TEB's 'Non-Circling, Circling Approach'

If you think the conditions **are just too taxing for man** and machine, **ask for a different approach** or divert

BY **JAMES ALBRIGHT** james@code 7700.COM

Editor's note: On May 15, 2017, a Learjet 35A crashed on approach to Teterboro Airport in New Jersey, killing both pilots, the only persons aboard. Winds at the time were reported as 320 at 16 kt. gusting to 32 and the aircraft had been cleared for the ILS Runway 6, circle to land Runway 1. While the NTSB's final report isn't expected until sometime next year, a review of procedural considerations under such conditions can help ensure flight safety.

When is a circling approach not a circling approach? If you are in the simulator flying the Memphis International Airport, Tennessee (KMEM) Localizer to Runway 27, chances are you will be circling to Runway 18R and will be expected to do so at minimums. In a Category D aircraft, you will be evaluated on your ability to keep the airplane at the 1,020-ft. Minimum Descent Altitude (MDA), which is just 679 ft. above the landing surface, and within 2.25 sm of the airport or risk losing sight. You are circling.

Now, let's say you are in your airplane on a clear day with great visibility. In fact, the only blemish on this otherwise perfect day for flying is that the winds are 340/24G40. At Teterboro Airport, New Jersey (KTEB), this means you will be flying the ILS to Runway 6, circle to Runway 1, using a left base with an overshooting wind. You can't fly a straight-in because that will impact the heavy traffic pattern at Newark Liberty International Airport, New Jersey (KEWR). You can't overfly the airport for a more desirable right base into the wind, because Teterboro is just too busy. New York Approach Control and Teterboro Tower both use the same terminology: "Cleared the ILS Runway 6, circle to 1." So you are circling, right?

It depends on what you mean by "circling," and your understanding of the terminology makes all the difference. Of course, Teterboro is not unique when it comes to the need to circle in visual meteorological conditions (VMC), but its extremely high traffic density and proximity to several major New York City area airports probably makes it the most challenging example. Once you understand what it is you are

A Gulfstream GIV lands on Runway 24 at Teterboro.

NASA

A virtual tower

expected to do, you can more safely maneuver your aircraft in this difficult airspace. Your success depends on how well you understand yourself, your aircraft and the airport. Only then can you guarantee success.

But first: What exactly does "circling" mean?

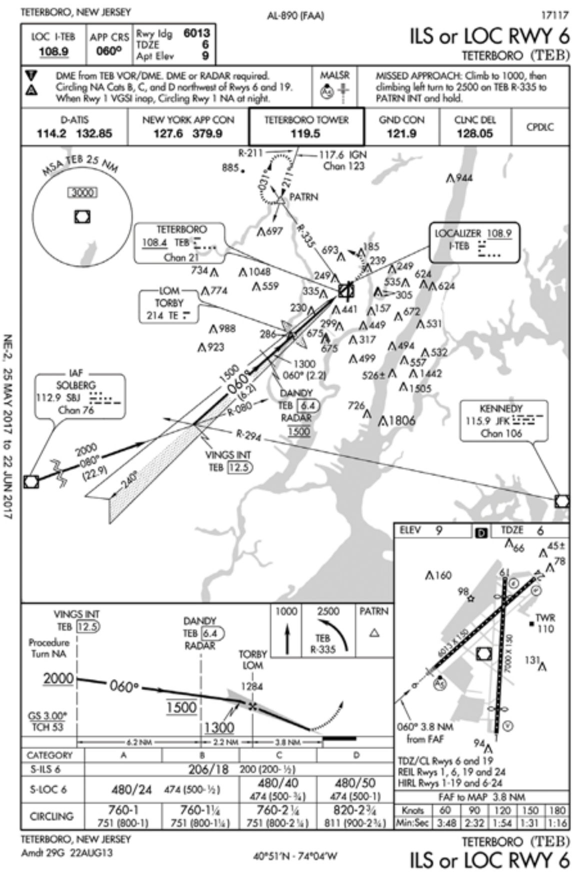
Understanding the Terminology

The Pilot/Controller Glossary tells us that the "circle-to-land" maneuver is "initiated by the pilot to align the aircraft with a runway for landing when a straight-in landing from an instrument approach is not possible or is not desirable. At tower-controlled airports, this maneuver is made only after ATC authorization has been obtained and the pilot has established

JAMES ALBRIGHT/BCA

required visual reference to the airport." In the very next entry, the Glossary tells us that the terminology "Circle to Runway [runway number]" is "used by ATC to inform the pilot that he/she must circle to land because the runway in use is other than the runway aligned with the instrument approach procedure." In both cases, we pilots are led to believe this is part of the instrument procedure and because of the way we are trained, that telegraphs specific procedures that are probably not air traffic control's intent.

Most professional, instrument-rated pilots are checked regularly using the standards listed in the FAA's Airline Transport Pilot and Aircraft Type Rating Practical Test Standards



The Teterboro ILS or LOC RWY 6, FAA AL-890 25 May 2017

for Airplane (FAA-S-8081-5F). These check rides include circling approaches that hammer home the need to:

(1) Descend at a rate "that ensures arrival at the MDA at, or prior to, a point from which a normal circle-to-land maneuver can be accomplished."

(2) Avoid "exceeding the visibility criteria until in a position from which a descent to a normal landing can be made."

(3) "Maintain the desired altitude within -0, +100 ft."

(4) Maintain "airspeed/V-speed within +/-5 kt."

In the pilot's mind, that is what "circling" is all about. But is that the controller's intent?

The perfect case to illustrate this dichotomy of intent versus perceived intent is the Teterboro ILS Runway 6, circle to Runway 1 instruction that the Lear 35 pilots were given in May. When the winds dictate landings on Runway 1, which does not have an instrument approach, ATC will normally instruct pilots to shoot the ILS to Runway 6, "circle zero one," "circle at TORBY" or "after TORBY enter the left base Runway 1." Even if the term "circle" isn't used, the pilot may perceive this as a circling maneuver. If this instruction was given during a simulator check ride, the weather would be reduced to minimums and the pilot would be expected to begin maneuvering no earlier than the visibility minimums. A Category D aircraft, for example, would begin maneuvering when within 2.25 sm, which is only 2.17 nm.

Tower will usually instruct aircraft to begin their maneuver no earlier than TORBY, but sometimes this instruction is understood and not stated. TORBY is 3.8 nm from the end of Runway 6, well outside the visibility minimum on the approach plate for even the highest approach category. In fact, TORBY is also outside approach circling radii given in the U.S. Standard for Terminal Instrument Procedures (TERPS) or the Aeronautical Information Manual (AIM). This is clearly not the same circle-to-land maneuver envisioned by the pilot from his or her training experiences.

The controller assumes the pilot knows how to best maneuver his or her aircraft from one runway to the next and doesn't presume to tell the pilot how to fly. The pilot may not correctly understand the controller's intent, but that's usually manageable and experience with the approach will reduce any misunderstandings. However, there are two more hurdles to overcome before understanding how to circle at any given airport. The pilot must first understand his or her own capability and then must understand the airplane's strengths and weaknesses. Only then can the pilot hope to accomplish the "non-circle, circle."

JAMES ALBRIGHT/BCA

Pilot Jon Becker examines the leading edge of his Challenger 604 before a flight to Teterboro

Understanding the Pilot

As a young U.S. Air Force pilot, one of my least favorite Military Airlift Command regulations was called the "You can't go unless you've been" rule. It meant at least one pilot in the cockpit had to be familiar with the destination or the crew could not go. As I gained experience with one challenging airport after another, I started to appreciate the value of "local knowledge."

As business pilots, we don't have this luxury and are often expected to go anywhere, anytime without airport-specific training. Fortunately, that "anywhere, anytime" expectation is rarely a problem for us. If you are flying a 3-deg. ILS to 6,000 ft. or more of good, hard asphalt, what can possibly go wrong?

To the uninitiated, Teterboro would seem to be nothing too challenging. It isn't in mountainous terrain. It has two long runways, a full-time tower and some of the best air traffic controllers in the business. If you are well practiced at operating in a dense IFR environment, Teterboro is rarely more challenging than flying into and out of Los Angeles International Airport (KLAX) or Chicago O'Hare International Airport (KORD). But if the winds dictate a landing on Runway 1 or 24, the game changes entirely. Until you've experienced both of those runways on a windy day, you would be wise to talk to someone who has and perhaps try those approaches in a simulator first. But even if you are a Teterboro expert, you need to be an expert with your aircraft, too.

Understanding the Aircraft

Just as our training experiences can misshape how we interpret circle-to-land instructions, our early flight training may give us a false idea about airspeed margins when maneuvering. In the simulator, we practice all manner of stalls but recover at the first sign of a stall, which is usually provided by the stick shaker. During the recovery, the airplane can get a little unruly but is generally controllable. However, we rarely, if ever, experience a full aerodynamic stall in the simulator because the aircraft we fly aren't approved for such stalls. That's why shakers, nudgers, pushers and other warning devices are installed.

If we did experience a full aerodynamic stall in flight, we may be surprised to find that not all aircraft remain perfectly controllable, may not stall wings level, or may not produce a self-correcting pitch down. Now this kind of experience isn't really needed provided we ensure we never stall the airplane. We are given a margin above the stall of course, but that margin isn't always enough.

Transport category aircraft must have a reference landing speed (VREF) at least 23% above reference stall speed (VSRO), the speed at which the airplane stalls in 1-G flight. That margin would seem to be adequate under most conditions, but is it?

We are trained early in our careers to realize that stall speeds go up with increased aircraft weight and bank angle. But there is an additional element that can change the stall speed even at equal weights and bank angles, and this element comes into play during a circling maneuver. The element in question is the load factor on the wing, also known as the "G load."

Stall Speed at X G's=Stall Speed at 1G√X

From our primary aircraft training we associate G loads with bank angle and know a 60-deg. level turn produces a load factor of 2 Gs. But you can experience 2 Gs with much less bank angle by simply pulling back on the yoke. Even a moderate amount of turbulence can add to your load factor. If this happens to you while maneuvering to land, your stall speed can sneak up on you.

Let's say your aircraft stalls at 100 kt. at a given weight, landing configuration and environment when in 1-G flight. If your Vref is based on 1.23 Vsro, you will be at 123 kt. and have a healthy margin above the stall. Now let's throw in a level turn.

Bank Adjusted Load Factor=1/cos [(bank angle)]

As long as we keep our bank angle to less than 30 deg. the load factor is almost negligible, only 1.15 G. But now our stall speed is 107 kt., leaving us with only a 7-kt. margin. If a gust of wind or perhaps a slight overshoot causes our bank angle to increase, so too, will our load factor. A 36-deg. bank angle in a level turn brings our example airplane to a stall. If we are in a descending turn and have "unloaded" the wing we get some of that margin back. But if we are pulling back harder to tighten the turn, even a 30-deg. bank angle can result in a stall.

Old-timers will tell you they used to add 5 kt. "for the kids" and, on a really gusty day, they would add another 5 kt. for the family dog. Many aircraft today require we add half the steady wind plus the full gust increment but at least 5 kt. and at most 20 kt. A 24-kt. wind gusting to 40 kt., for example, requires the full additive of 20 kt. (One half of 24 is 12, and the gust increment is 16.) Armed with such an additive, our example airplane will fly the circle-to-land maneuver at 143 kt. That airspeed pad will protect the airplane against load factors up to 2 Gs, which would allow for up to 60 deg. of bank in level flight. If the air is turbulent, however, the 2 Gs can be realized at much lower bank angles.

Cosines and square roots are not something most pilots want to contemplate with a handful of airplane while aiming for a small patch of concrete or asphalt. But the math serves to remind us that our margin above the stall isn't as large as we think, especially with a bank angle and a gusty wind thrown in.

Yet, there is another item of aircraft performance we should understand but may never get to experience. When your aircraft stalls, how does it behave?

Most of us learn aircraft stall behavior in small trainers where exceeding the wing's critical angle of attack (AOA) results in some buffeting over the tail and perhaps a wings-level drop of the nose. Very few transport category aircraft permit full stall training and even in a full-motion simulator training is limited to the "approach to stall," that point where electronic stall warning systems are activated.

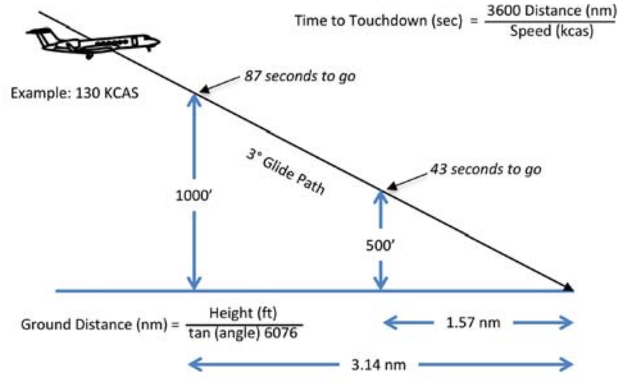
These factors can instill in some pilots the belief that a full stall in a large business jet is no worse than in a basic trainer. This might be true. But it may be more likely that the larger aircraft can drop a wing, pitch up or even remain in the same attitude while picking up a large sink rate. Some business jets can snap into a roll faster than the pilot can react. But aircraft manufacturers don't make it a habit of publicizing any adverse behavior. It is up to pilots to understand that their airplane may not behave kindly in a stall, making the need to avoid the stall in the first place that much more important.

OK, we get it. Stalling a transport category aircraft is a bad idea and circle-to-land maneuvering can raise stall speeds high enough to reduce or eliminate stall margins. So how do we avoid putting our aircraft into what could be an unrecoverable flight attitude? It is easy, if you really understand what it takes to fly a stable approach off a circling approach.

Understanding the Stable Approach

Just about everyone these days preaches the need for a stable approach and just about everyone defines a stable approach as being configured and in a landing attitude, on speed, on glidepath and on centerline no later than 500 ft. above the runway. But what is lost on many people is that flying a stable approach off a 3-deg. glidepath takes distance, 1.57 nm to be exact.

If you are targeting a touchdown 1,000 ft. down the runway — that comes to 0.17 nm — that means you should plan to be at 500 ft. above the touchdown zone elevation when 1.57 – 0.17 = 1.4 nm from the end of the runway. But not only at that



JAMES ALBRIGHT/BCA

Example stable approach flown at 130 KCAS

altitude but also on speed, on centerline, wings level and fully configured to land. (Getting there while still in 30 deg. of bank doesn't count.)

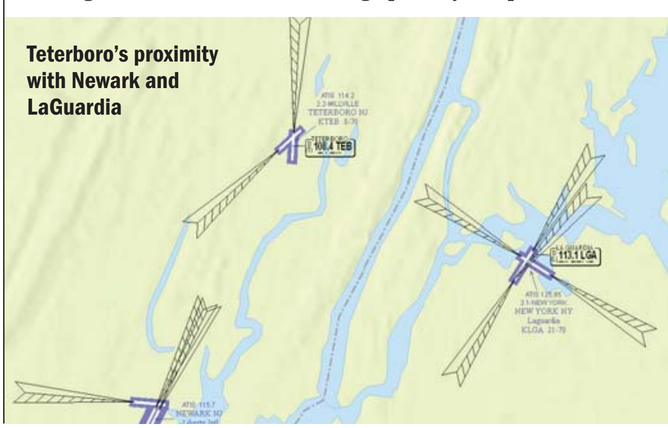
A steeper glidepath shortens the distance. A 3.5-deg. glidepath, for example, brings you to 500 ft. at 1.35 nm. But generally speaking, shooting for 500 ft. when 1.4 nm from the end of the runway serves as a good rule of thumb.

There is a school of thought that says we can lower our stabilized approach altitude to 300 ft. when in good weather and flying a visual traffic pattern or circling approach. You may have even flown such a maneuver expertly at your home airport under normal conditions. But can you do that at every airport under every wind condition you feel comfortable with? I think an hour in a simulator with a variety of crosswinds should dispel the notion that 300 ft. is enough. I don't think it is. There is no better place to demonstrate the need for a 500-ft. stabilized approach height than the busiest business aviation airport of all: Teterboro.

Understanding the Airport: Teterboro as the Perfect Example

Teterboro provides two perfect examples of non-circle, circling approaches because of its unique location wedged underneath the Newark Liberty International Airport and LaGuardia Airport, New York (KLGA) flight paths. The controllers are experts at packing what seems to be an infinite number of airplanes into what is most definitely a finite amount of airspace.

The flow of business and private aircraft into Teterboro is staggering. In calendar year 2016, for example, the airport averaged 485 takeoffs and landings per day, despite what can



Teterboro's proximity with Newark and LaGuardia

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often be weather that could leave other airports unable to cope. Pilots often breathe a sigh of relief when the ATIS reports landings to Runways 6 or 19, knowing they will have an ILS guiding them and a predictable chain of aircraft ahead and behind them. But if the winds or New York area traffic flow require landings to Runway 1 or 24, cockpit pulse rates tend to quicken.

ILS Runway 6, Circle to Runway 1

Let's look at a series of "circling" approaches coming off the ILS Runway 6 followed by a right turn to base and ending with a left turn onto final for Runway 1. We'll do this for a no-wind situation as well as a wind of 340/16G30. In my Gulfstream G450, that wind requires a 20-kt. additive, using half the steady wind plus the full gust increment but no less than five or greater than 20. With a typical VREF of 130, that means I will be flying at 150 kt.

A fundamental requirement for understanding aircraft performance in a circling approach is the concept of turn radius. You can estimate your aircraft's 25-deg. bank angle turn radius by dividing your speed in miles per minute by three. (For more about this, see "Approach Impossible," *BCA*, May 2017, page 40). Flying at 150 kt. (2.5 nm/min.) gives you a turn radius of about 0.83 nm.

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The view after turning right from the ILS 06 at Teterboro

Now that we have our turn radius, we are left with the decision of where to aim when setting up our base to Runway 1. We will probably be instructed, "After TORBY circle to Runway 1." Because TORBY is 3.8 nm from Runway 6, we may be tempted to delay our turn. But once we turn right to set up for the left base, we will see three landmarks that could complicate our decision-making.

The ILS Runway 6, circle to Runway 1 makes for a good test to see if a pilot really understands (or believes) in stable approaches. I've met many pilots who claim you need to turn from the ILS Runway 6 to a base to Runway 1 by aiming inside one of three landmarks: the stadium ("MetLife" or "Giant" stadium, depending on your age), Xanadu (also known as American Dream Meadowlands) or the radio towers just outside. To some pilots, a turn outside these landmarks shows you are of "lesser stock."

These pilots may argue that you need to turn inside the stadium because of nationwide TFR 4/3621, which prohibits flying within 3 nm of a stadium having a seating capacity of 30,000 or more during certain games. But the TFR also exempts "those aircraft authorized by and in contact with ATC for operational or safety of flight purposes."

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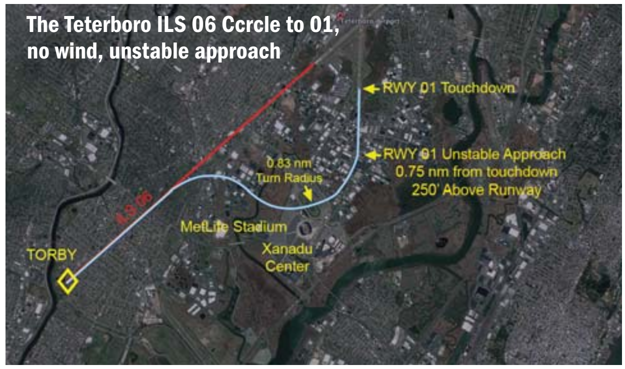
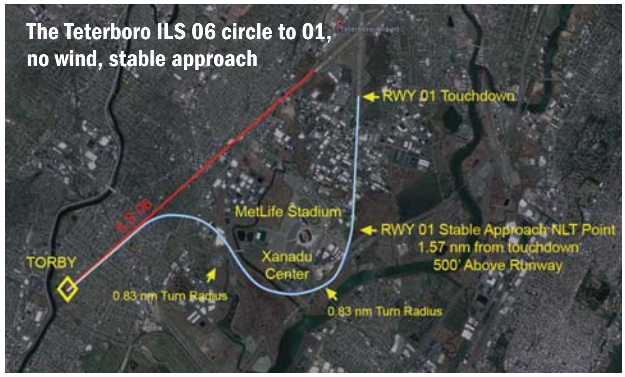


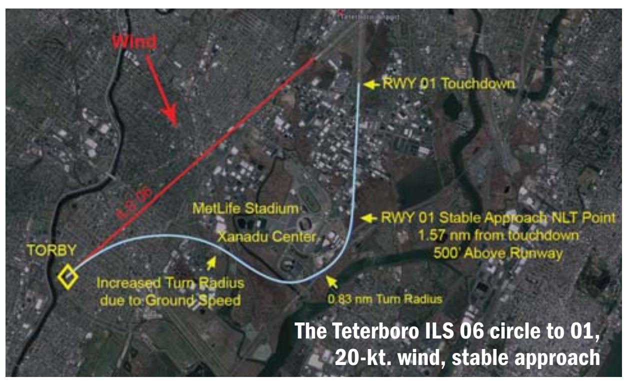
The Teterboro ILS 06 Ccrcle to 01, no wind, unstable approach



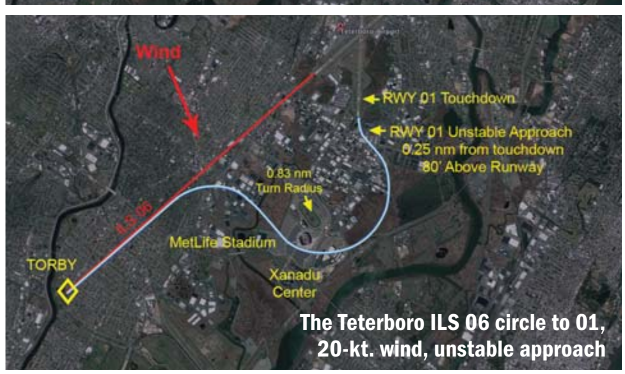
The Teterboro ILS 06 circle to 01, no wind, stable approach

Regardless of motivation, those pilots who attempt to circle inside the stadium will not be able roll out with enough distance to allow a 500-ft. stable approach, even on a calm wind day.

Starting the turn so as to maneuver just outside of the stadium, Xanadu and towers, you roll out exactly where you need to be for a stable approach, 1.57 nm from touchdown at 500 ft. above the runway.



The Teterboro ILS 06 circle to 01, 20-kt. wind, stable approach



The Teterboro ILS 06 circle to 01, 20-kt. wind, unstable approach

Now what happens if we throw in a 20-kt. wind from the northwest? Our turn radius will be greatest with the wind at our back and that requires we begin our turn at TORBY if we still wish to roll out at 500 ft. for a stable approach to Runway 1. Starting our turn earlier allows us to avoid overflying MetLife Stadium, Xanadu and the towers and still roll out on final for a stable approach. Now, what if we still insist on flying inside the stadium?

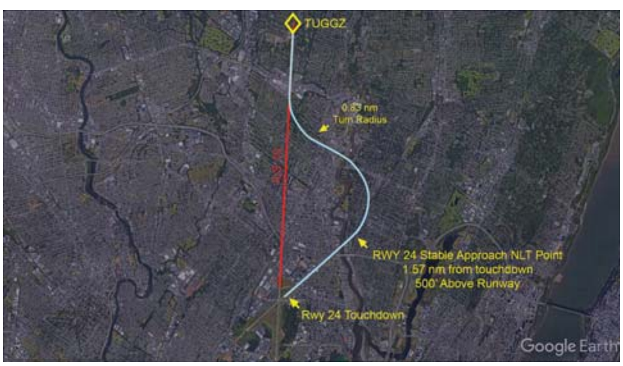
It simply cannot be done. We will need to increase our bank angle, but even then we are likely to end up over the stadium and then it will be impossible to roll out on course. If you limit the bank angle to 45 deg. I think you might be able to roll out over the numbers at 80 ft. That is hardly a stable approach! The lesson is clear, when instructed to circle to Runway 1, you should start the turn so as to maneuver around MetLife Stadium and Xanadu. Delaying this turn will cost you a stable approach.

ILS Runway 19, Circle to Runway 24

The ILS Runway 19, circle to Runway 24 is easier in two respects but harder in two others. It is easier because you don't have to worry about encroaching into Newark's airspace and you don't have to worry about overflying MetLife Stadium, Xanadu or those radio towers. But it is harder because you don't have any good visual references and things happen much faster due to the proximity of both runway ends. Depending on your avionics, there are techniques to help.

You are normally given clearance for the ILS Runway 19, circle to Runway 24, with a speed restriction until TUGGZ, which is 4.5 nm from the end of Runway 19. The point at which you should start maneuvering is hard to judge because the end of each runway is very near and the angle between them quite small. Generally speaking, for an airplane flying at 150 kt., starting your turn 3 mi. from the end of Runway 19 works with no winds. How do I know that?

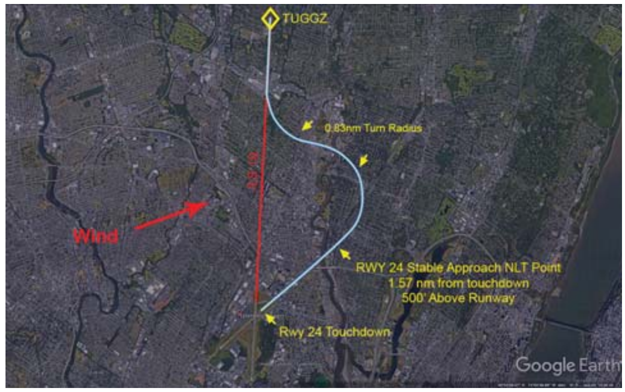
I want to be rolled out no later than 1.57 nm from touchdown.



The Teterboro ILS 19 circle to 24, no wind

The normal touchdown point is 1,000 ft. (0.17 nm) down the runway. Let's subtract 0.17 from the 1.57 and say we want to roll out 1.4 nm from the end of the runway. Our two turns make up an "S-turn" and almost amount to two turn radii added, so that's 0.83 + 0.83 = 1.66 nm. So 1.4 + 1.66 = 3.06, which is close enough to 3.0 to call it 3 nm. Drawing it to scale validates this.

What about a 20-kt. overshooting wind? You can compute that by understanding the entire air mass is moving 20 kt. to the east. Knowing that it takes time = (distance/velocity) = (4.5 nm) / (150 nm/hr.) = 0.03 hr. to fly from TUGGZ to the end



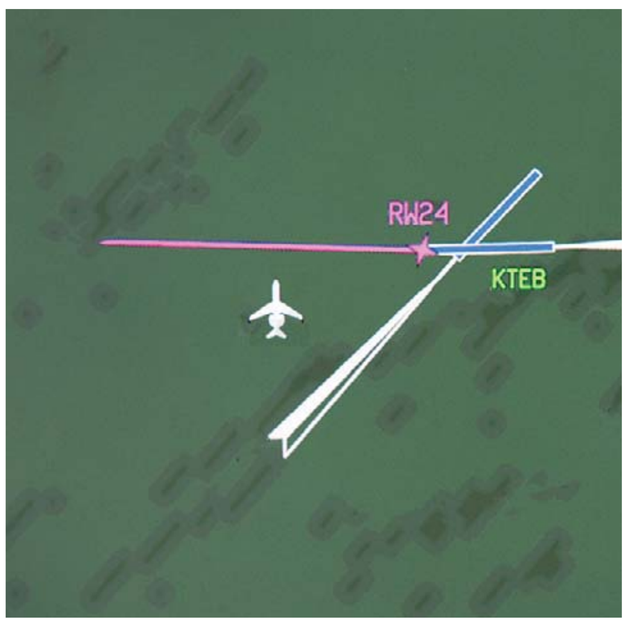
The Teterboro ILS 19 circle to 24, 20-kt. wind

of Runway 19, we can approximate our eastward lateral drift during that time to be distance = (velocity)(time) = (20 nm/hr.) (0.03 hr.) = 0.6 nm.

Graphically, we see that starting the initial turn a half mile early seems to give us an extra half mile to line up on Runway 24 in time to make a stable approach. Easy? Well, knowing where to aim for your rollout is the issue here, just as it was for the ILS Runway 6, circle to Runway 1. Teterboro could make both of these procedures easier with charted visual flight procedures (CVFPs). Both runways seem to be perfect candidates for the CVFP defined in the AIM, Section 5-4-24. But until the day that happens, pilots can arm themselves with a few techniques.

Improving Your Non-Circling, Circling Approach Situational Awareness

The best way to improve your "circling" at Teterboro (or anywhere else) is to understand that you want to roll out 500 ft. above the landing surface about 1.5 mi. from touchdown. The



JAMES ALBRIGHT/BCA

The Teterboro ILS 19 circle to 24 as seen from a Gulfstream G450 cockpit map display

best way to do that is to increase your situational awareness by any means possible. As with many things in aviation, the more toys you have in the cockpit the easier it becomes, but all you really need is an approach plate. So here we go, from simplest to easiest, four techniques.

(1) Draw an extended centerline on the approach plate — Most approach plates will have some sort of scale on the side and you can measure 1.5 mi. and draw a line on the extended final of your landing runway. From there imagine the turn radius and you will have an idea of when your turn needs to be made. Keep in mind that many real-world circling approaches cannot be made to a stable final approach to keep within the posted visibility minimums. (That might be your best clue that you don't want to circle at minimums.)

(2) Draw an extended centerline using the FMS — Some avionics suites will allow you to extend the runway centerline with

The Teterboro ILS 06 circle to 01 as seen from a Gulfstream G450 cockpit chart display

Gulfstream G450 synthetic vision showing right base looking at 4, 5, and 6 mi. to go markers

a few keystrokes. If you size the display so as to have a meaningful range mark, you can shoot for the appropriate final. If, for example, you have a 3-mi. range ring, you shoot for half that distance from touchdown. If the runway is drawn to scale, you can use it to visualize a rollout point. In the example shown, the runway is 1 mi. long so you want to aim a runway and a half away. On other aircraft, the ILS "feather" has a fixed scale and can also be used to judge distance.

(3) Size the display of a moving map with an aircraft symbol so as to provide a visual base turn depiction — In our KTEB ILS Runway 6, circle to Runway 1 example, we can zoom into the approach plate and realize the distance between TORBY and Runway 6 is 3.8 nm. We should be shooting to roll out on final for Runway 1 that is about half that distance from touchdown. (Some simulator instructors will call this cheating. In the box that might be the case. But in real life this is called using all the tools available to keep things safe.)

(4) Use synthetic vision — Some synthetic vision setups provide range marks from the landing runways, in which case you need only shoot for a rollout providing at least beyond the 1 and 2 nm marks.

The Key to Success: Planning and Knowing When to 'Bail'

Circling in a simulator or at an airport where you aren't competing with other airplanes in a long line of arrivals and departures can seem relatively easy compared to the Teterboro non-circle, circling approach. The same can be said at a few other airports in the country where not only do you have to fly a demanding visual approach, but you need to do so while meshing with other aircraft. But Teterboro can be the most challenging of all because of its proximity to several other very busy airports.

Both of these approaches are perfectly safe and are routinely accomplished by hundreds of pilots every year, even in very strong and gusty wind conditions. Most of these pilots are veterans at this kind of thing and experience really does help. If you are faced with your first trip to Teterboro, you would be well-served to try both approaches in a simulator first. But even the most seasoned Teterboro veteran needs to know when to say no to these procedures.

On May 15, 2017, I was scheduled to fly to Teterboro, the closest airport to my passenger's meeting in New York City. The winds were forecast to be 340/25G40 all day long. I knew this would require an approach to Runway 6, circle to Runway 1. While the winds were just below my G450's maximum demonstrated crosswind value, I knew the overshooting wind would push me to my limits as a pilot. I elected to use Runway 34 at Westchester County Airport, New York (KHPN) instead.

But what if you find yourself about to circle for a runway where the winds have suddenly changed and your ability to negotiate the turn is in doubt? Or perhaps you simply forgot to turn as early as needed? You could find yourself at your maximum bank angle with your target runway slipping away from you. What then? The tower controller has undoubtedly seen this before and will understand, especially if you make it clear what is happening. "I overshot the runway, I need to go around." If you think another try with a longer final would work, say so. But if you think the conditions are just too taxing for man and machine, ask for a different approach or divert. Your confession can make life easier for the rest of us. They may change the active runway or your words can warn the next pilot not to attempt the maneuver. That next pilot could be me; so let me say "thanks" in advance. BCA