Circling and the Visual Segment

The circling approach contains ambiguities and complexities unmatched in instrument flying.

By Wally Roberts

THE CIRCLING MANEUVER COMES in all shapes and sizes. "Circling" can be as simple as making a slight S-turn off the electronic final approach course, or a steeper-than-normal final. It can also be an extended restricted-visibility, close-in and low-level trip around to the opposite side of the airport.

This aspect of the visual completion of an instrument approach procedure has no small risk when pushed to the limits, from stall/spin crashes to a collision with close-in terrain. Also, the ground rules at airports without operating control towers are complex, ambiguous and fraught with the additional burden of a mid-air collision risk with aircraft operating under VFR in the vicinity of the airport.

Finally, the FAA circling obstacle clearance criteria are very permissive compared to the International Civil Aviation Organization (ICAO) international PANS-OPS terminal instrument procedures criteria. Normally, I don't attempt to compare TERPs criteria with PANS-OPS criteria, but the differences between the FAA view of what's adequate in this regard is at great odds with the rest of the world. At airports with a lot of close-in obstacles, pilots must literally bet their lives on this stuff.

Protected airspace

Figure 1 (on right) is contained in the AIM, and comes from the U.S. TERPs Handbook. ICAO PANS-OPS (used by most other countries of the world) uses the same radii/tangent concept for area construction, except the PANS-OPS protected airspace is much larger (see table below).

The PANS-OPS radii shown are for an airport elevation of 2,000 feet. The values shown for TERPs remain constant, regardless of airport elevation.

Circling Approach Area Radii (nautical miles)		
App. Cat.	TERPS	PANS-OPS
A	1.3	1.68
B	1.5	2.66
C	1.7	4.20
D	2.3	5.28

TERPs requires a minimum of 300 feet of required obstacle clearance (ROC) over the highest obstacle in the circling maneuvering area, whereas PANS-OPS has vertical obstacle clearance requirements that vary with approach category. Both criteria require a minimum height above airport (HAA) that determines the MDA in the event there are no significant obstacles. This is to prevent a B-747 from circling at 300 feet agl, at an airport without obstacles! This application of HAA is known as the obstacle clearance height (OCH) in the vernacular of PANS-OPS.

In the U.S., where the controlling obstacle, plus the 300-foot ROC, exceeds 550 feet HAA, ROC is the only determinant when the procedures specialist is evaluating the circling maneuvering area for obstacles. However, even a significant obstacle within the circling maneuvering area might not be the limiting factor when establishing the circling MDA. The missed approach area must be clear of obstacles along a 40:1 slope, which could result in both straight-in and circling minimums higher than would be required by obstacles in either the final approach segment or circling maneuvering area.

Circling Approach Area Required Obstacle Clearance and Minimum HAA/OCH (HAA/OCH shown in parenthesis)		
App. Cat.	TERPS	PANS-OPS
A	300 (350)	295 (394)
B	300 (450)	295 (492)
C	300 (450)	394 (591)
D	300 (550)	394 (689)

Figure 2 (page 6) shows the minima box for the VOR/DME or GPS Runway 14 at Winnemucca, NV. Note that the straight-in MDAs, as well as circling MDAs, increase by higher approach category, which is a real clue that the limiting factor is the ***turning*** missed approach obstacle environment. (Where a missed approach obstacle is the most restrictive factor in determining minimums in a straight-ahead missed approach, all categories of straight-in MDAs would be the same.) As a matter of policy, circling minimums can never be lower than straight-in minimums.

Excluded sectors

Both TERPs and PANS-OPS permit portions of the circling maneuvering area to be excluded from use by pilots in order to avoid a substantial increase in circling minimums, where the significant obstacle is only located to one side of the airport. Such exclusions are denoted by runway extended centerline boundaries. These exclusions are annotated to the minimums with easily missed notes.

Figure 3 (page 6) shows the minima box for the ILS Runway 9 at Riverside, CA. Between the Agnes step-down minima, and the part-time remote altimeter setting minima, Note 1 (For Cat D), "Circling not authorized north of rwy 9-27" is virtually

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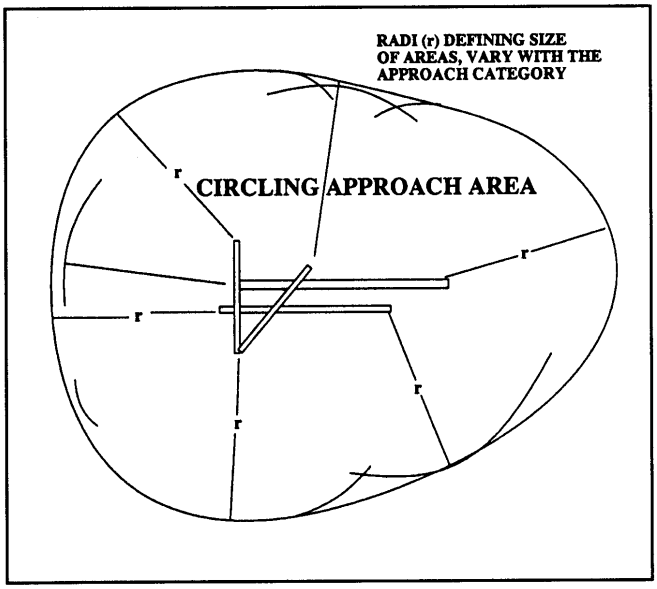

Figure 1. *Radii that determine the size of the maneuvering area vary with approach category. (See table on left.)*

Circling and...

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lost in the "noise" of this minima box. This is a good example of why these notes should be reviewed before flight.

When not to circle at MDA

At airports with fairly low circling MDAs, the best practice is to remain at a normal traffic pattern altitude when cloud and visibility conditions permit. Obviously, it's easier to fly a pattern at 800 or 1,000 feet agl, than at 350 or 450 feet agl. Think of that circling MDA as an absolute floor, to only be used when absolutely necessary to assure clearance beneath clouds and adequate visual references.

At an airport with an operating control tower, FAR 91.129 (e) mandates a large or turbine-powered airplane to fly a 1,500-foot agl pattern, unless cloud conditions require circling at a lower altitude, down to the circling MDA. The same general logic applies to small aircraft operations, and is implied by minimum safe altitude rules and common sense.

Regulatory ambiguities

At airports with operating control towers, the rules for circling are fairly straightforward. The tower regulates the Class D airspace to the exclusion of VFR operations when it is officially under IFR weather conditions. The pilot who must circle need not worry about conflicting traffic in the circling maneuvering area.

FAR 91.129 ("Operations in Class D Airspace") specifically addresses circling from an IAP. At a tower airport, if you and the tower controller agree, you can circle in any manner consistent with the conditions and limitations set forth in the IAP. The control tower portion of the controller's handbook cautions the controller against issuing restrictions that could cause you to depart the critical circling maneuvering area, such as "extend downwind" or "I'll call your base."

What about circling at airports without an operating control tower? High-traffic, non-tower airports are the closest thing to anarchy we have in aviation. Add to that an airplane circling out of an IAP in weather conditions that are arguably marginal VFR, and the conditions are ripe for conflict. Most of all, this is the type of airport where the circling MDA should be yielded in favor of the local traffic pattern altitude when weather conditions permit.

STRAIGHT-IN LANDING RWY 14		CIRCLE-TO-LAND
MDA(H) A,B: 4620' (321') C: 4840' (541') D: 5560' (1261')		Max Kts / MDA(H)
A	1	90 / 4700' (396') - 1
B		120 / 4760' (456') - 1
C	1½	140 / 4840' (536') - 1½
D	3	165 / 5560' (1256') - 3
AMEND 0 MAP at D1.0		

Figure 2. *An increase in the straight-in MDAs by approach category is a tip-off that there are obstacles in the turning missed approach area.*

The regulations for non-tower airports are far less protective of the circling aircraft than the provision for Class D airspace contained in FAR 91.129 (f). The primary rule for the Class E or G airport is FAR 91.126 (b); i.e., left-hand patterns unless the airport's approved indicators dictate right-hand patterns.

What if the non-tower airport has right-hand traffic, but you want to circle left for better visibility during restricted visibility conditions? What about the IAP that prohibits circling in the sector where the local airport has its traffic pattern (admittedly an unusual condition)? Does the regulatory IAP's circling minimums constitute an FAA waiver to the airport's designated traffic pattern? I'll leave the answers to these legal questions to the legal beagles. The best doctrine is to be a "good neighbor" when circling at a non-tower airport, by attempting to follow local traffic patterns to the maximum extent possible.

IFR circling regulations

The FAR 91 rules that pertain directly to the instrument-procedural aspects of flying the circling approach are contained in FAR 91.175 (e) (2). Although 91.175 (e) (2) is a negative statement about when a missed approach is required during the circling maneuver, it also contains by implication what you must see in order to circle, i.e., "an identifiable part of the airport is...distinctly visible to the pilot during a circling maneuver at or above MDA...(excepting temporary) inability to see an identifiable part of the airport (because of the)...normal bank of the aircraft during the circling maneuver." Why the legal folks didn't choose to state this affirmatively elsewhere in FAR 91.175 escapes me, other than most of these regulations are piecemeal fixes.

When it comes time to descend below the circling MDA, FAR 91.175 (c) comes into play, with its attendant requirements to make a normal descent to landing and to have one, or more of the runway-specific visual cues continuously in sight. (See "Where to Start the Missed Approach" [July, 1995 *IFRR*] for more about missing the approach from a circle-to-land.)

Practical ramifications

The circle-to-land is often made because a strong wind favors a runway that doesn't have a straight-in IAP. In many cases, such

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STRAIGHT-IN LANDING RWY 9	ILS	LOC (GS out) With Agnes	LOC (GS out) Without Agnes	CIRCLE-TO-LAND With Agnes	CIRCLE-TO-LAND Without Agnes
When Tower operating.	DA(H) 1042' (250')	MDA(H) 1220' (428')	MDA(H) 1300' (508')	Max Kts / When Tower Operating MDA(H)	MDA(H)
				90 1220' (404') - 1	1300' (484') - 1
				120 1280' (464') - 1	
With Ontario Altimeter Setting	DA(H) 1082' (290')	MDA(H) 1260' (468')	MDA(H) 1340' (548')	140 1440' (624') - 1¾	1440' (624') - 1¾
	FULL / RAIL or ALS out	RAIL out / ALS out	RAIL out / ALS out	165 [1] 1440' (624') - 2	[1] 1440' (624') - 2
A	1	1	1	Max Kts / With Ontario Altimeter Setting MDA(H)	MDA(H)
B				90 1260' (444') - 1	1340' (524') - 1
C		1	1	120 1320' (504') - 1	
D		1½	1½	140 1480' (664') - 1¾	1480' (664') - 1¾
				165 [1] 1480' (664') - 2	[1] 1480' (664') - 2
Gnd speed-Kts		70	90 100 120 140 160	[1] Circling not authorized north of rwy 9-27.	
GS 3.00°		378	485 539 647 755 863		
SWAN LAKE to MAP 5.2		4:27	3:28 3:07 2:36 2:14 1:57		

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Figure 3. *"Note overload" makes it easy to miss a circling restriction note. This is a good example of why it's important to review the chart before flight.*

runways have no VASI or other vertical guidance aids. So, when is it safe to descend below the circling MDA, especially at night and perhaps with rain obscuring the perceptual cues? The easy answer is: if you aren't familiar with the airport, it might be risky to very unsafe. Circling at night is much riskier than circling during the day, everything else being equal.

At airports where the circling MDA has a relatively high HAA, there is something out there slightly more than 300 feet below the MDA. Is this unseen obstacle along your proposed descent path? The best possible course of action is to delay descent until late base leg. If you're operating as Category A, then you must be within 1.3 miles of the runway threshold. If you make a fairly steep approach under such conditions, you're probably in good shape. If there is a VASI, then you know that the visual final is in good shape to at least circling distances.

Elect higher category

At an unfamiliar airport, a real good hedge for the light airplane pilot is to elect the highest circling MDA for the airport. Where Category D is authorized, this gives you a 2.3-mile circling area instead of 1.3 or 1.5 miles. This often, but not always, means you're restricted to a higher circling MDA.

The circling MDA for all approach categories is the same when one, or a very few, isolated significant obstacle(s) occur within the Category A maneuvering area, with lower obstacles out to the limits of the Category D circling maneuvering area.

Figure 4 (below) shows the minima box for the ILS Runway 19 at Bremerton, WA. There are other reasons all categories of circling MDAs could be the same, such as descent gradient limitations in a circling-only final approach segment, or a missed approach obstacle problem. The reasons aren't important, however, the fact that you can use Category C or D at such a location without an MDA penalty is significant. (Note, however, at Bremerton if you elect Category D you cannot circle west of Rwy 1-19).

Operational proficiency

Not only must the proficient instrument pilot be generally aware of all of the operating and regulatory nuances I've outlined, he/she must be able to fly the circling maneuver with a high degree of proficiency, especially at low HAA MDAs, and during restricted visibility conditions. Circling at low altitudes, with the attendant requirement to keep the airport in sight, is a great setup for an unrecoverable stall/spin crash.

Proficiency at circling requires intimate familiarity with target power settings that assure safe margins above stall, yet remain within the speed limit for the applicable approach category. You can't get too much practice at attitude and altitude control while going back-and-forth from the instruments to the airport.

This is a maneuver that can first be practiced again and again at a low MDA and at a non-noise sensitive airport under good day, VFR conditions. After altitude and speed can be precisely maintained into the position for descent below MDA to landing, then the practice should advance to a rainy, windy day, but where the ceiling is fairly good, along with at least 2-3 miles visibility. In this latter case, there is no need to fly the IAP, rather just practice departing a simulated electronic final approach course and circling with the rain pounding on the windshield, and with a highly proficient CFII at your side.

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STRAIGHT-IN LANDING RWY 19

	ILS			LOC (GS out)			CIRCLE-TO-LAND NA West of Rwy 1-19 for Cat D Aircraft		
	1 DA(H) 688'(250')		2 DA(H) 738'(300')	3 MDA(H) 1220'(782')				With Local Altimeter Setting	With Seattle-Tacoma Intl Altimeter Setting
	FULL	RAIL or ALS out	MM out		RAIL out	ALS out	Max Kts	MDA(H)	MDA(H)
A	3/4	1	3/4	3/4	3/4	1	90	1220'(781')-1	1300'(861')-1
B					1 1/4		120	1220'(781')-1 1/4	1300'(861')-1 1/4
C				1 3/4	2 1/4		140	1220'(781')-2 1/4	1300'(861')-2 1/4
D			1	2	2 1/2		165	1220'(781')-2 1/2	1300'(861')-2 1/2

Gnd speed-Kts		70	90	100	120	140	160
GS	3.00°	377	485	539	646	754	862
CHECO to MAP 4.8		4:07	3:12	2:53	2:24	2:03	1:48

1 DA(H) 768'(330') with Seattle-Tacoma Intl alt set.
2 DA(H) 818'(380') with Seattle-Tacoma Intl alt set.
3 MDA(H) 1300'(862') with Seattle-Tacoma Intl alt set.

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Figure 4. *On this IAP, Category A, B, and C aircraft can use a higher category for circling with no increase in MDA. There is a restriction, however, for Category D circling.*

Cold Or Low, Look Out Below

We learned the above phrase early during primary flight training. In instrument flying, the "low" part is taken care of by the center sector or airport altimeter setting. But, what about "cold?"

The Canadians and even the U.S. Air Force get quite concerned about the effect very cold terminal area and surface temperatures have on instrument flight operations. There have been discussion within the FAA about the issue, but nothing has come of it.

There is nothing, however, to prevent pilots from making additives for very cold temperatures during IFR flying. If you're over the mountains during very cold conditions, an easy fix is to never accept the MEA as an assigned altitude. File, or request, at least 1,000 feet above the MEA in mountainous areas when it's really cold.

What is ***really*** cold? Well, it depends how high your altitude is above the altimeter setting source and how low the surface temperature is. The Air Force has a good rule-of-thumb formula: The error is proportional to the difference between actual and standard temperature and the height of the aircraft above the altimeter setting source. The amount of error is approximately 4 feet per thousand feet for each degree of Celsius of difference. This is an approximation, and assumes a standard lapse rate.

For example, if the altimeter setting is at sea level, and it's -20° C at the surface (35° below standard for that altimeter setting source elevation), an airplane at 10,000 feet would be (4 x 10) x (35), or 1,400 feet lower than the indicated altitude of 10,000 feet.

What about the MDA when it's -40° outside? If you're on an unrestricted approach clearance into a mountain area airport, it is a good idea to pad those minimum segment altitudes, as well as minimums, in approximation to this formula. This includes circling MDAs with very high HAAs. Remember, however, if there's an element of an altitude assignment by ATC with the approach clearance, then you need to coordinate with them.