

# Circling Approach Survival Guide

BY JAMES ALBRIGHT james@code7700.com

If you fly circling approaches in the U.S. on a regular basis and train in a simulator, then you know that what you learn in the box has very little to do with what you need to do in the airplane. We all know the “Memphis Localizer Runway 27, Circle to Runway 18R” is not likely to happen in real life. But it happens every six months in the simulator because the geometry and geography of the approach makes it easy to succeed. (FAA test standards for simulator training require at least a 90-deg. change in direction while keeping the airport in sight.)

We also know that the only time we really have to circle at minimums is when there are no other options. A circling approach is made necessary when things are, by definition, out of the ordinary: the final approach course is more than

30 deg. off the landing runway’s heading, the final approach course does not cross the extended centerline of the landing runway, or the required descent angle exceeds the maximum permitted for the approach category.

But what we may not know, but should know instinctively, is that most circling approaches in the U.S. are designed to make you fail. These U.S. approaches, along with some you can find overseas, have been designed in accordance with the U.S. Standard for Terminal Instrument Procedures (TERPS). If the approach was developed prior to late 2012 the circling approach protected area may require excessive bank angle because it does not account for altitude or wind and does not provide for a stabilized approach starting at least 500 ft. above the runway. In other words, it is setting you up for failure.

In contrast, TERPS circling approaches designed after late 2012, which we can call “new TERPS,” take care of the altitude issue and assume a 25-kt. wind. These newer approaches are annotated with a “Shadowed C” symbol to denote expanded circling approach maneuvering airspace radii.

If you train in the simulator by memorizing landmarks, using timing cues and waiting to roll the wings level just a hundred feet off the deck, then you are also setting yourself up for failure. If a future destination requires circling at visibility minimums, you might tell yourself you’ve done it a hundred times in the simulator so circling in the airplane should be no big deal. Well, it is a big deal. I believe circling at TERPS minimums, old or new, is not prudent. I’ll offer an easy way to derive your own circling minimums that will turn likely failure into likely success while ensuring a safe approach and landing.



STEVE (SLATS) DENNY, AMATEUR PHOTOGRAPHER

The Circling Approach Threat Under Old and New TERPS		
	Old TERPS	New TERPS
Visibility minimums (given in statute miles) encompass circling approach radii (given in nautical miles)	X	X
Maneuvering airspace accounts for aircraft bank angle limits and increased true airspeed with altitude	X	✓
Maneuvering airspace accounts for the impact of wind	X	✓
Maneuvering airspace allows at least a 500-ft. stabilized final approach	X	X

## Visibility Minimums

Many years ago, TERPS (Volume 1, Paragraph 260a) established what has become the “coin of the realm” when it comes to how much space an aircraft has while maneuvering to circle. Obstacle clearance was based on keeping the aircraft within predetermined distances from all landing surfaces. Graphically, a circle is drawn from the end of each runway at the landing airport and the extremities of each arc are connected.

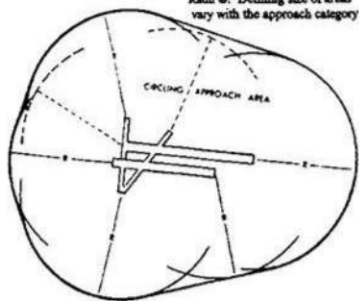
Simulator check airmen have reinforced this concept of circling approach radii by ensuring that the pilots they evaluate keep within these distances. Category D pilots, for example, have ingrained into their psyches that they may start maneuvering and must limit maneuvering to 2.3 nm.

While this part of TERPS was replaced in 2009 and circling approaches designed after late 2012 no longer use these radii, a vast majority of existing approaches in the U.S. are still based on them. If you take your instrument checkride in a simulator, you will not only be using these outdated maneuvering radii, but you also will be using

Table 4. CIRCLING APPROACH AREA RADII. Par 260a.

Approach Category	Radius (Miles)
A	1.3
B	1.5
C	1.7
D	2.3
E	4.5

Radii Ⓞ. Defining size of areas vary with the approach category



the TERPS-mandated minimum authorized visibilities.

TERPS Volume 1, Paragraph 3.3.3 (old and new) authorizes visibility minimums as low as 1 sm (Categories A and B), 1.5 sm (Category C) or 2 sm (Categories D and E). Note these visibilities are given in statute miles while the maneuvering airspace is given in nautical miles.

There are two ways to look at this

Approach Category	Minimum Visibility	Maneuvering Radii
	(sm)	(nm)
A	1	0.87
B	1	0.87
C	1.5	1.30
D	2	1.74
E	2	1.74

disparity. An optimist would say we are fortunate to have adequate obstacle clearance greater than the minimum visibility. We know that as long as we stay within the visibility minimum distance,

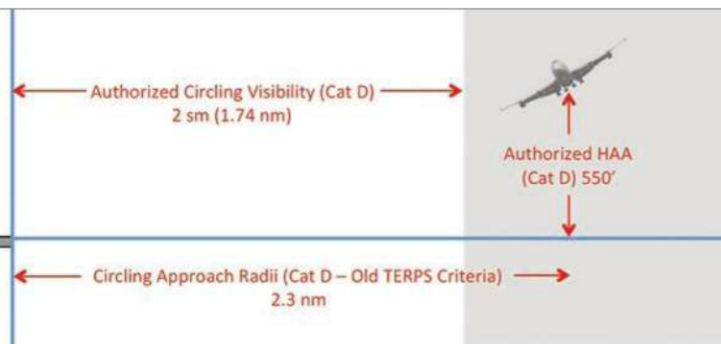
## Bank Angle and Altitude Impacts

A typical circling approach places the airplane on a tight downwind, leaving only enough room for a base turn followed by a very short final. In fact, TERPS provides a Category D aircraft with only a 0.6-nm straight segment following maneuvering. A Category D aircraft circling at its maximum approach speed at sea level will have a turn radius of 0.85 nm (turn diameter of 1.70 nm), which means it will just barely be able to fit within the visibility minimum of 1.74

nm. If you back out a 0.6-nm final approach, you're left with a diameter of just 1.1 nm (1.7 - 0.6 = 1.1). To maneuver this tightly requires at least 37 deg. of bank, far beyond what is prudent while sloshing around at night in

the muck at low altitude.

A Category D aircraft's maneuvering radii goes from the old TERPS 2.3-nm standard up to 3.6 nm at 1,000 ft. MSL, and even more as altitude increases. New



we are assured we won't hit anything. But as pilots we are paid to be pessimists. While we are assured we can maneuver within the authorized radii, we could lose sight of the runway while doing so.

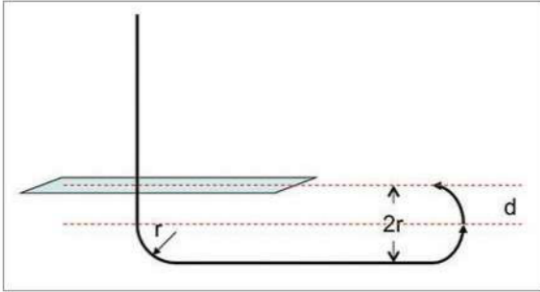
Let's say, for example, we are flying a Category D aircraft to an approach where the lowest authorized visibility minimum is 2 sm (1.74 nm). We would brief that we may not begin the circle until within 2.3 nm of the runway. Additionally, we must keep the aircraft within that distance to assure obstacle clearance. The problem is that we could actually lose sight of the runway if we flew more than 1.74 nm from it. Is your aircraft's turn radius less than 1.74 nm? Probably. But you typically need more than just your turn radius; you need your turn diameter.

TERPS, however, leaves the approach's lowest authorized visibility minimum unchanged.

We often blame the winds when a circling approach doesn't work out as planned. The winds are indeed a problem but not because of circling radii.

You don't need a math degree to fly a circling approach, but you should understand the arithmetic is stacked against you when circling at visibility minimums. There is a lot of math behind the scenes here. If you want to see the magic behind the curtain go to [http://code7700.com/flight\\_math.html](http://code7700.com/flight_math.html)





### The Impact of Wind

Measuring the impact of a crosswind during a circling approach would seem to be a classic example of too many variables and not enough information. The wind is heading in one direction and the aircraft's heading is constantly changing. If you just consider the aircraft flying a perfect 360-deg. circle at a constant bank angle, however, you can draw several conclusions by looking at the air mass as a whole.

Consider an aircraft approaching Runway 09 but having to circle to Runway 36 because the winds are 360/20 and the runway is wet. How far south will that wind blow the aircraft? If the aircraft flies the maneuver at 165 KTAS, the answer turns out to be one-half of a mile. That may not seem like much, but when Category D visibility minimums can be as low as 2 sm, it could be enough to cause you to lose sight of the runway.

New TERPS assumes a 25-kt. tailwind by adding to the computed true airspeed. Old TERPS appears to have done the same thing for sea level conditions but does not explicitly mention winds for circling radii. In either case, the impact of a wind up to 25 kt. may put the aircraft on the edge of authorized circling radii, which always exceeds minimum visibilities. Even if the visibility is well above minimums there is still a problem. Your obstacle clearance is based on the maneuvering radii, but that distance is measured against the radius from the end of the runway, not from a point that will allow a stabilized approach.

### TERPS Criteria Do Not Provide a Stabilized Approach

Old TERPS does not address the need to turn to align with the landing runway following a circling approach; it just assumes this happens. Newer TERPS criteria do specify a minimum straight leg

segment but it isn't much: Category C aircraft are afforded a 0.5-nm straight segment and Category D aircraft are given 0.6 nm.

These paltry straight leg segments essentially ignore the Instrument Procedures Handbook, FAA-H-8261-1A requirement: "For the final segment of a circling approach maneuver, the approach must be stabilized 500 ft. above the airport elevation or at the MDA, whichever is lower."

Many pilots judge a 3-deg. glidepath

newer TERPS design plans on aircraft rolling out of their bank angles on final approach at 160 ft. (Category C) and 190 ft. (Category D). This is hardly the procedure to use if you believe in flying a stabilized approach.

If your standard operating procedures require a stabilized approach no later than 500 ft. above the runway — and they should — the minimum final approach you should allow off a 3-deg. glidepath is 1.57 nm, more than double the TERPS straight leg segment.

Of course, dealing with theoretical turn radii and approach visibilities can lead one into thinking these are

**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.

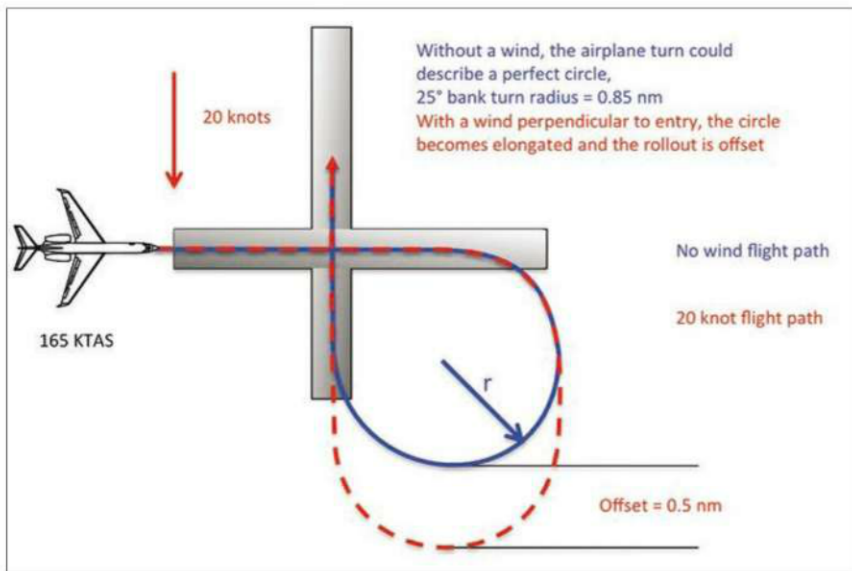
Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
All Altitudes	1.3	1.5	1.7	2.3	4.5

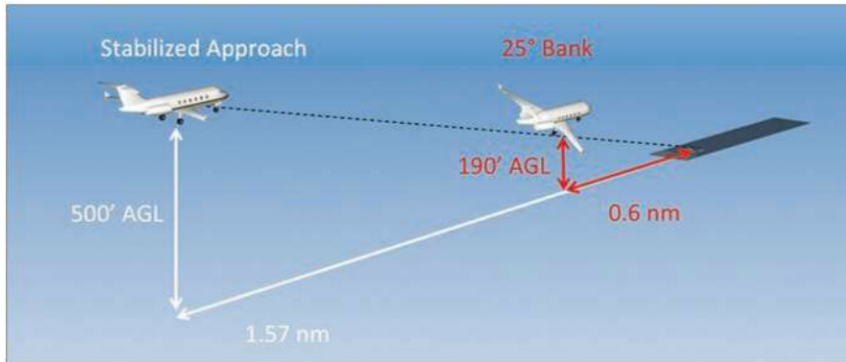
**EXPANDED CIRCLING APPROACH MANEUVERING AIRSPACE RADIUS**  
Circling approach protected areas developed after late 2012 use the radius distance shown in the following table, expressed in nautical miles (NM), dependent on aircraft approach category, and the altitude of the circling MDA, which accounts 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

using the 300 ft. per nautical mile rule of thumb. This rule of thumb is very close to the mathematically pure solution of  $6,076 \text{ ft.} \times \tan(3 \text{ deg.}) = 318 \text{ ft.}$  Armed with this knowledge, we see the

just worst-case scenarios and surely things are better in real life. But don't be fooled. You can diagram just about any "old TERPS" approach and discover the problem exists "out there," where you





might find yourself circling in the near future.

### An Example in 'Old TERPS' Design

Approach designers consider local topography and obstacles to establish the published height above airport (HAA) and the circling visibility minimums. In many cases, the HAA used to determine your circling approach minimum descent altitude requires the visibility to be raised. You will be assured of obstacle clearance, but you may not be able to maintain visual contact with the airport environment.

Runway 5 at Hanscom Field, Bedford, Massachusetts, for example, does not have an instrument approach. If the winds or a runway closure make Runway 5 your only option, you can expect to be cleared the ILS or LOC Runway 11, circle to Runway 5. The weather required for the approach for a Category D aircraft is an 800-ft. ceiling and 2.25-sm visibility.

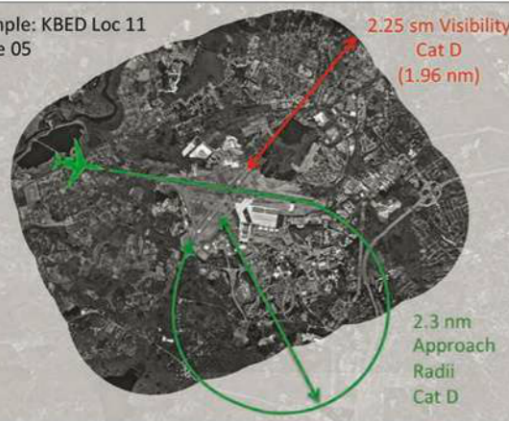
When the tower is open, the reported visibility often considers the entire airport and probably underreports the visibility. In other words, if tower says the visibility is 2.25 sm, it is probably at least that. But when the tower is closed, the reported visibility comes from a visibility sensor located very near the approach end of Runway 11. If the Automated Surface Observing System reports the visibility is 2.25 sm, you can only be sure the visibility near the sensor will be 2.25 sm. But that translates to only 1.96 nm.

If you need all of that 2.3 nm to circle, you could easily lose sight of the environment at 1.96 nm. You could tighten your bank angle but that still leaves you without a straight leg segment. This will not be a stabilized approach unless you insist on a higher visibility. But how much higher?

### Personal Circling Approach Minimums

If you honestly catalog your circling approach history you should find that the visibility for just about all of them was much higher than minimums. For those that were at minimums on an approach designed under either the new or old TERPS, it is unlikely any were completed with a stabilized approach.

Example: KBED Loc 11 Circle 05



Chances are that most of your circling at minimums was done in a simulator, after which a relieved instructor patted you on the back for not dragging a wingtip as you rolled out on centerline 50 ft. off the deck and a couple of thousand feet down the runway. To fill the squares, you may have to continue to demonstrate these unstable and long landings in the box, but in the airplane you should make sure all of your approaches are stable and in the touchdown zone. And you'll need a plan to do this.

The easiest way to think about it is to start from the touchdown point and then work your way backward. Using our 318 ft. per nautical mile formula, we determine a stabilized approach beginning 500 ft. above the touchdown point requires a 1.57-nm-long final approach.

Since the touchdown point is 1,000 ft. down the runway, we subtract the 1,000 ft. (about 0.16 nm) from the 1.57 nm to get the visibility required from the end of the runway (about 1.4 nm). So you need to be rolled out, wings level and stabilized no less than 1.4 nm from the "first brick" of the runway. Then you should plan on being no further than one turn diameter from that roll-out point. Turn diameter for a Category C aircraft at a 1,000-ft. MDA flying at its maximum category speed is 1.2 nm. For a Category D aircraft the diameter is 1.7 nm.

With up to 20 kt. of headwind to the landing runway the offset away could be as much as 0.5 nm. Of course, with more wind you will need an even higher adjustment.

Now, let's add up the mileages for a Category D aircraft. First, we have the 1.4-nm stabilized final. To that we add the turn diameter of 1.7 nm, giving us 3.1 nm. Factoring in another 0.5 nm for 20 kt. of wind gives us a total of 3.6 nm, which is equal to 4.2 sm of prevailing visibility.

The total for Category C would be 3.1 nm and 3.6 sm. You may wonder if you really need 3.5-sm (Category C) or 4.25-sm (Category D) visibility to safely fly a circling approach. After all, these numbers are higher than the VFR minimums! Try to imagine flying your jet at 550 ft. toward the middle of the runway on a perpendicular heading. Now imagine having to maneuver so as to end up on a 500-ft. stabilized approach without ever flying beyond 1.7 nm

or 2.3 nm of that same runway. It would be a challenge on the best of days.

Is raising your personal circling visibility minimums a sign that you cannot measure up to the standards set by the approach designers? Perhaps. But these approaches were designed without consideration of the real-world environment, instrument flight bank angle limits and the imperative of flying a stable approach. In essence, these approaches were designed to make you fail.

You can deny the designers that end result by raising your visibility minimums. Never start a circling approach unless you know the visibility will allow you to keep sight of the runways using normal maneuvering to a stabilized approach that ends at the touchdown zone of the runway. **B&CA**