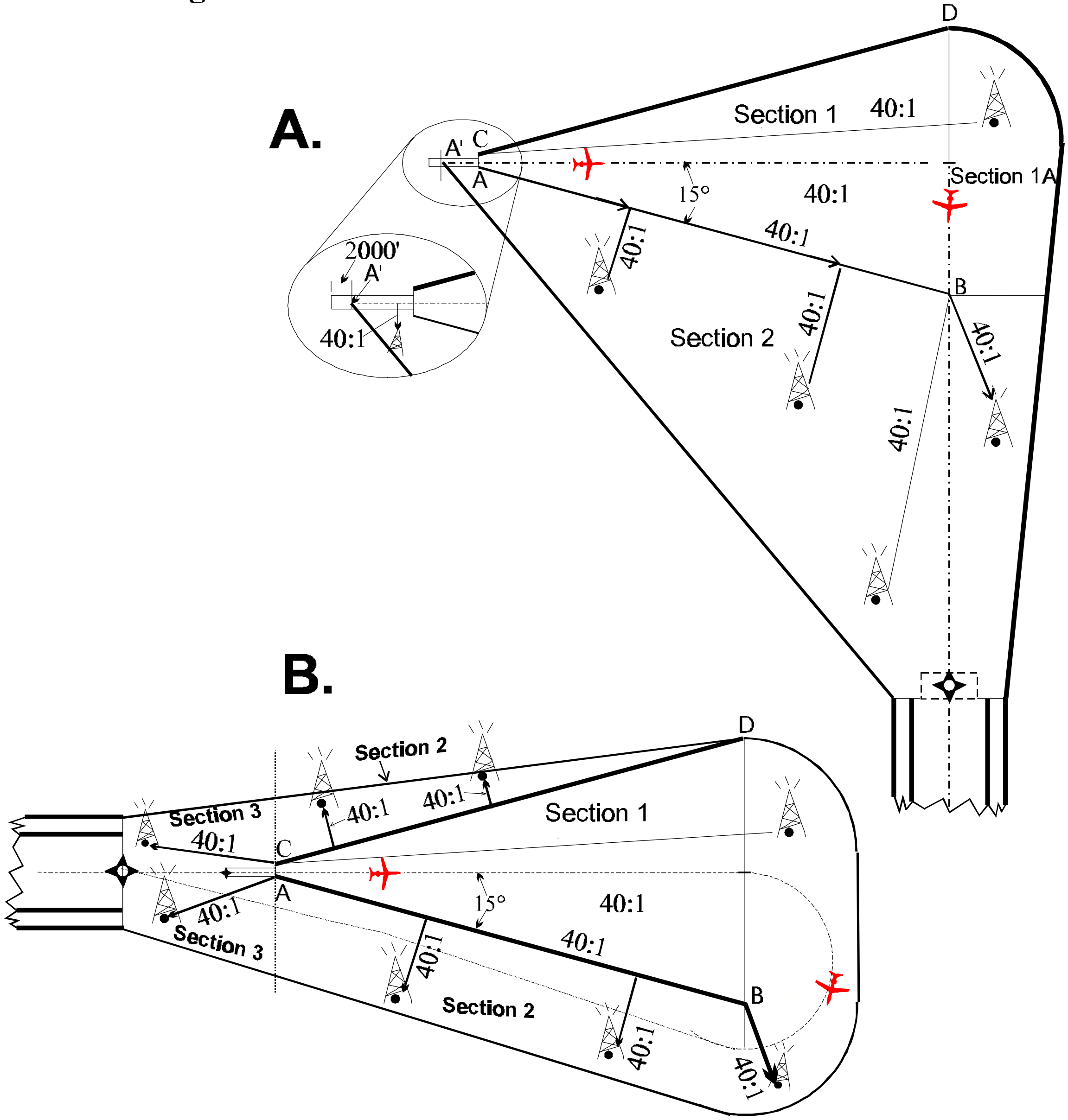
15.3 **EVALUATE THE DF LEG, TURNS MORE THAN 90°,** by measuring shortest distance from the DER to the obstacle within the primary area of section 1. Measure the shortest distance to the "evaluation baseline" from DER and then to the obstacle in section 2 (see figure 33).

Figure 33. More than 90° Turn, Obstacle Evaluation



15.4 **EVALUATE THE CLIMB TO ALTITUDE AND TURN** procedure by measuring shortest distance from the DER to each obstacle within primary area of section 1. Establish an elevation of the A-B-D-C lines by measuring 40:1 from DER to the B-D line. Obstacles beyond the B-D line, section 1A, are measured 40:1 from the DER. Evaluate the shortest distance with a 40:1 slope to the obstacle in section 2 from an edge of the A-B (D-C if applicable) lines starting at their established elevation (see figure 34A). Obstacles in section 3 are evaluated 40:1 from A-C using the elevation established for the A-B-D-C area (see figure 34B).

Figure 34. Evaluation of Climb to Altitude and Turn



15.5 **WHEN THE DEPARTURE JOINS AN EN ROUTE AIRWAY**, normally the departure area ends at the point where the departure course and the en route course intersect. Where the standard climb gradient (200 feet/NM) allows the aircraft to reach the MEA/MCA, further evaluation of the OCS beyond the intersection is not required. Where the standard climb gradient does not allow the aircraft to reach the MEA/MCA, continue the OCS evaluation to the point where the height of the OCS equals the lowest MEA for all directions of flight minus applicable en route ROC.

15.6 WHERE PENETRATIONS OF THE OCS IN PARAGRAPH 15.5 OCCUR:

15.6.1 Provide a CIH evaluation to the MEA, see paragraph 17.1, at the departure/airway intersect point (preferred holding pattern alignment is on the airway); or

15.6.2 Provide a climb gradient to MEA at the departure/airway intersect point; or

15.6.3 If during a CIH evaluation an OCS penetration occurs, establish a climb gradient to clear offending obstacles.

15.7 WHERE THE STANDARD CLIMB GRADIENT will not allow the aircraft to comply with an airway MCA, provide a note indicating climb gradient required. For example: Departures north bound on Victor 240 require a minimum climb of 426 feet/NM to 7,300 feet.

15.8 THE OCS HEIGHT where the departure course and en route segment intersect is determined by measuring the shortest distance within the primary area to a line drawn perpendicular to the departure course through the point of intersection defined by a WP/FIX/NAVAID.

15.9 APPLY A LEVEL SURFACE EVALUATION for the entire departure in a similar manner as stated in Order 8260.3B, paragraph 274.

16.1 CLIMB GRADIENTS. Do not exceed a 500-foot per NM climb gradient without approval from Flight Standards Service.

16.1.1 Climb Gradients to Achieve Operational Requirements. Climb gradients for purposes to achieve operational requirements, such as the initial climb, where the distance to first turn WP is less within 2 NM, calculate a climb gradient to that WP using the following formula:

$$\left(G = \frac{(APT + 400') - DERELEV}{D_I} \right)$$

Where: G = climb gradient (feet/NM)

APT = airport elevation

DERELEV = DER elevation

D_I = distance (NM) from DER measured along the route centerline

NOTE: The 400′value may be increased by operational/air traffic requirements.

Example: Airport elevation = 3,000′

DER elevation = 2,950′

The first WP is located 1.6 NM beyond the DER.

$$G = \frac{(3{,}000' + 400) - 2{,}950'}{1.6} = 281'/NM$$

16.1.2 Climb Gradients to Achieve Obstacle Clearance. For any segment, including the initial climb area, avoid obstacles (including equivalent obstacles from paragraph 15.2.1) which penetrate the OCS, by specifying a climb gradient that provides 24 percent of the gradient as ROC not to exceed the maximum required obstacle clearance specified in paragraph 15.1 applied over distance (D). Apply the minimum climb gradient required for obstacle clearance. The minimum climb gradient for an obstacle is determined from the formula:

$$\boxed{G = \frac{H_O}{0.76D} \text{ or } \frac{H_E}{0.76D}}$$

Where: G = Climb Gradient (feet/NM)

H_O= Height (feet) of obstacle above DER (feet) or H_E (equivalent obstacle in secondary area) as appropriate.

D = Distance (NM) from DER measured along the shortest distance within the primary area.

Example: Determine minimum climb gradient (G)

E_E	9,615'
DER elevation	-7,640'
Height (H_E) of equivalent obstruction above DER	1,975'

D = 3.51 NM

$$G = \frac{1{,}975'}{0.76(3.51)} = 740.36 = 740 \text{ feet/NM}$$

16.1.3 Specify the climb gradient to an altitude where a gradient greater than 200 feet/NM is no longer required. The climb gradient termination altitude **(A_T)** may be determined by the formula:

$\boxed{A_T = DG + DER\ elevation}$

Example: Minimum climb gradient termination altitude (A_T)

[3.51 x 740] + 7,640' = 10,237.4' = 10,300' MSL (round to the next higher 100-foot increment)

Using example in paragraph 16.1.2: "-------with a minimum climb of 740′/NM to 10,300′."

16.1.4 **Multiple Climb Gradients**. Where multiple climb gradients exist within a segment, (e.g., due to multiple obstacle clearances, and/or as well as air traffic control requirements, or to meet en route MCA requirements) publish the highest computed climb gradient for that segment. When multiple climb gradients result from separate sources, a breakout of each source with the corresponding climb gradient should be published.

16.1.5 **Climb Gradients** based on an MCA or ATC requirements are calculated using flight track distance. Measurement is between DER and a point where an altitude is required or WP/FIX/NAVAID, or between WP's/FIX's/NAVAID's.

Example: Flight track distance: 12 NM

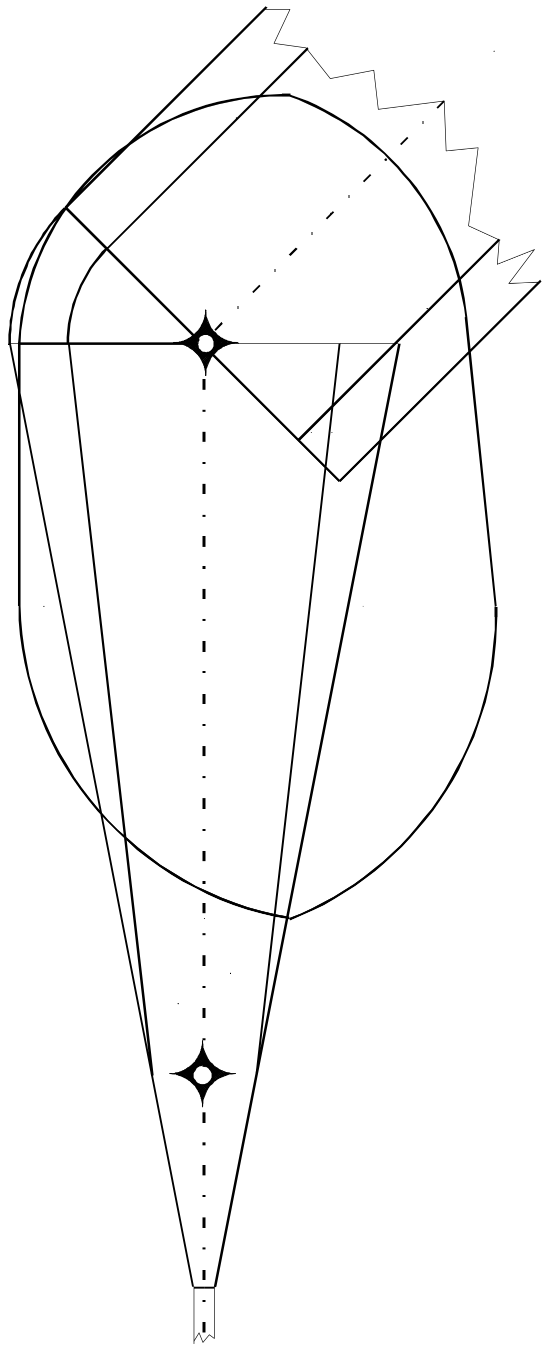
Altitude	8,000′
elev DER	- 1,200′
	6,800′

$$G = \frac{6{,}800'}{12} = 566.66 \text{ (round to nearest foot) } 567' \text{ per NM.}$$

G = climb gradient

17.1 **CLIMB IN A HOLDING PATTERN.** For a CIH, apply the criteria in Order 8260.3B, paragraph 293b, and Order 8260.38A, paragraph 8. Minimum holding shall be at an altitude where radar service can be provided or when joining an airway provides en route operations (see figure 35).

Figure 35. Climb-in-Hold



18.1 END OF DEPARTURE. The departure evaluation terminates at:

18.1.2 A WP/FIX/NAVAID not on an en route structure:

18.1.2 a. Where radar service can be provided.

18.1.2 **b. Where a CIH evaluation is required** to reach an altitude in which radar service can be provided.

18.1.3 **An en route WP/FIX/NAVAID** from which the aircraft can continue en route operations.

SECTION 2. DIRECTIVE FEEDBACK INFORMATION

19.1 **INFORMATION UPDATE.** Forward for consideration any deficiencies found, clarification needed, or suggested improvements regarding the content of this order to:

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

19.1.1 **Your Assistance is Welcome.** FAA Form 1320-19, Directive Feedback Information, is included at the end of this order, for your convenience. If an interpretation is needed immediately, you may call the originating office for guidance. However, you should also use FAA Form 1320-19 as a follow-up to the verbal conversation.

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

L. Nicholas Lacey
Director, Flight Standards Service

U.S. Department
of Transportation

**Federal Aviation
Administration**

Directive Feedback Information

Please submit any written comments or recommendations for improving this directive, or suggest new items or subjects to be added to it. Also, if you find an error, please tell us about it.

Subject: Order 8260.44A, Civil Utilization of Area Navigation (RNAV) Departure Procedures

To: 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)