Factual Report – Attachment 20

FAA TERPS Change 21

OPERATIONAL FACTORS

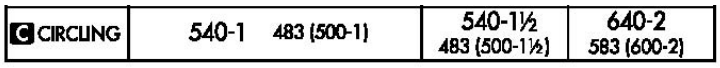
CEN17MA183

Federal Aviation Administration

CHARTING NOTICE

Date:	November 5, 2012
To:	Users of the Terminal Procedures Publication (TPP) and the Users of the Digital Terminal Procedures Publication (d-TPP) DVD.
From:	Aeronautical Navigation Products (AeroNav Products)
Subject:	New Expanded Circling Approach Icon Legend Page

Beginning with the **November 15, 2012** chart publication date, explanatory text describing new circling criteria that will affect circling approach area dimensions by expanding the areas to provide better obstacle protection will be added to the front matter legend pages. Affected procedures will have a negative "C" icon on the circling line of minima to which the new criteria has been applied. For a detailed explanation of the new criteria, see the explanatory text and tables in the front matter of the TPP (pages B1 & B2), as well as a detailed explanation to be published in the AIM. Users can expect to begin seeing charts with the negative C icon in the near future.



IMPLEMENTATION OF NEW CIRCLING CRITERIA BASED ON TERPS 8260.3B CHANGE 21

Background

The FAA has modified the criteria for circling approach areas via TERPS 8260.3B Change 21. The circling approach area has been expanded to provide improved obstacle protection. As a result, circling minima at certain airports may increase significantly.

Standard Circling Approach Maneuvering Radius

Circling approach areas developed prior to 2011 used the radius distances (in NM) as depicted in the following table. The distances are dependent on the aircraft approach category.

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
All altitudes	1.3	1.5	1.7	2.3	4.5

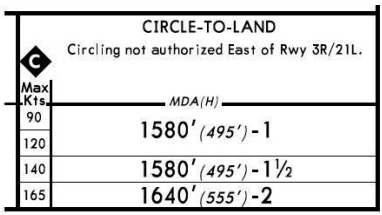
Expanded Circling Maneuvering Airspace Radius

Circling approach areas for approach procedures developed beginning in 2013 use the radius distances (in NM) as depicted in the following table. These distances, dependent on aircraft category, are also based on the circling altitude which accounts for the true airspeed increase with altitude.

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
1000 or less	1.3	1.7	2.7	3.6	4.5
1001 – 3000	1.3	1.8	2.8	3.7	4.6
3001 – 5000	1.3	1.8	2.9	3.8	4.8
5001 – 7000	1.3	1.9	3.0	4.0	5.0
7001 – 9000	1.4	2.0	3.2	4.2	5.3
9001 and above	1.4	2.1	3.3	4.4	5.5

Affect on Jeppesen Charts

Charts where these criteria have been applied can be identified by the symbol C in the CIRCLE-TO-LAND minima box.



The new minima will be published on approach procedure charts on an as-revised basis as the new criteria are applied by the FAA and issued via their source documents.

TERMS/LANDING MINIMA DATA

CIRCLING APPROACH OBSTACLE PROTECTED AIRSPACE

The circling MDA provides vertical obstacle clearance during a circle-to-land maneuver. The circling MDA protected area extends from the threshold of each runway authorized for landing following a circle-to-land maneuver for a distance as shown in the tables below. The resultant arcs are then connected tangentially to define the protected area.

STANDARD CIRCLING APPROACH MANEUVERING RADIUS

Circling approach protected areas developed prior to late 2012 used the radius distances shown in the following table, expressed in nautical miles (NM), dependent on aircraft approach category. The approaches using standard circling approach areas can be identified by the absence of the C symbol on the circling line of minima.

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
All Altitudes	1.3	1.5	1.7	2.3	4.5

C EXPANDED CIRCLING APPROACH MANEUVERING AIRSPACE RADIUS

Circling approach protected areas developed after late 2012 use the radius distance shown in the following table, expressed in nautical miles (NM), dependent on aircraft approach category, and the altitude of the circling MDA, which accounts for true airspeed increase with altitude. The approaches using expanded circling approach areas can be identified by the presence of the C symbol on the circling line of minima.

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
1000 or less	1.3	1.7	2.7	3.6	4.5
1001-3000	1.3	1.8	2.8	3.7	4.6
3001-5000	1.3	1.8	2.9	3.8	4.8
5001-7000	1.3	1.9	3.0	4.0	5.0
7001-9000	1.4	2.0	3.2	4.2	5.3
9001 and above	1.4	2.1	3.3	4.4	5.5

Comparable Values of RVR and Visibility

The following table shall be used for converting RVR to ground or flight visibility. For converting RVR values that fall between listed values, use the next higher RVR value; do not interpolate. For example, when converting 1800 RVR, use 2400 RVR with the resultant visibility of ½ mile.

RVR (feet)	Visibility (statute miles)	RVR (feet)	Visibility (statute miles)
1600	¼	4500	⅞
2400	½	5000	1
3200	⅝	6000	1¼
4000	¾		

RADAR MINIMA

	RWY	GP/TCH/RPI	CAT	DA/ MDA-VIS	HAT/ HATh/ HAA	CEIL-VIS	CAT	DA/ MDA-VIS	HAT/ HATh/ HAA	CEIL-VIS
PAR	10	2.5°/42/1000	ABCDE	**195**/16	100	(100-¼)				
	28	2.5°/48/1068	ABCDE	**187**/16	100	(100-¼)				
ASR	10		ABC	**560**/40	463	(500-¾)	DE	**560**/50	463	(500-1)
	28		AB	**600**/50	513	(600-1)	CDE	**600**/60	513	(600-1¼)
CIR	10		AB	**560-**1¼	463	(500-1¼)	CDE	**560-**1½	463	(500-1½)
	28		AB	**600-**1¼	503	(600-1¼)	CDE	**600-**1½	503	(600-1½)

Visibility (RVR 100's of feet)

Visibility in Statute Miles

All minimums in parentheses not applicable to Civil Pilots. Military Pilots refer to appropriate regulations.

Radar Minima:

1. Minima shown are the lowest permitted by established criteria. Pilots should consult applicable directives for their category of aircraft.
2. The circling MDA and weather minima to be used are those for the runway to which the final approach is flown- not the landing runway. In the above RADAR MINIMA example, a category C aircraft flying a radar approach to runway 10, circling to land on runway 28, must use an MDA of 560 feet with weather minima of 500-1½.

NOTE: Military RADAR MINIMA may be shown with communications symbology that indicates emergency frequency monitoring capability by the radar facility as follows:

(E) VHF and UHF emergency frequencies monitored
(V) VHF emergency frequency (121.5) monitored
(U) UHF emergency frequency (243.0) monitored

Additionally, unmonitored frequencies which are available on request from the controlling agency may be annotated with an "x".

A Alternate Minimums not standard. Civil users refer to tabulation. USA/USN/USAF pilots refer to appropriate regulations.

A NA Alternate minimums are Not Authorized due to unmonitored facility or absence of weather reporting service.

T Takeoff Minimums not standard and/or Departure Procedures are published. Refer to tabulation.

25 MAY 2017 to 22 JUN 2017

There is no specific definition of “protected airspace” in FAA Order 8260.3, United States Standard for Terminal Instrument Procedures (TERPS) however that term is interpreted to mean the Obstacle Evaluation Area (OEA) described in paragraph 2-7-1. The Instrument Procedure Handbook does reference “protected airspace” as the area within the Circling Approach Radius (CAR) which defines the size of each circling OEA.

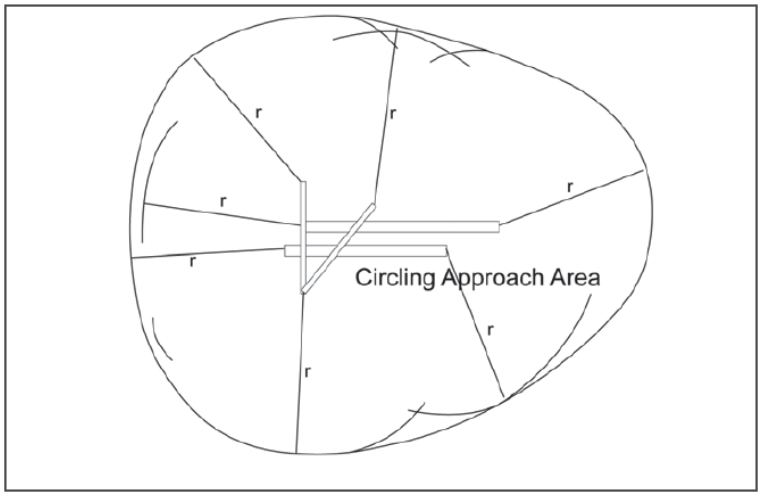
> “The TERPS Change 21 to the *circling protected airspace* afforded much greater obstacle protection. However, it also afforded the pilot the opportunity to use the extra *protected airspace* to mitigate the need to conduct a high descent rate, unstabilized approach that was often necessary as a result of the previous criteria for the Circling Approach Radius (CAR). For example, under TERPS Change 21, a sea level airport with a 1,500 ft HAA will have CAT C CAR of 2.86 NM, a 1.16 NM (68.5%) increase over pre-TERPS Change 21 CAR for CAT C. This extra *protected airspace* can be used by the pilot to maneuver the airplane instead of being forced to use high descent rates which are often necessary for high HAA circling approaches.” [1]

As alluded to in the IPH excerpt, TERPS Change 21 (June 5, 2009) increased the size of the circling OEA. Prior to that date the circling OEA was determined by a fixed circling radius based on aircraft approach category. See Table 1, and Figure 1 below.

Table 1

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
All Altitudes	1.3	1.5	1.7	2.3	4.5

Figure 1



[1] U.S. Department of Transportation, *Instrument Procedure Handbook* (2015), 4-9

As of the current date, the Change 21 circling areas have not yet been applied to all approaches, including those at Teterboro. Those with the Change 21 expanded circling areas can be identified by the presence of the C symbol on the circling line of minima on the approach procedure chart (see Section 5-4-20 of the Aeronautical Information Manual (AIM) and the circling information section on page B2 of the U.S. Terminal Procedures Publications (TPP)).

Change 21 circling OEA are unique to each airport based on variables such as true airspeed and bank angle. When Change 21 circling OEAs are applied at Teterboro, the circling radii are as shown in Table 2. When compared to the existing circling OEAs at Teterboro, the results are no change to Category A, a 0.31NM increase to Category B, a 1.13NM increase to Category C, and a 1.4NM increase to Category D.

Table 2

KTEB Circling Area		
	Pre Change 21	Post Change 21
CAT A	1.3NM	1.3NM
CAT B	1.5NM	1.81NM
CAT C	1.7NM	2.83NM
CAT D	2.3NM	3.7NM

Changes to Circle to Land criteria and minimums:

8260.3B Change 20 (12/07/2007)

Expanded the methodology for establishing circling visibility minimums.

> **3.1.3 Approach Lighting Systems.**
> Approach lighting systems extend visual cues to the approaching pilot and make the runway environment apparent with less visibility than when such lighting is not available. For this reason, lower straight-in (not applicable to circling) visibility minimums may be established when standard or equivalent approach lighting systems are present.
>
> **3.2.1 b. The circling MDA (CMDA)** HAA must be no lower than that specified in *paragraph 3.3.3* and *table 3-9*. The CMDA must provide the minimum ROC in the circling maneuvering area and meet the missed approach requirements specified in *paragraph 3.2.1a*. The published CMDA must provide the minimum required final obstacle clearance in the final approach segment and the minimum required circling obstacle clearance in the circling approach area. The CMDA must not be above the FAF altitude or below the straight-in MDA of the highest nonprecision approach (NPA) line of minima published on the same chart. When precision approach (PA) or APV procedures are published standalone, i.e., without an accompanying nonprecision line of minima, the

CMDA must not be above the intermediate segment altitude or below the straight-in DA of the highest PA or APV line of minima published on the same chart.

Note: When dual minimums are authorized, the CMDA is compared against the SI MDA associated with the corresponding minima set (i.e., circling with stepdown minimums checked against SI with stepdown minimums).

3.3.1 b. Establish circling visibility minimums when:
3.3.1 b. (1) Straight-in alignment cannot be met (e.g., for "Circling-only" procedures not meeting straight-in alignment requirements, *see paragraph 162*).
3.3.1 b. (2) Straight-in alignment requirements are met, but descent gradients/angles preclude publication of straight-in minimums (*see paragraph 252*).
3.3.1 b. (3) Published in conjunction with Straight-in minimums.

3.3.2 d. STEP 4. Determine visibility based on evaluation of the visual portion of the final approach segment. Evaluate the visual area associated with each usable runway at an airport. Apply the STANDARD visual area described in *paragraph 3.3.2d(1)(a)* to runways to which an aircraft is authorized to circle (either in association with a SI procedure, or a Circling only).

Note 1: The type of visual area assessment conducted and the subsequent results depend on how the runway is used in relation to the procedure being developed. For example, a runway is served by an approach procedure not aligned with the runway centerline, and is authorized for landing from a circling maneuver on another approach procedure to a different runway receives both standard and offset evaluations. However, it is not necessary to publish the results of a STANDARD area assessment to the runway to which the approach is being developed.

3.3.2 d. (2)(b) 3. Do not publish a VDP, limit minimum visibility to 1 mile/5000 RVR, and publish a note denying the approach (both straight-in and circling) to the affected runway at night [*also see paragraph 3.3.2d(2)(d)]*.
3.3.2 d. (2)(c) 20:1 Surface Penetrations (circling runways). Mark and light the penetrating obstacles or publish a note denying night circling to the affected runway (except as noted below).
3.3.2 d. (2)(d) 20:1 Surface Penetrations are sometimes impossible to mark and light. In these cases **ONLY**, nighttime operations may continue where an operating VGSI set at an angle $\geq$ 3 degrees serves the runway and its associated OCS is verified to be clear. The approach chart must be annotated to indicate the straight-in approach procedure or circling operation (as appropriate) is not authorized at night when the VGSI is Inoperative.

3.3.3 Establishing Circling Visibility Minimums
3.3.3 a. STEP 1. Determine MAP to nearest landing surface distance (*see figure 3-3b*):
3.3.3 a. (1) When published in conjunction with Straight-in minimums. [*paragraph 3.3.1b(3)]* or when the HAA is less than 1,000 ft proceed to *STEP 3*.
3.3.3 a. (2) For "Circling-only" procedures not meeting straight-in alignment requirements [*paragraph 3.3.1b(1)]*. When the MAP is located prior to nearest landing

surface, measure the shortest distance from the plotted position of the MAP in SM (*see figure 3-3b*) and proceed to *STEP 2*. When the landing surfaces are encountered prior to the MAP, proceed to *STEP 3*.

3.3.3 a. (3) When Straight-in alignment requirements are met, but descent gradients/ angles preclude publication of straight-in minimums *[paragraph 3.3.1b(2)]***.** Apply *paragraph 3.3.2a (see figure 3-3a)* to determine the distance and proceed to *paragraph 3.3.2b STEP 2*.

3.3.3 b. STEP 2. Publishing "Fly Visual to Airport" (Flight Standards approval required). When the MAP to nearest landing surface distance is greater than or equal to 3 SM **AND** the HAA is greater than or equal to 1,000 ft, specify visibility as 3 SM and annotate the procedure "Fly visual to airport." *See Order 8260.19, paragraph 855k for charting requirements.*

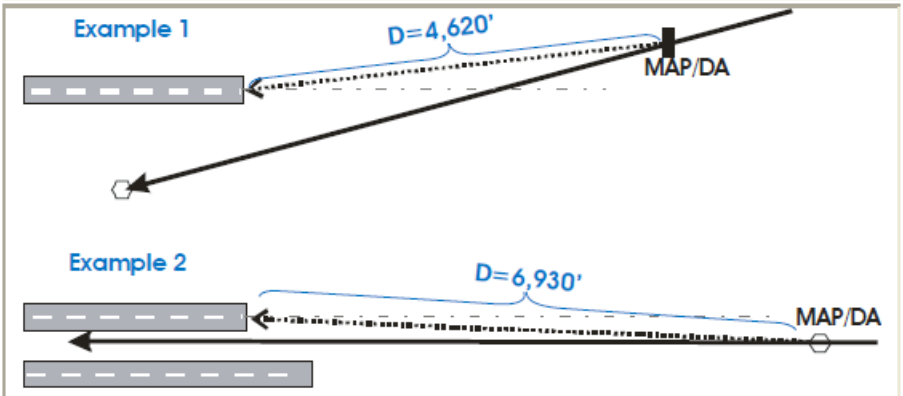
Note: *The FAA, in the preamble to a Title 14 Code of Federal Regulations (14 CFR) Part 91 change, has declared that the Administrator must retain the authority to approve instrument approach procedures where the pilot may not necessarily have one of the visual references specified in Part 91.175, and related rules such as 121.651, 135.225, and 125.381 which refer to and incorporate 91.175. There are other cases where the Administrator's authority to issue special provisions must also be available to approve visual approaches, contact approaches, helicopter procedures, or other items such as waivers for all-weather takeoff and landing research and development. It is NOT a function of procedure design to ensure compliance with Part 91.175. The annotation "Fly Visual to Airport" provides relief from Part 91.175 which should not be granted routinely.*

3.3.3 c. STEP 3. Determine circling visibility/RVR from the appropriate table(s). Find the highest value from *tables 3-9, 3-10, and 3-11*.

3.3.3 c. (1) ***Table 3-9*** **specifies the lowest civil and military HAA** and visibility authorized for circling approaches. If the computed HAA is greater than the minimum specified in *table 3-9*, refer to *table 3-10* to determine the minimum visibility based on the resultant HAA applicable to the appropriate aircraft category. In addition, *table 3-11* specifies the minimum visibility based on facility to runway distance and is applicable to circling visibility for conventional NPA procedures.

3.3.3 d. STEP 4. Determine **visibility based on evaluation of the visual** portion of the final approach segment (*see paragraph 3.3.2d*).

Figure 3-3a. *SI Alignment and SI with Circling Minimums.*



V_{MAP} = D/I (round to next higher reportable value)

Where

D = Shortest distance from MAP/DA to threshold

I = statue mile increment in feet (i.e. 1/8 = 660' 1/4 = 1,320', etc.)

Example 1

V_{MAP} = 4,620/660' = 7

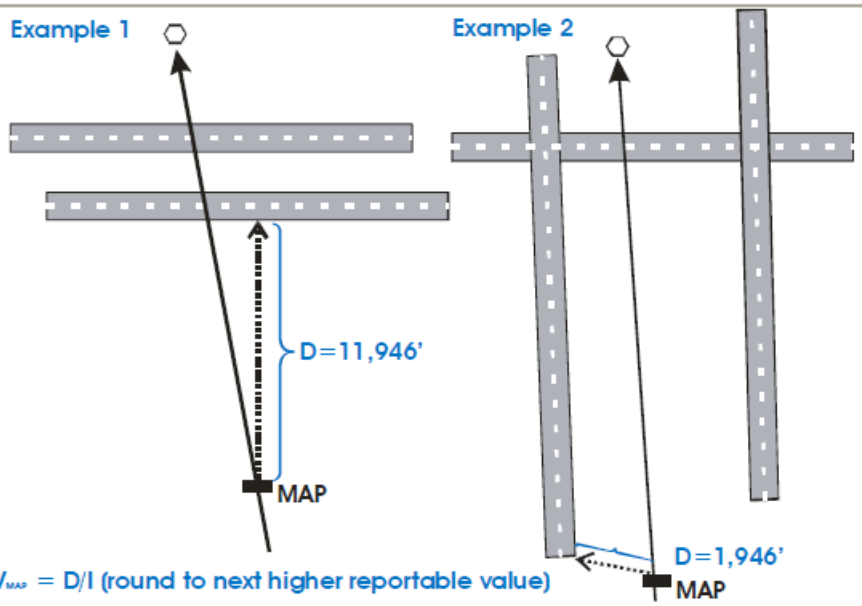
V_{MAP} = 7/8th SM

Example 2

V_{MAP} = 6,930/1,320' =5.25

V_{MAP} = 5.25/4 (round up to 1 ½ SM)

Figure 3-3b. *Circling Not Aligned with Runway.*



V_{MAP} = D/I (round to next higher reportable value)

Where

D = Shortest distance from MAP to nearest landing surface

I = statue mile increment in feet (i.e. 1/8 = 660' 1/4 = 1,320', etc.)

Example 1

V_{MAP} = 11,946'/1320= 9.05

V_{MAP} = 9.05/4 (round up to 2 ½ SM)

Example 2

V_{MAP} = 1,946'/660' =3=2.95

V_{MAP} = 2.95/8 (round up to 3/8 SM)

Table 3-9. *Lowest Authorized Circling HAA and Visibility/RVR.*

Aircraft Category	A	B	C	D	E
Height Above Airport Elevation in Feet	350	450	450	550	550
Visibility in SM/meters	1 / 1600		1 1/2 / 2400	2 / 3200	

Table 3-10. *Effect of HAA on Circling Visibility Minimums.*

HAA (ft)	351 - 810				811 & ABOVE		
CAT A	1				1 1/4		
HAA (ft)	451 - 810				811 - 950		951 & ABOVE
CAT B	1				1 1/4		1 1/2
HAA (ft)	451 - 600	601 - 670	671 - 740	741 - 810	811 - 880	881 - 950	951 & ABOVE
CAT C	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3
HAA (ft)	551 - 670		671 - 740	741 - 810	811 - 880	811 & ABOVE	
CAT D	2		2 1/4	2 1/2	2 3/4	3	
HAA (ft)	551 - 600	601 - 670	671 - 740	741 - 810	811 & ABOVE		
CAT E	2	2 1/4	2 1/2	2 3/4	3		

Table 3-11. *Facility Distance Effect on Circling Visibility Minimums.*

NAVAID TYPE	CAT	DISTANCE FROM FACILITY TO MAP OR NEAREST LANDING SURFACE (whichever is farther)				
		0 – 10 NM	> 10 – 15 NM	> 15 - 20 NM	> 20 - 25 NM	> 25 - 30 NM
ASR	A	1	1	1	N/A	N/A
	B	1	1 1/4	1 1/4	N/A	N/A
	C	1	1 1/2	1 1/2	N/A	N/A
	D/E	1	2	2	N/A	N/A
NDB DF	A	1	1	N/A	N/A	N/A
	B	1	1 1/4	N/A	N/A	N/A
	C	1	1 1/2	N/A	N/A	N/A
	D/E	1	2	N/A	N/A	N/A
VOR/TACAN LOC SDF LDA	A	1	1	1	1	1
	B	1	1	1	1 1/4	1 1/4
	C	1	1	1 1/4	1 1/2	1 1/2
	D/E	1	1 1/4	1 1/2	1 3/4	2

3.3.3 e. STEP 5. Applicable only when required to permit circling from a straight-in aligned procedure *[paragraph 3.3.1b(2)]*, compare circling visibility to the SI visibility.
3.3.3 e. (1) The circling visibility must not be less than published SI no-light visibility of the highest NPA line of minima published on the same chart. When PA or APV procedures are published standalone, i.e., without an accompanying NPA line of minima, the circling visibility must not be less than the SI no-light visibility of the highest PA or APV line of minima published on the same chart.
Note: When dual minimums are authorized, the circling visibility is compared against the SI MDA associated with the corresponding minima set (i.e., circling with stepdown minimums checked against SI with stepdown minimums.
3.3.3 f. STEP 6. Establish circling visibility as the highest value determined from *STEPS 2-5* (as applicable)**.**

8260.3B Change 21 (6/05/2009)

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

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

Section 6, Circling Approach.

(a) Updates requirements related to the Circling Approach Area, revising the method of determining the size of the Obstacle Evaluation Area (OEA) to more closely align with ICAO methodology based ACF issue #92-02-105.
(b) Clarifies intent related to OEA evaluation when circling area restrictions are established based on ACF issue #92-02-105 and US-IFPP Change 21 Working Group recommendations.

SECTION 5. FINAL APPROACH
250. FINAL APPROACH SEGMENT. This is the segment in which alignment and descent for landing are accomplished. Final approach may be made to a runway for a straight-in landing or to an airport for a circling approach. The segment begins at the Final Approach Fix (FAF)/precise final approach fix (PFAF) and ends at the missed approach point (MAP) and/or Decision Altitude (DA). Criteria for alignment, length, obstacle evaluation area (OEA), and obstacle clearance surface/evaluation are contained in the chapters/directives specific to the facility/system providing navigation guidance. A visual portion within the final approach segment is also assessed for all approaches (see Vol. 1, chapter 3, paragraph 3.3.2d).

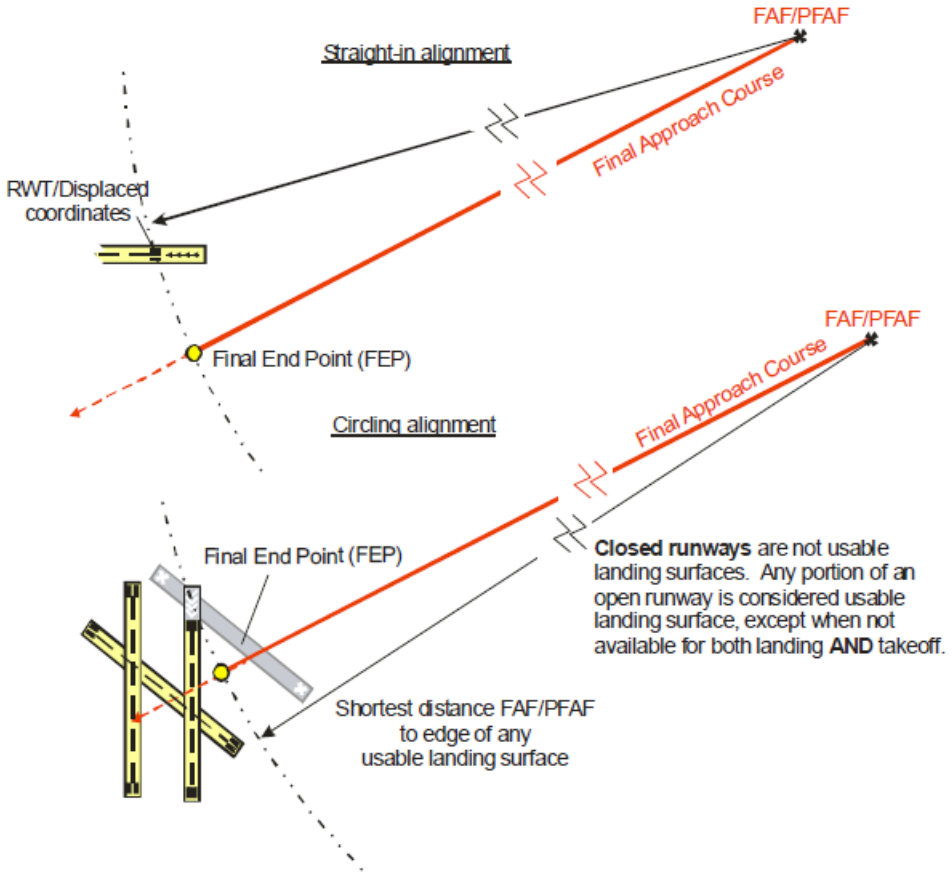
252. VERTICAL DESCENT ANGLE. Vertical descent angle (VDA) is normally used in this segment for non-precision procedures. Determine the VDA for all NPA procedures except those published in conjunction with vertically-guided minima or no-FAF procedures w/out stepdown fix(es). See applicable chapters/directives for guidance on no-FAF or procedures published with PA and APV minima. Optimum VDA is 3.00 degrees. Where operationally feasible, design straight-in NPA procedures (all CATs) to achieve a VDA equal to the commissioned angle of an installed visual glideslope indicator (VGSI) if within the standard VDA range. When a VGSI is not installed or not within the standard range, or final is circling aligned, design procedures at the optimum VDA when possible or within the following range:

STANDARD VERTICAL DESCENT ANGLES
FAA 2.75 VERTICAL DESCENT ANGLESfmins)
2.75)-3.50ERTICAL DESCENT ANGmins)
USAF 2.50 D/E mins)ll IAPS)
USN 2.500 D/E mins)ll IAPS
Note 1: Minimum VDA N/A to circling only procedures.
Note 2: CAT D/E VDA above 3.50 degrees must be annotated bove 3.50Civil Use.u The calculated VDA and the VGSI may be considered equivalent when the calculated angle is ± 0.20 degrees of the VGSI angle and the TCH used for the calculation is ± 3 ft of the VGSI TCH.

For a straight-in aligned procedure, when the minimum angle has not been achieved, modify the fix location or raise the FAF/PFAF altitude.

Calculate VDA based on the distance from the plotted position of the FAF/PFAF or stepdown fix to the plotted position of the final end point (FEP). The FEP is a point on the FAC equal to the distance from the FAF/PFAF to runway threshold (RWT) coordinates (or displaced threshold coordinates when applicable) or from FAF/PFAF to the edge of first usable landing surface for circling only aligned procedures. See figure 14-4.

Figure 14-4. Final End Point [Par 252].



a. Calculating Descent Angle (procedures meeting straight-in alignment). Calculate the VDA from the FAF/PFAF altitude (or stepdown fix altitude per Vol. 1, chapter 2, paragraphs 252c(1) or 252d) to threshold crossing height (TCH) using the following formula (radian calculations):

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

Where:

atan = arc tangent
ln = Natural logarithm
alt = FAF/PFAF alt. or 252c(1) / 252d stepdown alt.
THRe= Threshold elevation
r = 20890537
TCH = VGSI or Design TCH
D_{FIX} = Dist. (ft) FAF/PFAF or stepdown fix to FEP

When the maximum VDA calculated in accordance with Vol. 1, chapter 2, paragraph 252a is exceeded and altitudes/fix locations cannot be modified, straight-in minimums are not authorized. The procedure may be approved when restricted to circling minimums **IF** less than or equal to maximum VDA calculated in accordance with Vol. 1, chapter 2, paragraph 252b. In this case, when VDA is published, specify the VDA calculated in accordance with Vol. 1, chapter 2, paragraph 252a (published angle MAY exceed the maximum).

b. Calculating VDAs (procedures not meeting straight-in alignment or straight-in aligned procedures not authorized straight-in minimums). Calculate the VDA from the FAF/PFAF or stepdown fix altitude (Vol. 1, chapter 2, paragraphs 252c(2) or 252d) to the lowest CMDA using the following formula (radian calculations).

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

Where:

ln = Natural logarithm
r = 20890537
alt = FAF/PFAF or Vol. 1, chapter 2, para. 252c(2) / 252d stepdown fix altitude
CMDA = Lowest Published CMDA
D_{FIX} = Dist. (ft) FAF/PFAF or stepdown fix to FEP

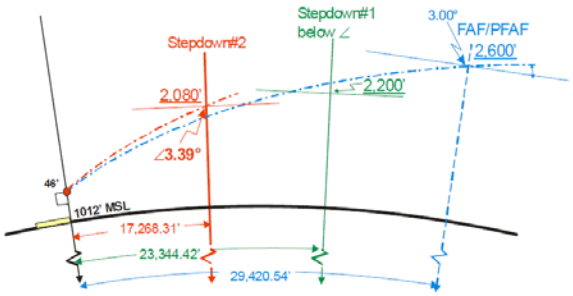
When the MAXIMUM VDA is exceeded, relocate the PFAF/stepdown fix and/or raise the CMDA until the angle is compliant.

(1) Determining Circling FAF/PFAF location to achieve a specified design angle. Procedures designed to circling alignment standards are not normally flown using a stabilized descent from the FAF/PFAF to landing. Therefore, the FAF/PFAF location is not ***predicated*** on VDA; however, the achieved angle must not exceed the maximum VDA. Establish the FAF/PFAF location in accordance with the alignment and segment length criteria applicable to the final approach Navigational Aid (NAVAID) or system and calculate the circling VDA.

1) For straight-in aligned procedures ONLY, when no other option is practical, calculate a VDA from each stepdown fix altitude above the vertical path (apply Vol. 1, chapter 2, paragraph 252a). Publish the greatest VDA and associate it with the applicable stepdown fix. *See figure 14-6.*

(2) For circling aligned procedures, when no other option is practical, calculate a VDA from each stepdown fix altitude above the vertical path (apply paragraph 252b) and ensure each angle is less than or equal to the maximum angle.

Figure 14-6. VDA with Stepdown Fixes [Par 252c].



(3) DO NOT raise stepdown fix altitudes higher than needed for obstacle clearance solely to achieve coincidence with the VDA vertical path (USN N/A).

4) DO NOT establish maximum, mandatory, or mandatory block altitudes at any final segment fix except where operationally required and approved by AFS-400 or appropriate military authority. Approval will include a check of the final sub-segment descent rates and will specify necessary restrictions (e.g. do not publish VDA, etc.).

SECTION 6. CIRCLING APPROACH

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

a. Obstacle Evaluation Area (OEA). The area for each CAT is based on true airspeed (VKTAS). The minimum altitude used for true airspeed conversion is 1,000 ft above airport elevation. Use the following formula for converting indicated airspeed (VKIAS) to true airspeed (VKTAS) is:

$$V_{KTAS} = \frac{V_{KIAS} \cdot 171233 \cdot \sqrt{(288+15)-0.00198 \cdot (\mathbf{alt}+\mathbf{k})}}{\left(288 - 0.00198 \cdot (alt+k)\right)^{2628}}$$

Where:

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

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

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

Where:

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

**Minimum CAR = 1.30 NM*

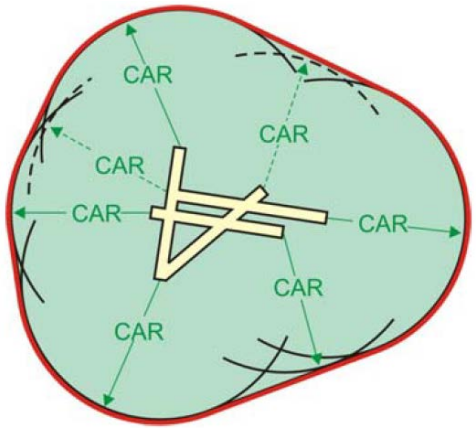
Table 4. Circling Approach Area Paramete rs [Par 260a].

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

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

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

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



c. **CMDA**. The published Circling Minimum Descent Altitude (CMDA) may not result in a Height Above Airport (HAA) lower than permitted by Vol. 1, chapter 3, table 3-9. Where

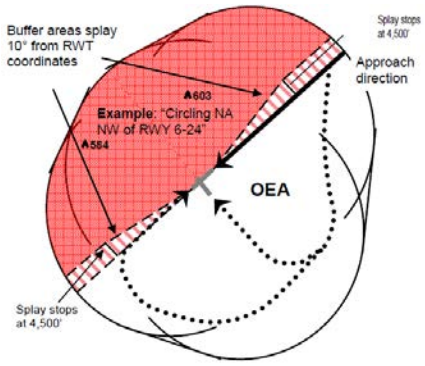
the CMDA results in a HAA greater than 1,000 ft, re-calculate CAR by increasing **k** to equal the actual HAA and re-evaluate the OEA. If the resulting HAA value increases, re-calculate and re-evaluate using the higher value.

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

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

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

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



b. Complex restricted area. Establish the restricted area as a single contiguous sector bounded by the centerlines of intersecting runways (or runways extended) continued outward to the OEA boundary, truncated (figures 15-2b through 15-2d) or expanded

(figure 15-2f) by a direct line from each set of RWT coordinates (or displaced threshold coordinates when applicable). The chart annotation includes the runway number and the general orientation of the restricted area from each runway described as a cardinal/intercardinal compass direction. *See Vol. 1, chapter 2, figures 15-2b through 15-2g and Order 8260.19, chapter 8.*

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

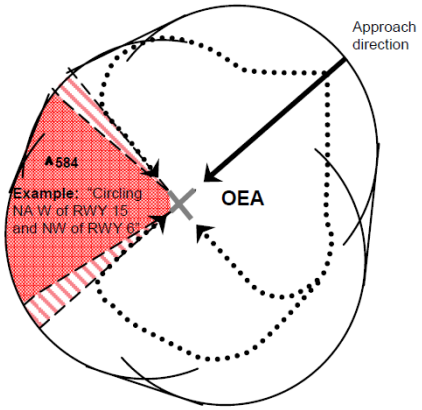


Figure 15-2c. Restricted Circling Area, Circling Aligned (Complex <180°) [Par 261b].

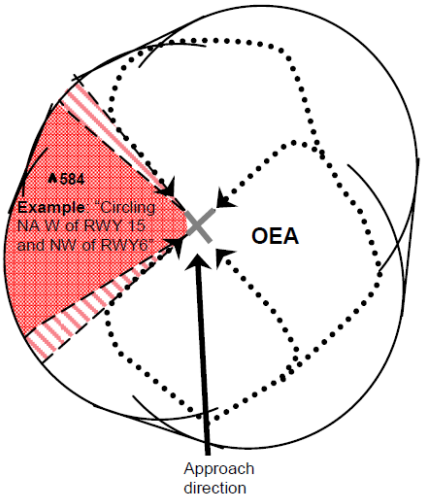


Figure 15-2d. Restricted Circling Area (Complex < 180°, Intersecting runways) [Par 261b].

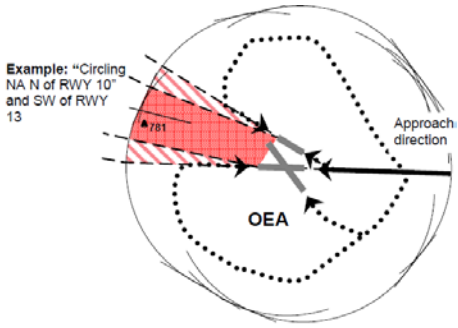


Figure 15-2e. Restricted Circling Area (Complex < 180°, Parallel runways) [Par 261b].

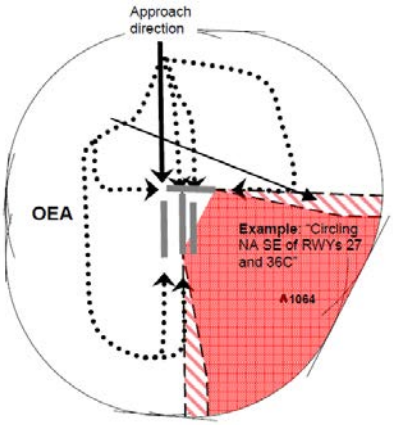
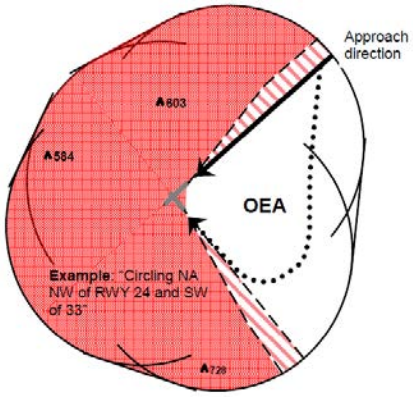


Figure 15-2f. Restricted Circling Area (Complex > 180°) [Par 261b].



3.3.3 Establishing Circling Visibility Minimums

3.3.3 a. STEP 1. Determine MAP to nearest landing surface distance (*see figure 3-3b*):

3.3.3 a. (1) When published in conjunction with Straight-in minimums. [*paragraph 3.3.1b(3)]* or when the HAA is less than 1,000 ft proceed to *STEP 3*.