Hold, Then Reverse

Sorting out the missed approach or traffic delay hold from the course reversal can be confusing.

By Wally Roberts

YOU'VE HEARD ME SAY AGAIN and again that there are only two ways to enter an instrument approach procedure: via radar vectors to the final approach course or via the full approach, which includes the published course reversal (unless you arrive on a "NoPT" route).

Some IAPs don't have a published course reversal, in which case all terminal routes are implicitly "NoPT." If an IAP doesn't have a published course reversal, there's no airspace evaluated and protected for a course reversal.

Bold vs. Thin Depiction

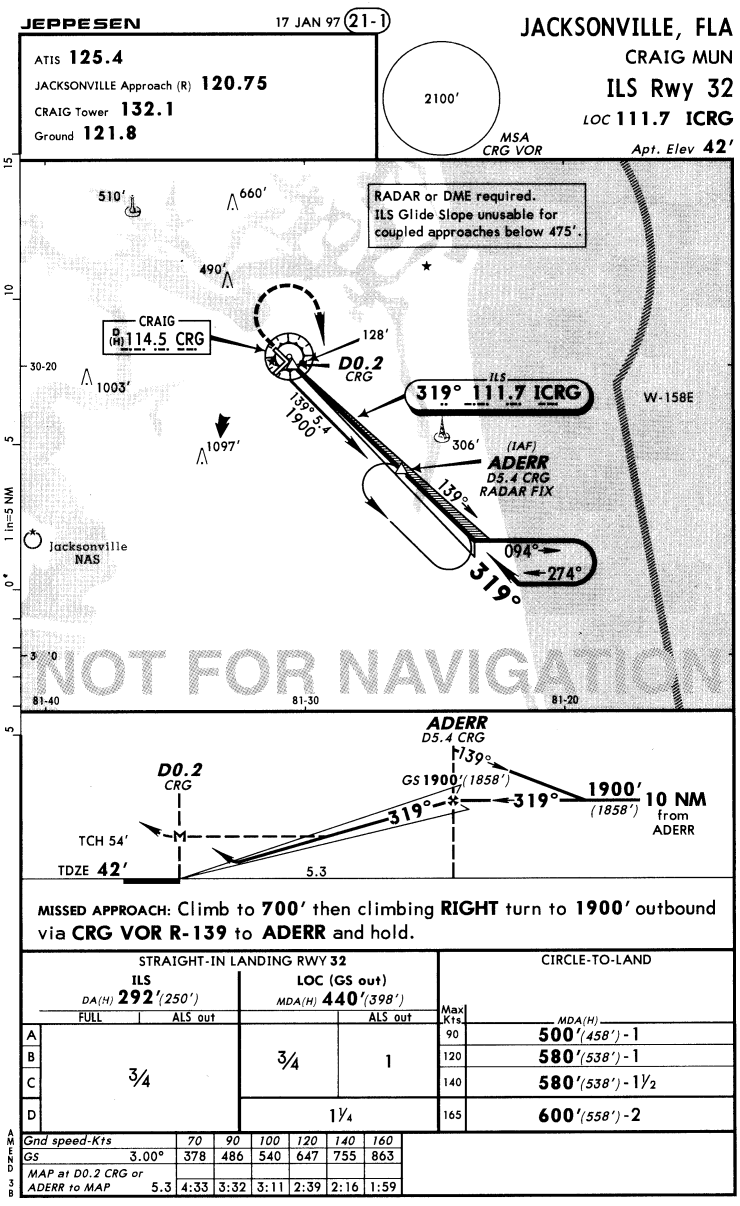
In the United States, and most of the world, charting convention dictates that the course reversal segment, and the subsequent approach segments to the missed approach point, be charted in the profile view as well as the plan view. Other segments are shown in the plan view only. Where there is no course reversal, it is left somewhat to the discretion of the approach designer where to begin the profile view, provided it includes at least both the intermediate and final segments.

The flight-track portion of the IAP in the profile view must be shown in bold type, where all other IAP flight tracks are shown in the plan view in thinner type. For purposes of this article the type thickness distinction, coupled with profile portrayal, is what informs us a holding pattern is established for course reversal in place of a standard procedure turn.

Any other holding pattern shown on an approach chart will be in thin type. With rare exceptions, the only thin-type holding pattern shown will be a holding pattern established as the end-point of the missed approach procedure.—*WR.*

What if, however, there's a holding pattern at the final approach fix (FAF) or the intermediate fix (IF) that is either depicted as the end-point of the missed approach procedure or perhaps it's charted only on the en route chart as a en route or terminal holding pattern? Can you make a course reversal in such a pattern if you see the need to reverse course? Well, it depends.

A course reversal is established to get you lined up on the final approach course within the intermediate segment so you don't need to maneuver signifi-



You're spinning in the hold at ADERR at 1,900 feet because of a missed approach. When cleared for the approach, you shouldn't go out for the procedure turn because you're already lined up on final out of the hold.

cantly to enter the narrow, critical final approach segment. It also ensures you're on altitude so you can configure the aircraft for final segment descent and landing. An exception is the on-airport VOR or NDB IAP without a FAF, in which the procedure turn takes you directly into the final approach segment.

Wherever possible, an IAP is supposed to have initial approach segments that line up with the intermediate segment sufficiently so a "NoPT" entry into the intermediate segment is possible. The other requirement is that an optimum descent gradient of 150 feet per mile (300 per mile maximum) be established for the intermediate segment. The intermediate segment is the shallowest approach segment because this is where complex aircraft are being slowed and configured for final approach.

Gradient within Course Reversal

A standard 10-mile procedure turn must have a completion altitude not greater than 2,000 feet higher than the intermediate altitude across the FAF. (Not more than 1,500 feet above MDA for either a VOR or NDB IAP without a FAF.) The altitude from the procedure turn IAF to the procedure turn completion altitude is not to exceed 250 feet per mile (optimum) to 500 feet per mile (maximum). As you can see, the approach designer can get rid of a lot of altitude in a conventional procedure turn.

A course reversal hold, however, is much more critical because you can only go outbound for one minute. If a course reversal hold is at the FAF, the maximum altitude difference between the minimum holding altitude and the intermediate altitude across the FAF is only 300 feet (the max per mile intermediate segment descent gradient). If the course reversal hold is at the IF, then 150-300 feet per mile is permitted for the distance from the IF to the FAF.

Real World Examples

Let's review a few real-world mixes of bold holding patterns, thin holding patterns and procedure turns. Refer to the ILS RWY 32 at Jacksonville, FL (page 10). This procedure incorporates a missed approach holding pattern at the IAF/FAF, as well as a standard procedure turn. All pertinent altitudes are the same: 1,900 feet for procedure turn outbound, procedure turn completion altitude, intermediate altitude over the FAF and missed approach minimum holding altitude.

Suppose you're spinning in the hold either because of a traffic delay or because you executed a missed approach and you're holding at 1,900 feet. When you're cleared for the approach, should you go outbound and do the procedure turn? The answer is no because you're lined up on final out of the hold and you're within 300 feet of the FAF altitude.

Could you elect to do the procedure turn in this case? Of course, but it would be wise to advise ATC. Further, if the

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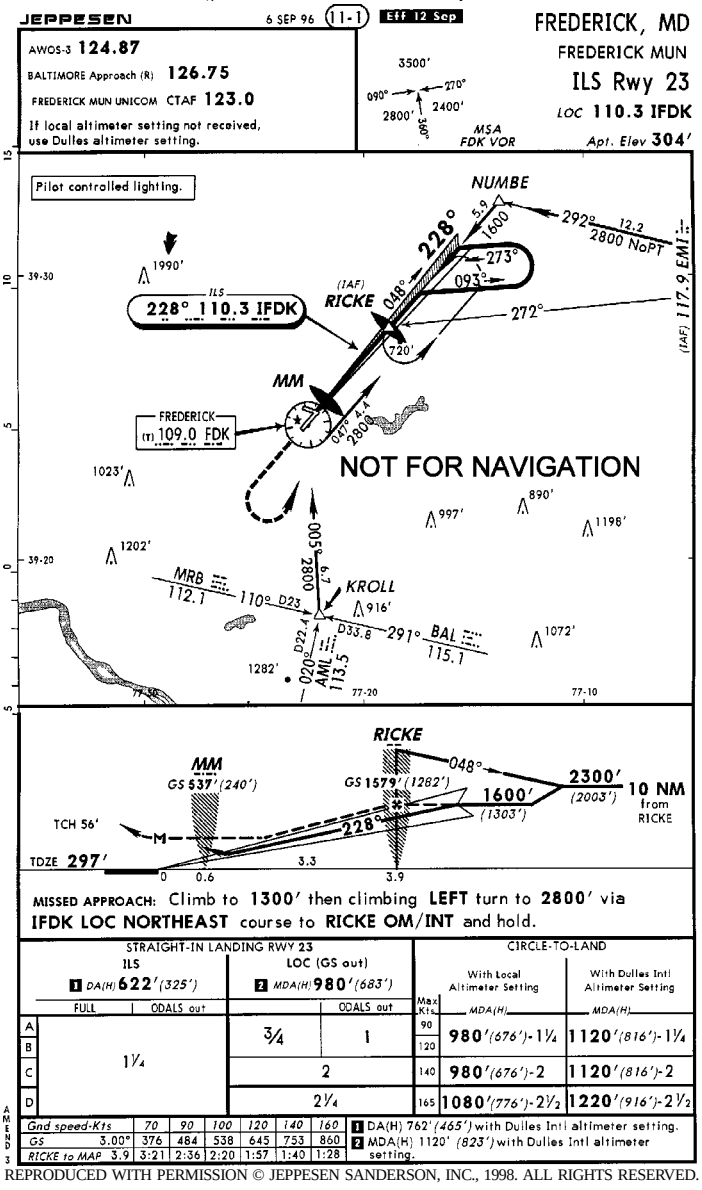

Both the missed approach hold and standard procedure turn are based on the IAF/FAF and both are on the same side. You can make a straight-in from the holding pattern with an approach clearance after a missed approach or arrival delay hold provided you extend the holding pattern out beyond one minute up to the 10-mile maximum.

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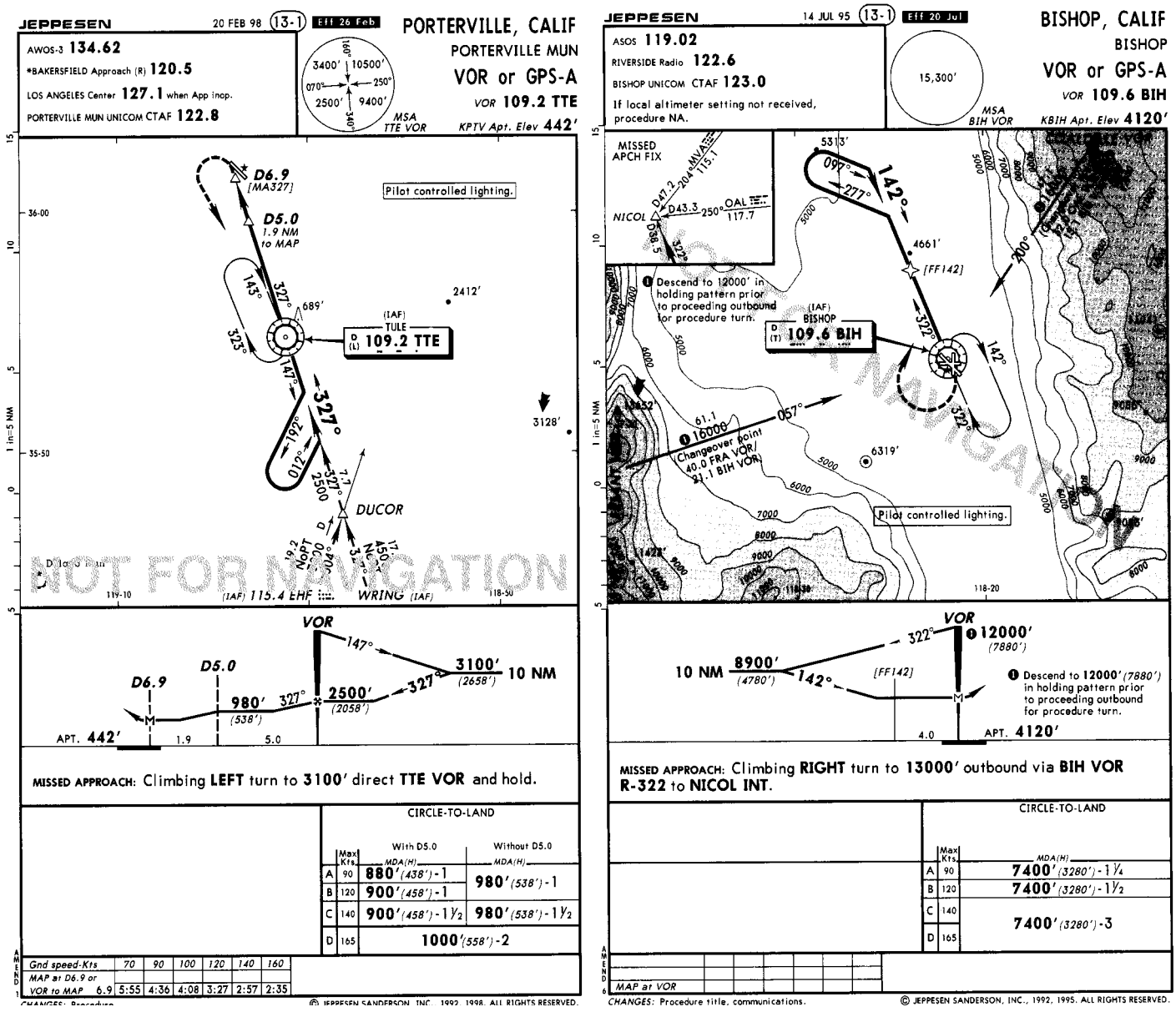
missed approach hold were on the same side of the intermediate course as the procedure turn, you could elect to extend the hold beyond one minute once cleared for the approach because you're at the procedure turn completion altitude and on the procedure turn maneuvering side. Since you aren't on the procedure turn maneuvering side in this example, however, you cannot extend the hold beyond one minute.

Same Side Turn

Refer to the ILS RWY 5 at Frederick, MD (page 11). Both the missed approach hold and standard procedure turn are based on the IAF/FAF and both are on the same side. Can you make a straight-in from this holding pattern with an approach clearance after a missed approach or arrival delay hold? Sure you can, provided you extend the holding pattern out beyond one minute up to the 10-mile maximum. You need to descend from 2,800 to 2,300 feet and be far enough out to leave 2,300 feet once established inbound in order to be below the glideslope.

Personally, my preference is to capture the outbound course in such cir-



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The VOR/GPS at Porterville (left) looks simple enough, however, ATC will sometimes park you in the hold at high altitude then clear you for the approach. Ask for another circuit in the hold to lose altitude if necessary. On the VOR/GPS at Bishop (right), note the two feeder route altitudes are 16,000 feet! You must descend to 12,000 feet in the hold before proceeding outbound for the procedure turn.

cumstances and do a more "conventional" procedure turn, but that is my technique. Procedurally, however, when cleared for the approach you're free to extend the hold, provided it's identically aligned with the procedure turn and is on the same side of course. If the published hold in this example were on the opposite side of course from the procedure turn, the one minute holding limit must be strictly observed when doing the course reversal.

High Altitude Hold

The VOR or GPS-A at Porterville, CA (page 12) has a missed approach hold that even the most innovate amongst us couldn't figure out how to turn into a course reversal. I have personal knowledge of this location and have known the Center (when approach control is inoperative) to put aircraft into this hold for traffic delays, then clear the aircraft for the approach from some pretty high altitudes. How high is too high? Well, it's up to you. Keep in mind the optimum descent gradient for the procedure turn outbound is 250 feet per mile (500 feet per mile maximum).

If I were holding above 8,000 feet and received an approach clearance, I would request one more circuit in the hold to lose altitude before I began the procedure turn.

Mountain Bowl Approach

The VOR or GPS-A at Bishop, CA (page 12) is an extreme case of a mountain bowl approach. The feeder routes to the IAF both have an MEA of 16,000 feet. This is too high to do a procedure turn! As a result, a holding pattern is charted to serve as a "descent to begin the procedure turn hold." This is an exception to the general rule that only course reversal and missed approach holding patterns are charted.

Holding Speeds

The maximum airspeed in all these holds for piston-engine folks is 175 knots. For jet jocks, however, it's more convoluted: 200 knots is the jet maximum at 6,000 feet and below. In the case of an IAP, however, you're well-advised to keep it below 200 knots even with course reversal holds at higher altitudes.

When It's Flexible

You have lots of flexibility where a missed approach hold is based on the same fix as the procedure turn and is on the same side of course. If the course reversal IAF is also the FAF, keep in mind you want to be able to get down after using the hold for a course reversal, but you can extend the hold once cleared for the approach to not exceed procedure turn distance limits.

If the missed approach hold is on the opposite side of the procedure turn, you're limited to one minute outbound, even when cleared for the approach. If this non-procedure-turn-side hold is at the FAF, use a 300-foot maximum difference in minimum holding altitude and FAF altitude as a rule-of-thumb as to whether to go straight-in from such a holding pattern.

Know the Minimum Altitude

Always keep focused on the applicable minimum altitude, whether it be the minimum holding altitude, procedure turn completion altitude or inbound altitude over the FAF.

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GPS and Victor Airways

It's important to understand the ambiguities of "direct-to" GPS navigation.

By Wally Roberts

THE "LAT/LON" SYSTEM OF NAVigation is referenced to True North. Magnetic courses, bearings, and headings have no real use in this system, except to accommodate magnetic compass systems. GPS is predicated on the "LAT/LON" system for aviation navigation purposes, which would be far simpler to use if everything could be referenced to True North.

However, until the engineers figure out a cost-effective "true compass" for small aircraft, and we continue to have the VOR system, we're stuck with using magnetically-compensated GPS navigation. If we went to true-north reference for GPS today, we would no longer be able to display essentially correct wind crab angles on our HSI, we would be unable to overlay GPS onto the VOR system, and ATC would have to switch its massive domestic radar system to a true-north reference. Pilots would have nightmares trying to convert magnetic compass headings to true on the fly.

All calculations made during the design of a GPS approach are in terms of true course. The approach designer then adjusts the approach courses for the airport's local magnetic variation. Nonetheless, the GPS "engine" in your IFR box knows only true course. As a result, the avionics vendors use various proprietary algorithms to convert the GPS true course back to magnetic.

These conversions aren't precise by any means. It's not unreasonable to expect 1-2 degrees difference from one box to another at a given fix. Further, those VOR radials you see on the Victor airways might or might not be the actual magnetic course of the airway radial. The VOR station's alignment with magnetic north drifts over time and is only tweaked by the FAA at widely-spaced intervals.

The net effect could be a course error of greater than four degrees in some instances if you attempt to intercept and track a VOR radial using the indicated bearing shown on your GPS, and using "Direct-To" (or with some boxes, the "OBS mode") when the GPS bearing is the same as the charted radial. This could result in some significant deviations from intended track when at any substantial distance from a VOR station—in extreme cases taking you completely outside Victor airway protected airspace.

Stored Flight Plans

If you fly a Victor airway with a stored flight plan, the errors discussed above disappear, because you are now navigating on an "iron rail" between published, magnetically-independent waypoints. (The magnetic bearing shown by the GPS may be off 1- 4 degrees, but this will just appear to be a little bit of crosswind blowing across the CDI's iron rail between published waypoints.) This is one of two critical reasons that the FAA insisted on an "iron rail" stored flight plan for every IFR-approved GPS approach, overlay or standalone. The other critical reason for database approaches is to eliminate errors in entering either a waypoint name or much worse raw LAT/LON.

"Build" Your Own Airways

Except for one or two of the IFR receivers out there, you have to manually build your own Victor airways. This means if you enter the wrong VOR identifier or five letter intersection name you could have huge errors. A reasonableness test will usually catch these errors, however.

When manually building a Victor airway route, it's a good idea to throw in a midpoint intersection on longer legs. Where the airway has a dogleg, it's essential to enter the turning point five-letter identifier. These dogleg turn points weren't previously named, but most—if not all—are now named and in your database. With an IFR GPS box that has an airway database, all of this airway building is done for you by the vendor and Mr. Jeppesen—a strong argument in my view to buy a receiver with a built-in airway database.

Feeder Routes

Feeder routes to initial approach fixes aren't required to be in the approach's database string. If not, make sure you fly the "iron rail" via a flight plan leg from the feeder fix to the IAF, especially if the feeder route extends for a considerable distance. Non-flight-plan-leg "Direct-To" should be generally limited to short range operations where an exact track isn't important. Some examples of this include a short-range clearance direct to a feeder fix or IAF, or a missed approach to a VOR or NDB. The only time the "Direct-To" button should be used for a long range clearance is where the controller initiates clearing you direct to a distance fix. You should limit this to operations in the US and Canada.

Shift your thinking about GPS to visualize it as true area navigation system that only knows how to fly a great circle from one LAT/LON position to another. If you keep that concept in mind you will understand that only by using flight plan legs can you consistently and accurately overlay the non-area-nav, non-LAT/LON, VOR airway structure.

If your IFR GPS receiver doesn't have a built-in airway database:

- Add a midpoint intersection on long legs.
- Enter any airway doglegs.
- Create a flight plan route from the feeder fix to the IAF.