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IFR

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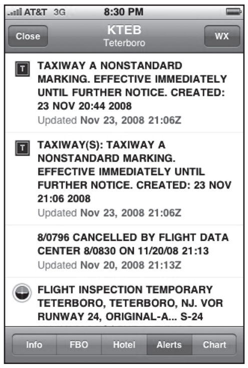

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DON'T WATCH THE NEEDLES

Sometimes the best way to avoid an ILS sword fight on the CDI is to stop looking at the instrument so much.

by Neil Singer

The ILS is an interesting beast. It's typically the last approach to be mastered by a would-be IFR pilot, yet the first to be requested by that same, now-rated, pilot on a low-IFR day. Procedurally, the ILS is often the simplest approach to conduct. However, it's usually the most demanding to hand-fly. That demand can turn and bite the IFR pilots who don't practice the ILS as often as real proficiency requires.

When conducting recurrent training, witnessing a hand-flown ILS is often enough to give an accurate picture of a pilot's overall stick-and-rudder ability, as well as a crystal clear look into their understanding of attitude instrument flying. The ILS serves as a magnifying glass, where weakness in either of those two areas will almost inevitably show in a sloppy approach.

The good news is there are a handful of tricks and techniques that, used properly, can make hand-flying an ILS a quite easier proposition. These tips are also applicable to any approach with vertical guidance, such as an LPV or LNAV with the addition of vertical "advisory-only" guidance. Even a pure, non-precision approach can benefit from the application of the lateral techniques.

With no other distractions, the pilot will fly nearly down the center of the runway with no aid from the HSI at all.

First, Check Your Attitude

Attitude flying basics say we should spend more effort monitoring instruments that predict what the airplane will do next (control instruments), rather than those that tell us what has already happened (performance instruments). That means the HSI or CDI is actually the least important instrument to monitor, which is contrary to most pilots' beliefs (and scans).

Think of it this way: The HSI can only tell you that you've already strayed from the course or glideslope, while other instruments can tell you that you're about to go astray. A 10-degree bank on the AI means the localizer needle is going to be moving if it hasn't yet, regardless of whether it's centered. A centered glideslope isn't going to stay that way for long if the VSI is showing zero.

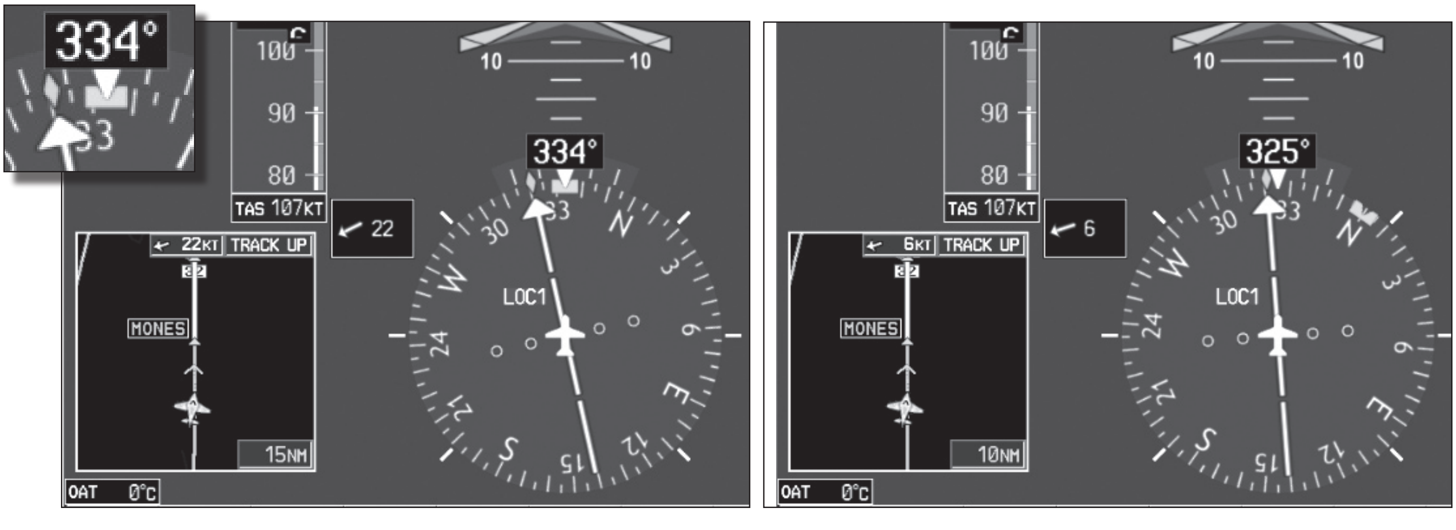
From this, we can derive a "most important" instrument for each of lateral and vertical control. We'll get to these in a bit. Keep in mind that, as always, the attitude indicator is really the "most important," for it will allow us to control the designated instrument with precision. The buck stops with the AI, so to speak.

After the error of spending too much time reacting to the CDI and too little scanning the important instruments, the next big mistake many pilots make on the ILS is over-controlling. Truth be said, this is simply a basic problem many IFR pilots have, on an ILS or otherwise. The sensitive nature of the ILS just amplifies the problem.

Making a Lateral Move

The first trick to flying a good ILS is staying on the thick black line with-

Below: *Put the track marker—a diamond here—over the desired course and you'll track that course. With small wind angles (**right**), you may need to move the heading bug out of the way.*



out spending so much mental bandwidth that monitoring the glideslope is an afterthought. To do that we need to make small corrections to the aircraft in bank, and spend a relatively high amount of time focused on the instrument that can best prevent localizer deviations.

So what should be that instrument? Unfortunately, the answer is, “It depends.” What it depends on is the level of sophistication of the cockpit instruments in your aircraft. The very best instrument for this purpose is a track display. Some electronic HSIs, such as the Avidyne Entegra system and newer G1000 installations, display real-time ground track as a line or symbol on the HSI.

It cannot be overemphasized how useful this information is. A track display takes all the work out of correcting for a crosswind on an approach by showing a pilot where the airplane is going, as opposed to simply heading. Keep the track the same as the inbound course, and don’t worry where your heading ends up. Likewise, a centered needle means nothing if your track line is 10 degrees different from the inbound course. If you are lucky enough to fly an aircraft with a track display, it should be the instrument that receives the most attention of any in the lateral axis.

Lacking a track display, the heading indicator (which we’ll just call the DG) is our next best option, hopefully augmented with digital track readout on a panel-mounted or handheld GPS. Here we need to mentally overlay the digital track info from our GPS onto the DG to try to determine a reference heading. That heading keeps the track equal to the inbound course. When you find the reference heading, set the heading bug to that heading as a reminder, assuming your plane is so equipped.

With no GPS to give us track info, we need to resort to old-fashion trial and error.

Once we have a good idea of what heading or track to fly, a large amount of effort should be spent on keeping it. If the inbound course of an ILS is 090, and a pilot can keep his track exactly 090, the CDI’s going to stay centered whether you look at it or not. With particularly recalcitrant pilots, I will tune the NAV receiver to another frequency once established on the localizer and have the pilot simply maintain exact inbound track and level flight. With no other distractions, the pilot will fly nearly down the center of the runway with no aid from the HSI at all.

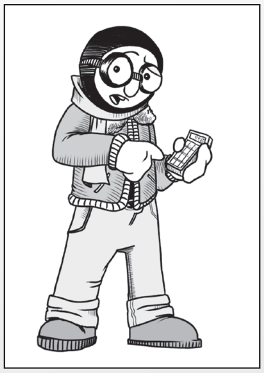
Despite our best efforts, we occasionally drift off our desired track,

NEIL’S MATH CORNER: PITCH DOWN THREE

You can go out and derive the pitch setting for an ILS from trial and error, but there’s a simpler way. Engage the autopilot in level flight (or maintain exactly level flight by hand) and configure the aircraft as you would for an ILS. Flaps, in particular must be exactly as they will be on the approach. Reduce the power until the aircraft stabilizes in level flight, at the indicated airspeed you will fly on an approach. Ensure that the speed is truly stable, and note the pitch attitude. Now subtract three degrees from that number, and you have your target pitch on an ILS. Here’s why this works.

Starting with the equation:

Angle of Attack = Angle of Chord Line - Angle of Flight Path

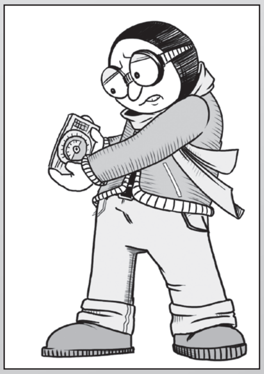


Now do some quick substitutions. We’ll use airspeed as a proxy for angle of attack (which is valid for set loading conditions and a given flap configuration), and pitch attitude as a proxy for angle of chord line (valid as long as flap configuration doesn’t change and we’re looking for a relative number and not an absolute one).

For a fixed speed, changing pitch attitude by x degrees means that our flight path will change by x degrees. Flying a standard ILS requires a flight path three degrees less than level, so subtract three from the pitch attitude required for level flight and you’ll ride down the glideslope. Simple. You’ll still need to adjust power for speed, though.

For lateral corrections in crosswinds, the difference between the inbound course and the reference heading can be determined by the following formula:

Wind Correction (degrees) = Crosswind Component (knots) / True Airspeed (nm/min)



Since most GA aircraft fly an approach between 90 and 120 knots, using 1.5 or 2 for true airspeed in nm/min will give satisfactory results. Imagine you’re flying an ILS with an inbound course of 296 at 100 knots, and the ATIS winds are 330 at 15. Winds are 30 degrees from the inbound, so crosswind component is 50 percent of total winds, or 7.5 knots. Our speed is closer to 1.5 nm/min than 2 nm/min, so 7.5 degrees/1.5 equals 5 degrees of wind correction. Set the heading bug to 301, and you’ll be in good shape to get started.

Yes, the winds aloft will tend to be stronger and from a different direction than surface winds, but they’re also rounded to the nearest ten degrees on the ATIS, and up to an hour old, so don’t get too picky. It’s a starting point. *—N.S.*

TWENTY YEARS OF BOTCHING THE ILS: NO ONE IS IMMUNE

A bit more than a decade ago, we sifted all the accidents wherein a qualified aircraft and pilot impacted terrain under control—what's known in the vernacular as a controlled flight into terrain (CFIT)—while headed to or on an ILS ("Lawn Darts on the ILS," May 1998 *IFR*.) Hitting a mountain while milling around in the soup might be one thing, but we were curious about times when pilots who should have been good to go with the precision navigational aids wound up playing dirt diver instead. We also wondered if there was any correlation between hours of experience and choice of crash site.

In broad strokes, the period from 1987 through 1996 yielded on average about one of these every other month or so. There was some strange stuff, of course, but in general those accidents appeared to involve nothing more than simple failing to mind the altitude store. Most were on azimuth and the greatest number within this group (40 percent of the total) impacted on centerline within a mile of the threshold. Another quarter of the total was more grossly off altitude and azimuth. Most of the remainder were best described as just plain clueless, impacting terrain way out on the procedure or otherwise disoriented.

A couple of results in this group were of particular interest. First off, one in four of these CFITs occurred following multiple approaches. More interesting was the distinct correlation between pilot time and where they hit the ground. Lower-time pilots (under 1000 hours) tended to bang terrain far from the field or otherwise blow the procedure. The ones who got established OK but couldn't keep it between the ditches averaged around 1200 hours total time. High-timers tended to park it in the approach lights or environs.

Another intriguing factor was the time of day. Whether fatigue, the added workload and complications of a night approach, or (most likely) a combination thereof, nearly three-quarters of the total ILS CFIT accidents occurred in conditions listed by the NTSB as night (dark), with fully a quarter occurring after local midnight.

We're Not Getting Better

Do those same trends hold true today with all these new gizmos and their touted situational awareness? Last time, it was 66 total CFITs on the ILS over a 10-year span. This time it was 59, or still about one every two months on average. As before, about two-thirds were fatal. (It's that sudden stop, ya know.)

During the recent decade, high-time pilots still had a distinct tendency to hit close-in with a bit less than a third impacting terrain under control within roughly a half-mile of the runway threshold. Nearly three-quarters of those pilots had over 1000 hours total time and four had over 10,000 hours.

The pilots in just over a quarter of these accidents had a thousand hours or less. As before, the majority of these (63 percent) flew into terrain outside the outer marker. That being said, however, just under half of all the more recent CFITs—without regard to total time—impacted outside the OM, which is a much higher percentage than last time. Whether this is just a statistical anomaly based on a relatively small data set or it indicates a decline in overall procedural acumen, we don't know. If the differential is real, we will offer a sad prediction that the next 10-years' worth of this data will indicate an even greater slippage, given the increasing and potentially escalating costs of maintaining general proficiency.

A couple of things worth noting were substantially different this round. Ten years ago one in four accidents followed multiples approaches. This time only seven out of 59 could claim possible fatigue or "if at first you don't succeed" pressure. This we found surprising, as multiple approaches and mounting frustration from same is at least an understandable if not salutary motive for perhaps ducking under. This could be another sample-size anomaly. It could also mean skills are deteriorating such that our intrepid aviators don't survive the first attempt. We don't know.

One major factor that held for this round was the high percentage of CFITs under precision guidance that happened at night, with nearly three-quarters occurring during official dark or reduced light. Why should that matter on an IMC precision approach when you can't see outside anyway? Fatigue, the tank traps of the visual transition, or duck-under pressure building at the end of the day? Again, we don't know, but the results are consistent.

Ten years ago we reported that complacency, confusion and failing to stick with the procedure were killers. Surprise, surprise: It's still true. It doesn't look like the gizmos are buying us much safety in the overall numbers, either. The new monster lurking in the weeds might be a trend toward reduced proficiency. Time will tell. — *Jane Garvey*

Right: *Nearly all runways served by an ILS are 5000 feet long or longer and almost all GA aircraft can land with partial flaps. Don't change configuration at minimums unless you have to (or the mins are high enough it's a non issue).*

and thus off course. Many pilots do a great job keeping the needle centered, only to fall apart when any significant correction is called for. They over-control the aircraft and oscillate from left of course, to right, and again like a ping-pong ball.

To avoid this, make no more than a five-degree heading change from the reference heading. Inside the outer marker, the localizer is extremely sensitive, and even a large deflection will quickly come back to center with five degrees of intercept. Patience is called for here, not a 20-degree heading change that requires lightning-quick reflexes on the roll back to level. No more than five degrees of bank angle is required to change heading five degrees. In fact, any more will make it difficult to be precise with such a small heading change.

As an aid in ensuring no more than five degrees of heading change from reference heading is made, remember that most heading bugs, physical or on the glass-cockpit PFD, are about 10 degrees wide. Thus, center to edge is five degrees—our maximum desired variation from reference heading. Ensure heading never strays from the lateral limits of the heading bug, and over-correcting on the localizer is one less problem to fix.

Vertically Challenged

Of course, what sets the ILS apart from a non-precision approach is the challenge of tracking two needles simultaneously. The glideslope needle tends to become a point of excessive focus for many pilots, leading to the inevitable over-correcting and porpoising. The tricks to keeping on glideslope are the same as staying on the localizer: Focus on the correct instrument and make small, specific corrections when needed.

The VSI is to glideslope control what the track display is to localizer control. This is because, for any given groundspeed, there is one, and only one, vertical speed that will keep an aircraft on glideslope.

For the typical three-degree glideslope, that vertical speed is approximately equal to five times the groundspeed (in knots). Thus, flying at 100 knots, we need about 500 feet per minute descent to track the glideslope. With a headwind component of 10 knots, the vertical speed required decreases by about 50 fpm, small enough that the coarseness of our VSI display renders worrying about it nearly moot.

Once again, if we can hold the correct vertical speed, we could cover up the glideslope display and remain perfect on beam. Just as we bound our lateral corrections to no more than five degrees track or heading change, we want to have a limit in mind when we must alter vertical speed to catch the glideslope because we wandered off. For small corrections, a maximum of 200 fpm either side of target should be the goal.

For the typical ILS, vertical speed should never be more than 700 fpm or less than 300 fpm. For cases of extreme deflection that borders on necessitating a go-around, the limit can be expanded to 500 fpm either side of target, a range of zero—just fly level for a moment—to 1000 fpm.

More so than with localizer tracking, the role of the attitude indicator in setting desired performance is crucial with glideslope tracking. Having established that a precise vertical speed is critical to a well-flown ILS, we need to use the AI to help achieve that vertical speed with minimal effort.

Here's where having some defined pitch and power settings for our aircraft is essential. In the approach configuration, if a given power setting and pitch attitude results in a 500 fpm descent at our target approach speed, then that pitch/power combination will always give us those results.

Those two numbers should be burned into the mind of every IFR pilot. If you need 11 inches of MAP to hold 100 KIAS, then set 11 inches exactly. If you need two degrees pitch down, hold that exactly unless correcting for off-glideslope conditions. Remember that most small aircraft, need no more than one degree of pitch change to alter vertical speed by 200 fpm.

This means the ILS should be flown in a pitch range of only two degrees. That's why scanning the AI is critical. It's also why the larger pitch indications on a PFD can make it easier to hand-fly an approach. Keep in mind that target vertical speed (and, therefore, target pitch and power) will vary slightly with large headwind or tailwind components.

(continued on page 21)

direct-to request exceeds the service volume of the VOR to which you wish to proceed, ATC is required to provide radar monitoring and any required vectoring. If your WAAS GPS is approved under AC 90-100 for use as an alternate means of navigation, you can even use your GPS to proceed direct to a VOR that is out of service. Now, the controller may say, "unable direct" for a variety of reasons, but you have informed the controller that you are willing and able to accept a direct routing.

If a controller tells you, "Fly heading 350, vectors Red Bluff," and you notice that a 360 heading is virtually direct Red Bluff, you can respond with, "Heading 350, request direct Red Bluff." In these situations, I've found controllers are usually quite happy to give you direct-to the fix.

When you're being vectored to join an airway and you want a shortcut that you believe will not pose a traffic problem or an obstacle clearance problem, request direct-to the fix. A little caution is in order here: If you specify a fix that is outside the controller's sector, they may say "unable" simply because they don't know where that fix is located. In those situations, you can sometimes help the controller out by specifying your desired on-course heading to the desired fix.

If the shortcut you desire will take you through busy airspace at an inconvenient altitude when the controller is busy, the answer is likely to be, "Unable." Flying through a terminal area at a higher altitude and in a faster aircraft is more conducive to getting a shortcut than flying at a lower altitude in a slower aircraft.

If you fly the same route frequently, asking for a direct-to shortcut can help you learn any ATC constraints. Some controllers will take the time to explain when a shortcut will work and when it won't.

It's likely that we'll continue to hear how NextGen will allow aircraft of the future to route themselves, how VORs are going to be phased out, and how everyone will be able to fly direct to their destination. Until that comes to fruition, just plan your own direct-to routings. Ask for shortcuts from ATC, and save some time and fuel in the process.

John Ewing is a writer and flight instructor in Northern California.

DON'T WATCH THE NEEDLES

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One last tip on keeping the glideslope centered relates to the final few hundred feet of the approach. At this point, the sensitivity of the glideslope is super high, and any attempt to control the aircraft directly from the glideslope display is guaranteed to result in oscillations. Assuming on-course conditions, within 200 feet of DA, nearly all attention should be on maintaining wings level and the proper descent rate. In particular, guard against decreasing the descent rate, or even leveling off, prior to DA.

All ILS, All the Time

Flying a good, two-needle approach is more important than ever with WAAS providing vertical guidance to a growing number of airports. Deriving full safety and utility from a precision approach requires the pilot fly the approach with equal precision—even if to do so he needs to ignore the needles a bit.

Neil Singer is a mentor pilot in the Northeast

QUIZ ANSWERS ***(questions on page 12)***

1. **d.** It's the distance from the antenna, usually located at the far end of the field. For LDA approaches it might be elsewhere. This is rarely an issue other than wasting your time listening for the signal well outside this area.

2. **a.** The antenna for the ILS is on the far end of the runway and the width of the signal in degrees is adjusted to be 700 feet wide at the approach threshold. This means the further the antenna is from the threshold the narrower the beam must be. Not a big deal. If a certain runway seemingly has an oversensitive localizer signal, it's probably you, wind flowing over terrain, or some other issue, rather than a narrow localizer signal.

3. **b.** You can check out AIM table 1-1-4 to see the pairing of localizer and glideslope frequencies. You see that the range is 108.10 to 111.95, but that it skips the even numbers after the decimal (108.10, 108.15, 108.3, 108.03 ...).

4. **d.** The big difference between the SDF and LDA is course width. The LDA is comparable to an ILS while the SDF is wider, being fixed at six or 12 degrees. This means less precision (on your non-precision approach). SDFs are often oriented within three degrees of the runway orientation, but don't have to be. LDAs are often within 30 degrees of the runway orientation, but they don't have to be. If they are more than 30 degrees off, then only circling minimums are published.

5. **d.** Geez, since you're always supposed to read the plate and follow it, this answer should have been a gimme. That said, the point here is that some LDAs do have glideslopes and some of those—but not all—require you to receive and follow the glideslope to fly the approach. You'll see the warning to fly the glidepath in both the plan-view notes and the lack of any non-glideslope minimums.