# The Circle of Confusion, PART I

by Matt McDaniel

*"Cirrus 123CD, cleared for the GPS 27 approach, circle runway 18. Report commencing the circle."*

The above clearance sounds simple enough and is probably similar to one you've heard a number of times during instrument flights. Yet, the *circle-to-land instrument approach* is one of the most commonly misunderstood and fumbled procedures. Why? Is it the training, the variety of procedures, misunderstood rules and techniques, or just lack of practice? Most likely it is a combination of all these factors and more.

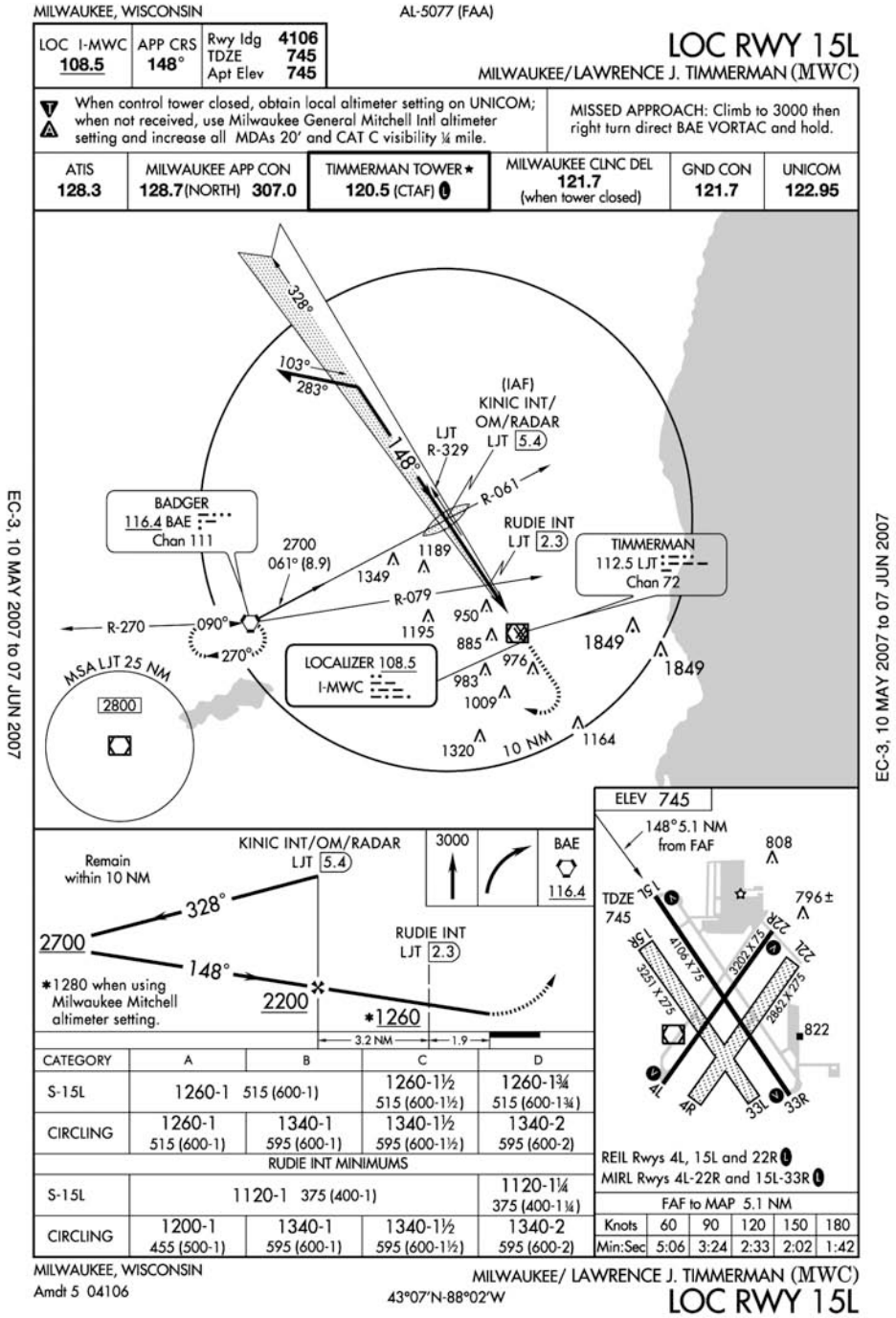


**FIGURE 1**
NOS Minimums format shows aircraft categories without speed reference.

## Determining Circling Approach Minimums

Circling minimums seem so elementary to most instrument pilots yet it is the single most common error in circling approaches that I see when instructing. It's a matter of knowing in which approach category your airplane belongs, often a little complicated when circling to land. Determining your airplane's category for straight-in approaches is simple. It is a matter of determining 1.3 times Vso (the stalling speed in the landing configuration, at max landing weight). In an SR22, that speed is 77 knots (59 × 1.3), putting Cirrus aircraft in approach category A which is defined as including any speed less than 91 knots. When it comes to circling approaches, things get a little more complicated and even confusing. Included in the front of each Terminal Procedures (NOS Approach Plate) booklet, the FAA states that, "an airplane shall fit in only one category." Jeppesen chart users may also reference this in the *Chart Glossary* section, behind the *Introduction* tab. Such a statement would lead a pilot to think that a given airplane's approach minimums would always be the same (category A, B, C, or D), however, that would be incorrect. In the same paragraph, the FAA goes on to say, "If it is necessary to maneuver an aircraft at speeds

in excess of the upper speed range for a category, the minimums for the next higher category should be used." Huh?

Simply put, Cirrus SR20 and SR22 aircraft are category A, although Cirrus pilots routinely circle at speeds in excess of the category A limit of 90 knots. This provides a safety margin above stall (or accelerated stall) speed for maneuvering the aircraft throughout the circle-to-land procedure. Generally, that "circling speed" is between 95 and 110 knots; I prefer 100 knots. Under these conditions, the Cirrus will fall into category B approach minimums for circle to land approaches (91-120 knots IAS).

To confuse us a little more, NOS plates do not include the speeds of each category. The pilot is expected to have the upper speed limit of each category memorized and know that if they exceed that speed while maneuvering (circling), they must use the next higher set of minimums [Figure 1]. Jeppesen helps the pilot a little more here. Starting in 1989, Jeppesen plates began publishing straight-in approach minimums adjacent to the associated aircraft category (A through D). To better assist pilots, next to the circling minimums, Jeppesen also publishes the upper speed limits for a given set of minimums, rather than just the category associated with them [Figure 2]. Kudos to Jeppesen for this, as it gives the pilot a visual cue to recall that circling minimums are actually determined by your indicated circling airspeed, *not* 1.3 Vso. Occasionally, a circling minimum might be based on an IAS other than the normal maximum speeds associated with Categories A thru D. In that case, the deviation will appear in the notes of an NOS plate.

| STRAIGHT-IN LANDING RWY23 | | | | | | | | | CIRCLE-TO-LAND | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 ILS DA(H) 856′ (200′) | | | LOC (GS out) MDA(H) 1060′ (404′) With Local Altimeter Setting | | | MDA(H) 1160′ (504′) With Indianapolis Intl Altimeter Setting | | | With Local Altimeter Setting | | With Indianapolis Intl Altimeter Setting |
| | FULL | RAIL or ALS out | | RAIL out | ALS out | | RAIL out | ALS out | Max Kts | MDA(H) | MDA(H) |
| A | 1/2 | 3/4 | 1/2 | 3/4 | 1 | 1/2 | 3/4 | 1 | 90 | 1080′ (424′)-1 | 1180′ (524′)-1 |
| B | | | | | | | | | 120 | 1120′ (464′)-1 | 1200′ (544′)-1 |
| C | | | 3/4 | 1 1/4 | 1 | 1 1/2 | | | 140 | 1140′ (484′)-1 1/2 | 1240′ (584′)-1 1/2 |
| D | | | | | | | | | 165 | 1220′ (564′)-2 | 1240′ (584′)-2 |
| 1 DA(H) 951′ (295′) with Indianapolis Intl altimeter setting. | | | | | | | | | | | |

**FIGURE 2 –** JEPP Minimums Format. Shows aircraft category for straight-in minimums and max speeds (IAS) for circling minimums.

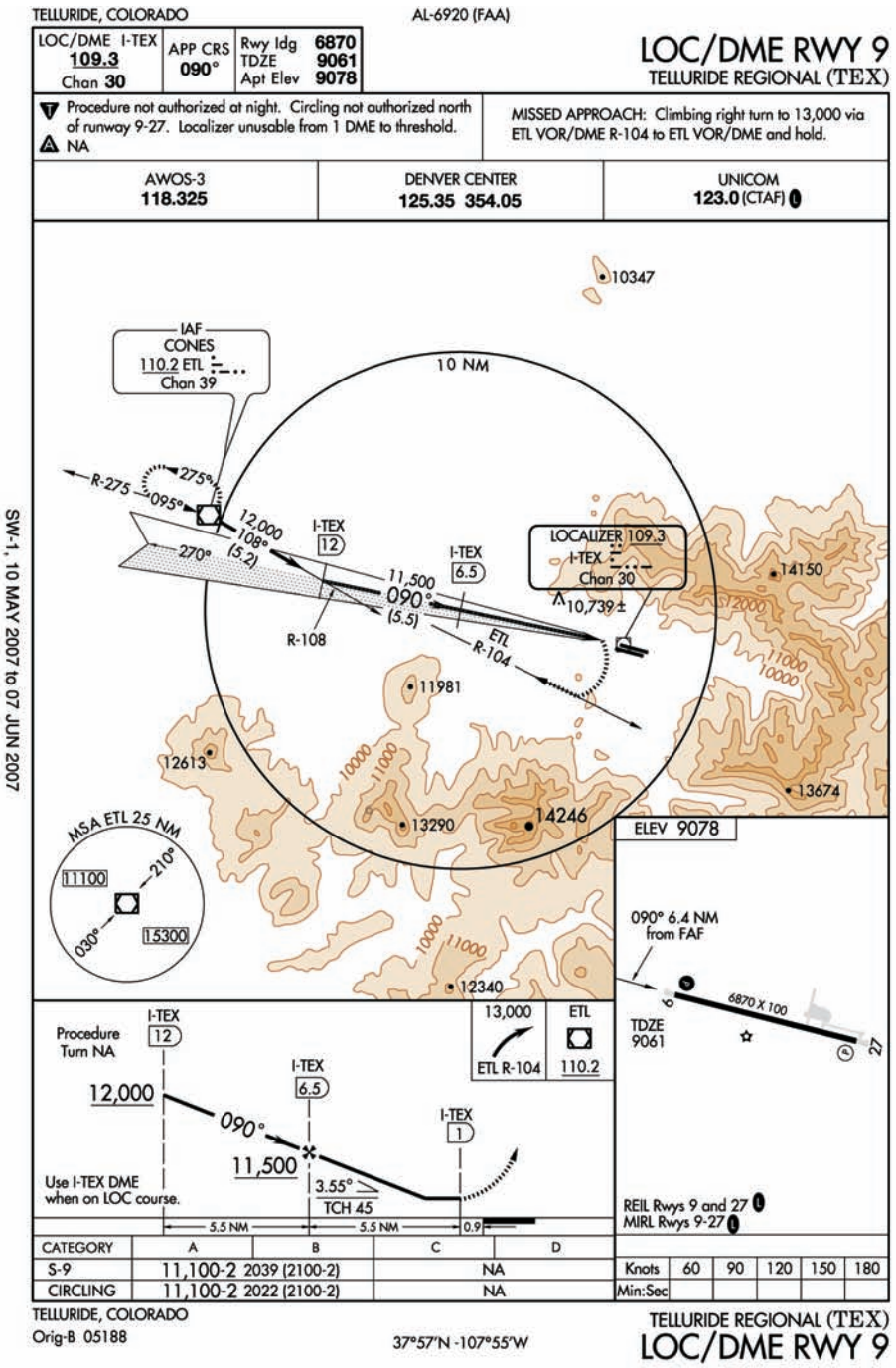


**FIGURE 3**
A very high altitude approach.

The speed will simply be adjusted in the circling minimums section of a Jeppesen plate.

Both NOS & Jeppesen plates publish the circling approach minimums in MSL, with an AGL height in parenthesis. It should be noted that circling approach minimum AGL altitude is reported as Height Above Airport (HAA) rather than Height Above Touchdown Zone (HAT). The average elevation of the airport itself could be significantly different from the appropriate touchdown zone elevation [Figure 3]. For the LOC/DME 9 approach at Telluride, Colo., note that both straight-in and circling have the same minimum of 11,100 feet MSL, however, the AGL altitudes are 2,039 feet for S-9 and 2,022 feet for circling, a difference of 17 feet. Why? It turns out that the straight-in AGL altitude is measured from the official Touchdown Zone Elevation (TDZE), while the circling AGL altitude is measured from the official airport elevation taken at the Airport Reference Point [APR], noted by the star on the approach plate's airport diagram. Since the TDZE for runway 27 is not published on this plate, if you were to circle to 27, that information would be unknown to you without looking elsewhere to find it.

It is vital to know at what speed you plan to circle and what category minimums correspond with that speed. Knowing and briefing this **before** the approach begins could make the difference between a successful or unsuccessful approach. Refer back to Figures 1 and 2: Circling minimums for a Cirrus flying at 100 knots IAS are 1,340 feet and one mile (Fig. 1) and 1,120 feet and one mile, with local altimeter (Fig. 2).

## Circling Minimum Radius

Once you have determined the correct minimums for your circling approach, you should make a mental note of your maximum circling radius. Circling minimums are set by determining a minimum height above and from any obstructions within a given "circling radius" from the airport. That "circling radius" is calculated by drawing a line from the end of each runway at the airport. Using that line, an arc is drawn using the runway end as its center point. Finally, each arc is connected to the adjacent arc using a tangent line [Figure 4]. The radius of each arc, and thus the total protected area within the "circling radius" is based on a maximum IAS, the same maximum airspeeds associated with each approach category, plus a small safety margin.

**CIRCLING APPROACH AREA RADII**

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

RADI (r) DEFINING SIZE OF AREAS, VARY WITH THE APPROACH CATEGORY

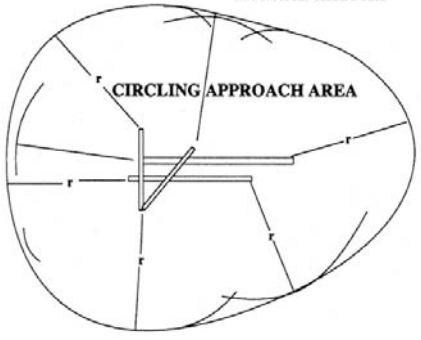


**FIGURE 4**
AIM figure 5-4-23

For Cirrus pilots, this means that at a maximum speed of 90 knots IAS (Category A) the radius is 1.3NM, while Category B (91-120 knots IAS) is 1.5 NM. Since an aircraft's turns have a wider radius with a faster IAS (given a constant bank angle and groundspeed), the aircraft needs a larger protected area the faster it flies. A wider area can easily encompass additional (and often higher) obstructions, resulting in higher circling minimums for each successive increase in speed and category. Therein lies the danger and an illegality of using Category A minimums when you are actually circling at Category B speeds.

For an extreme example, refer again to Figure 3. At TEX, Category C and D aircraft are not allowed to circle. This is because their wider circling radii (1.7 and 2.3 miles, respectively) extend into the surrounding high terrain, making a safe circling maneuver above 120 knots IAS impossible.

It should also be noted that the "circling radius" assumes that turns are made at an average bank angle of 25 degrees (US TERPS) or 20 degrees (ICAO) [Figure 4]. In my experience, instrument pilots are often hesitant to bank this steeply during a circling maneuver. Rather, they tend to stay near the standard-rate bank angles of ~ 10-15 degrees that they have been using during instrument flight. Since the circle is being done visually, exceeding standard rate can and should be done as necessary to remain within the safe zone of the "circling radius." If you are circling at 100 knots IAS (Category B), but are using Category A minimums (max IAS of 90 knots), there is a very good chance you will fly outside the maximum "circling radius" and subject yourself to unsafe distances and heights from terrain and obstructions.

Next issue's installment will discuss techniques and procedures for actually flying the circling approach. I'll touch on some of the challenges imposed by ATC, terrain, and poor technique. I will also cover the VFR aspect of circling approaches, going missed from a circle and some common errors made by pilots. COPA

About the Author: *Matthew McDaniel flies a Boeing 717 for a national airline and is an ATP, Master CFII, MEI, CSIP, and holds four turbine aircraft type ratings. He has over 8,500 hours, including well over 2,000 hours teaching in Cirrus aircraft since 2001. He owns Progressive Aviation Services, LLC (www.progaviation.com) and can be reached at: matt@progaviation.com or (414) 339-4990.*