Vectors To The Final Approach Course

ATC radar is used to substitute for the published initial approach segment .

By Wally Roberts

ONE OF THE GREAT TIME-SAVERS for both pilots and controllers is the use of ATC radar to vector an aircraft directly onto an instrument approach procedure fairly close to the final approach fix (FAF). I've discussed this concept in general terms in previous articles. In this article, I'll review the detailed ground rules for such vectors.

From the perspective of TERPs, a radar vector to the final approach course is a diverse radar initial approach segment, which substitutes for any published non-radar initial approach segment. The only time a vector to final actually intercepts the final approach segment, however, is with either an on-airport VOR or NDB approach that doesn't have a FAF. Normally, a vector to final intercepts the final approach course within the intermediate segment.

Shortening the intermediate

An intermediate segment normally must be at least five miles in length. A special rule permits an ILS intermediate segment to be less than five miles where a shallow intercept angle is used. A similar condition exists for vectors to final that permits the controller to shorten the length of the intermediate segment, but limits the intercept angle to 30 degrees and, in some cases, to 20 degrees. There is a minimum length for this radar-vector-shortened intermediate segment, which generally is at least three miles unless the reported weather provides reasonable assurance that the aircraft will be in VMC when passing the FAF, or the pilot requests a turn onto final at the FAF.

Base-leg concept

The majority of IFR arrivals in radar-controlled terminal airspace aren't lined up for a straight shot at the IAP final approach course. If this were the case, and the IAP were an "NoPT" procedure, ATC could simply exercise speed control and let the arrivals fly the full "NoPT" procedure. However, traffic comes from all directions, so the radar vector procedures are predicated on the controller typically lining you up for a modified base leg entry into the intermediate segment. Also, by providing vector services in addition to speed control, the controller achieves the maximum effective use of busy terminal airspace.

Compatible vectoring altitude

Not only must the turn onto final be at the proper intercept angle, and at least the prescribed distance from the FAF, the altitude of the vector must be in concert with the requirements of the IAP. In the case of a non-precision IAP, the assigned vector altitude must be at an altitude which will allow you to descend in accordance with the IAP. This is fairly loose language, but the altitude requirements for a precision IAP are much more concise: at an altitude not above the glideslope and not at an altitude below the glideslope intercept altitude shown on the approach chart.

If the ATC facility's minimum vectoring altitude is too high to satisfy the intercept altitude requirements, then vectors-to-final are not feasible even where there is adequate radar coverage. This would be very unusual at the primary airport served by a radar approach control, but is certainly a factor at secondary airports and where Center provides radar approach control services.

The approach gate

You've probably heard controllers use the term "approach gate" when vectors are provided to the final approach course. The approach gate is an imaginary radar fix on the final approach course, which must not be less than one mile from the FAF, and it must not be less than five miles from the landing threshold. This five-mile minimum limit takes care of the on-airport, no-FAF VOR or NDB IAPs, as well as those rare IAPs with a very short final approach segment. It's also significant to note that the FAF for a precision approach is the point at which the charted intermediate altitude intercepts the glideslope, which at some locations can be several miles prior to the charted (Maltese cross) FAF.

Except when the weather is likely to be VMC passing the FAF, or unless the pilot requests a turn on at the FAF, the vector must intercept the final approach course at least two miles prior

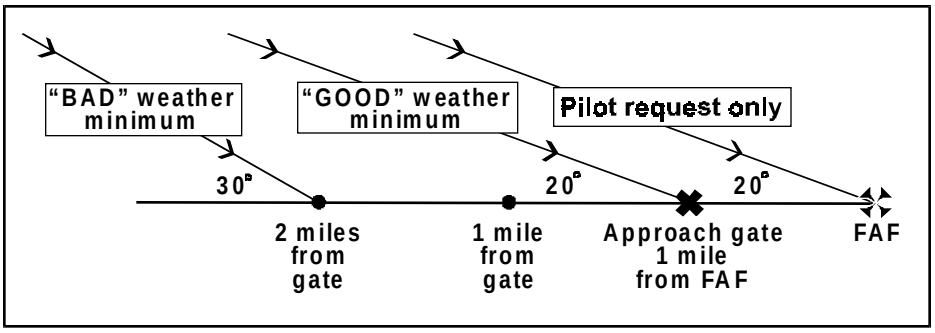

Figure 1. *This plan-view diagram shows the basic requirements that a controller must follow when vectoring an aircraft to intercept the final approach course. The final vector intercept angle is limited to 30 degrees, unless the vector is to a point on final less than two miles from the approach gate, in which case the maximum intercept angle is 20 degrees.*

to the approach gate, which almost always equates to at least three miles prior to the FAF.

By the book

The following is from the controller's handbook (Section 5-9-1) and provides guidance to a controller when vectoring aircraft to the final approach course:

"Except (for visual approaches), vector arriving aircraft to intercept the final approach course:

a. At least 2 miles outside the approach gate, unless one of the following exists:

1. When the reported ceiling is at least 500 feet above the MVA/MIA and the visibility is at least 3 miles (report may be a PIREP if no weather is reported for the airport), aircraft may be vectored to intercept the final approach course closer than 2 miles outside the approach gate but no closer than the approach gate.

2. If specifically requested by the pilot, aircraft may be vectored to intercept the final approach course inside the approach gate but no closer than the final approach fix.

b. For a precision approach, at an altitude not above the glideslope/glidepath or below the minimum glideslope intercept altitude specified on the approach procedure chart.

c. For a non-precision approach, at an altitude which will allow descent in accordance with the published procedure."

The controller's handbook also contains a table that limits the final vector intercept angle to 30 degrees, unless the vector is to a point on final less than two miles from the approach gate, in which case the maximum intercept angle is 20 degrees. The important number to remember is 30 degrees, which is the normal limit. This is why the controller can cut the corner on the intermediate segment, because he/she is (hopefully) lining you up at a lesser angle and at a more precise position than can be achieved with non-radar segments of the IAP.

Figure 1 (page 10) is a generic plan-view presentation of the requirements imposed on the controller.

Vertical profile

In addition to the horizontal limita-

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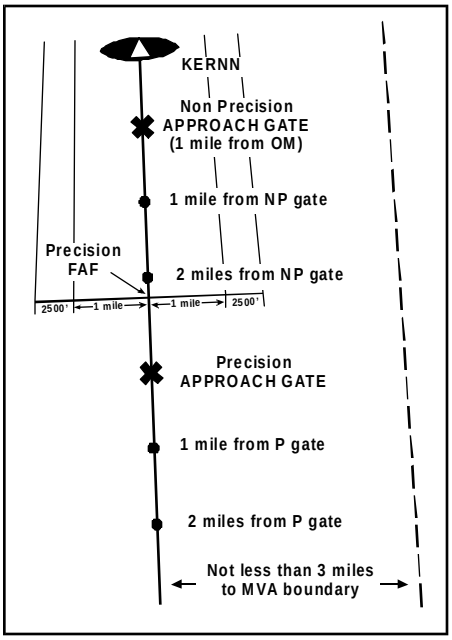

***Figure 2**. This shows the controller's vector requirements when applied to the SLC ILS RWY 34R. Note how much narrower the non-radar-protected airspace is than what the controller uses for vectoring (MVA boundary). Once you descend below the last assigned altitude, you lose the protection of the controller's radar altitude, and could lose clearance from high terrain unless you're within the narrower non-radar airspace protected for the IAP.*

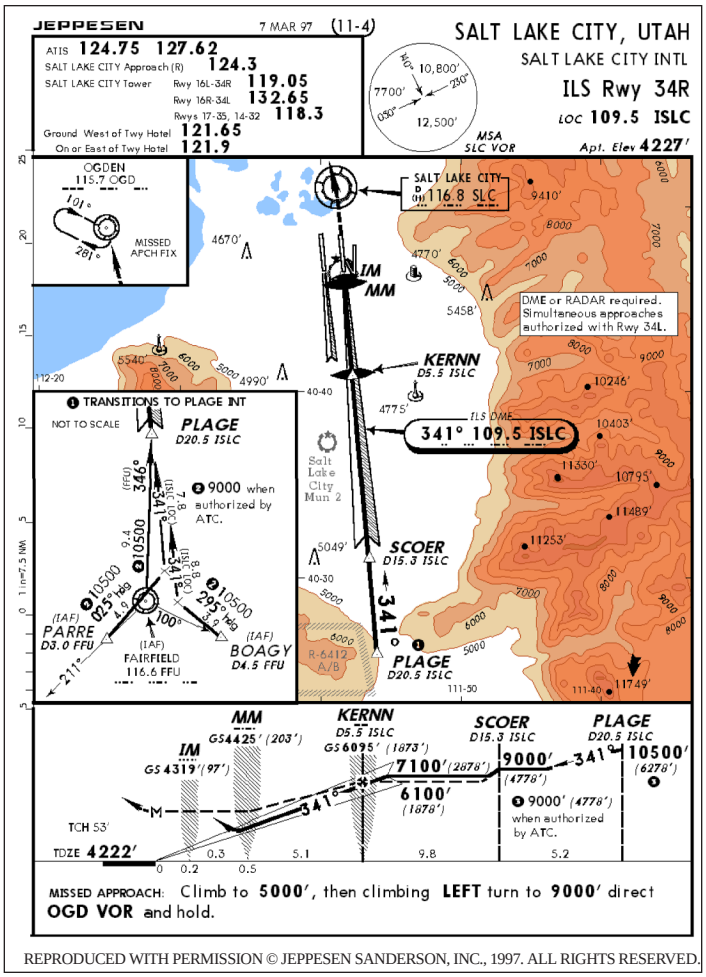

***Figure 3**. Note the intermediate altitude to the non-precision FAF is 6,100 feet, but to the precision FAF it's 7,100 feet. This is a subtle trap both controllers and pilots sometimes fall into. If you accept a vector to the ILS for this approach at less than 7,100 feet, you would be in violation of the FAR 97 IAP once the vector is terminated.*

Vectors to Final

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tions imposed on the controller, Paragraphs b. and c. quoted above impose the following vertical limitations:

Non-precision IAP: The final vector altitude must allow you to descend in accordance with the published procedure. While this guidance is somewhat imprecise, a vector at 4,000 feet to a point three miles prior to the FAF, and where the FAF crossing altitude is 2,000 feet, wouldn't be reasonable. What *should* be done by ATC (in order to apply the intent of TERPs) is to vector you at the altitude shown on the approach chart for crossing the FAF, if they turn you onto final close-in to the FAF (three miles, or less). However, if the vector turns you onto the final approach course farther out from the FAF, the controller can reasonably add 300 feet for each mile the intercept is more than three miles from the FAF.

Precision IAP: The imaginary approach gate should be fixed by ATC to be one mile prior to the precision FAF, instead of the OM or other Maltese cross FAF. At many locations, there is no practical difference between the precision FAF and the Maltese cross FAF. However, the ILS shown in Figure 3 (page 11) is a fairly common situation, where the precision FAF is several miles prior to the Maltese cross FAF (3.2 miles in the example shown). The vector to an ILS must be at an altitude not less than the glideslope intercept altitude shown on the approach chart, and at a position where the intercept with the localizer will not be above the glideslope.

The following examples cover most radar vector situations.

KSLC ILS Runway 34R

Figure 2 (page 11) is an enhanced version of Figure 1, and is tailored to the Salt Lake City (SLC) ILS RWY 34R (Figure 3, page 11). Figure 2 shows both the minimum limits of the MVA that the controller must use, as well as the protected airspace provided by the latter stages of the intermediate segment and the beginning of the final approach segment.

Note how much narrower the non-radar-protected airspace is than what the controller uses for vectoring. Once you descend below the last assigned altitude, you lose the protection of the controller's radar altitude, and could lose clearance from high terrain unless you're within the narrower non-radar airspace protected for the IAP. This gives you a clue why the FAA won't define "on-course" as anything other than a centered localizer needle. This is more critical than ever, with the advent of new, narrower ILS protected airspace criteria, shown in Figure 2.

In Figure 3, the intermediate altitude to the non-precision FAF is 6,100 feet, but to the precision FAF it's 7,100 feet. This is a subtle trap both controllers and pilots sometimes fall into. If the controller *knows* you're going to shoot the non-precision localizer approach, he/she could turn you onto final around three miles from KERNN at 6,100 feet. However, if you're being vectored for the ILS, the minimum altitude assigned must be 7,100 feet, and to a point not less than three miles from the precision FAF.

If you accept a vector to the ILS for this approach at less than 7,100 feet, you would be in violation of the FAR 97 IAP once the vector is terminated. That 7,100-foot minimum altitude is there for a reason, and is so stated on the IAP regulatory document as the minimum altitude for glideslope intercept. Whether violating this rule would

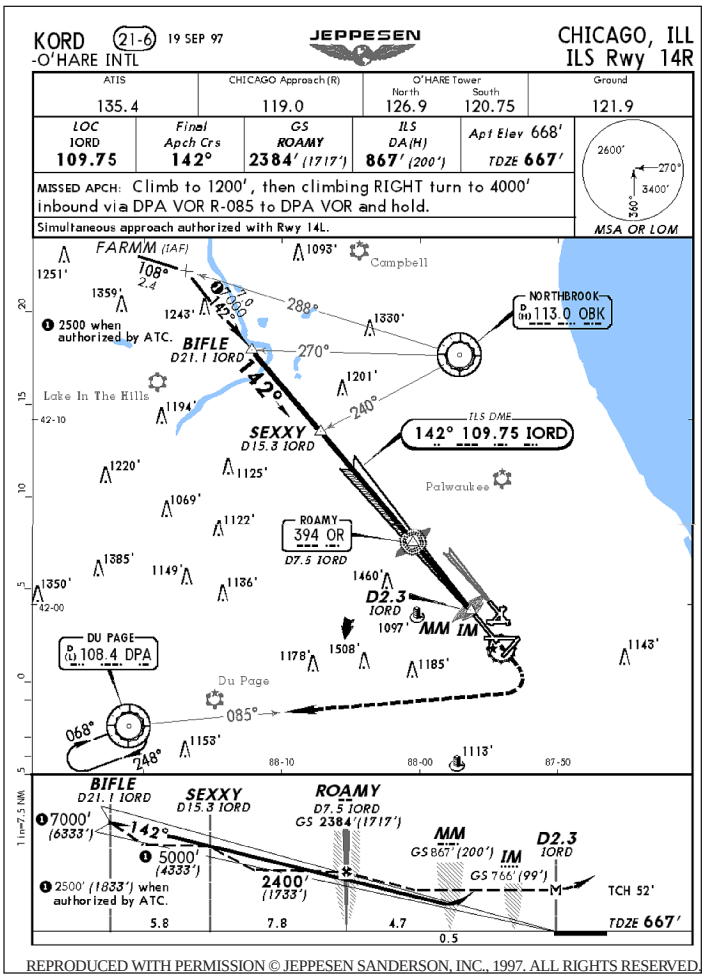

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***Figure 4**. The normal precision FAF is at the point where 7,000 feet intercepts the glideslope, but ATC is permitted to shift the precision FAF to the point where 2,500 feet intercepts the glideslope.*

ever hurt is problematic.

Sometimes controllers will vector you to a point much further out on an IAP. In Figure 3, a vector a couple miles outside PLAGE, for example, would be acceptable at 10,500 feet or at 9,000 feet because of Note 3. This far out, the altitude would be common for either a localizer or precision approach, because the location is well prior to the area where the nuances of the differences between precision and non-precision come into play.

KORD ILS Runway 14R

Refer to Figure 4 (page 12). The normal precision FAF is at the point where 7,000 feet intercepts the glideslope, but "❶" (on the profile) permits ATC to shift the precision FAF to the point where 2,500 feet intercepts the glideslope. As a result, a vector onto final at least three miles from the point where 2,500 feet intercepts the glideslope would be legal, because the 2,500-foot intercept has been "TERPs'd" and is authorized in the FAR 97 procedure. Such a note must always be present in order to have "dual" precision FAFs.

KHIE LOC Runway 10

FAR 91.175 (j) "Limitation on procedure turns," is normally triggered by vectors to final. However, in the IAP in Figure 5 (below), if the Center vectors an aircraft to intercept the Montpelier R-079 terminal route, a course reversal would be required for two reasons: the vector wasn't to the final approach course, and an NoPT authorization is not along the subsequent approach routing.

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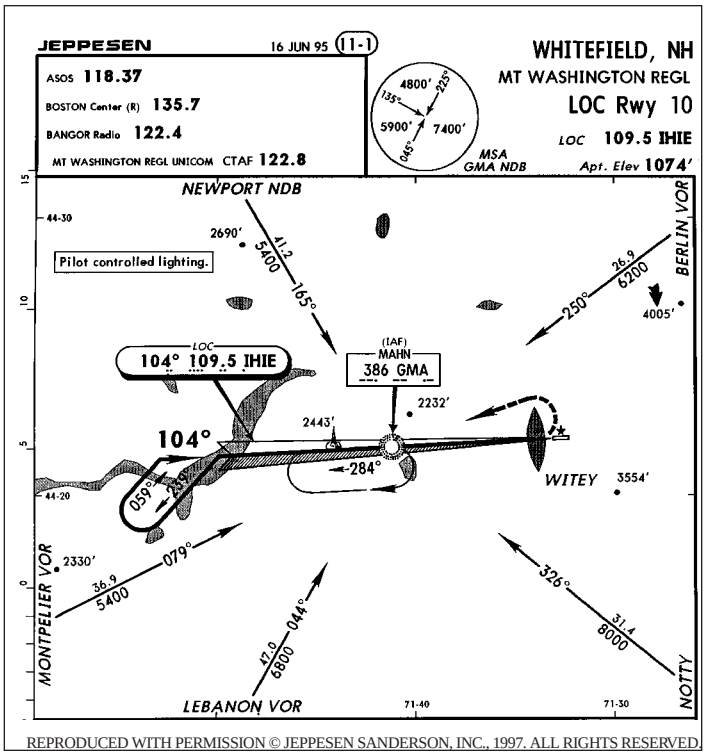

***Figure 5**. If the Center vectors you to intercept the Montpelier R-079 terminal route, a course reversal would be required because the vector wasn't to the final approach course, and an NoPT authorization is not along the subsequent approach routing.*

Vectors to Final

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KLOL VOR-C

In Figure 6 (below right), the IAP has a 31.7-mile feeder route that is exactly the final approach course. If the Center vectored you onto this route, would FAR 91.175(j) be triggered? Well, it depends, and this gets beyond the "easy understandings." If the vector is to a position more than 10 miles from LLC VOR, assume the course reversal applies, because you need to lose a lot of altitude that cannot safely be done except within 10 miles of the VOR. If, however, the controller calls 10 miles from the VOR and provides you with an altitude that will allow descent in accordance with the IAP, then you could go straight-in. If in doubt, do the course reversal, but let the controller know in advance what you'll do.

Proceed with caution

Here are some final words of caution to remember when being vectored for an approach:

- If a controller takes you across the final approach course, don't intercept it without a clearance. ATC isn't supposed to do this without advising you, but if they do, ask before turning.
- If a controller clears you for an approach before you intercept the on-course, he/she must give you an altitude to maintain until established. If he/she fails to do this, maintain the last assigned altitude until on-course (FAR 91.175(i)).
- When the winds aloft are strong, be prepared for some oddball problems. For all you know, the controller could have just come on-duty, and has yet to compensate for the winds.
- Center vectors to final are suspect at unfamiliar locations. Center radar is fair to poor, compared to approach control radar. Be aggressively safe when receiving such vectors.
- When clearing you for an approach, the controller must state your position relative to either the FAF, or earlier approach chart fix if vectored onto the approach further out, or the primary navaid if there is no fix on the approach (i.e., on-airport VOR/NDB).
- You can be turned onto the final approach course closer than 3 miles from the FAF if you request it, or if the weather reports indicate you should be in VMC prior to the FAF.
- Where an approach (VOR, NDB, GPS, or RNAV) has a course change at the FAF, a vector to the intermediate segment is considered to be a vector to the "final approach course" for purposes of FAR 91.175(j).
- Direct clearances to fixes or nav facilities within an IAP are *not* the equivalent of a radar vector to the final approach course. If ATC clears you direct to a point on an IAP where "NoPT" would not otherwise be appropriate, and then the controller clears you for a straight-in approach, it's your responsibility to reject such an inappropriate clearance. If not, it's you who will violate the FAR, not the controller. This type of incorrect handing is most likely to occur where a VOR or NDB facility is both the FAF and course reversal IAF. It could also occur by being cleared to a GPS waypoint that isn't an "NoPT" IAF.

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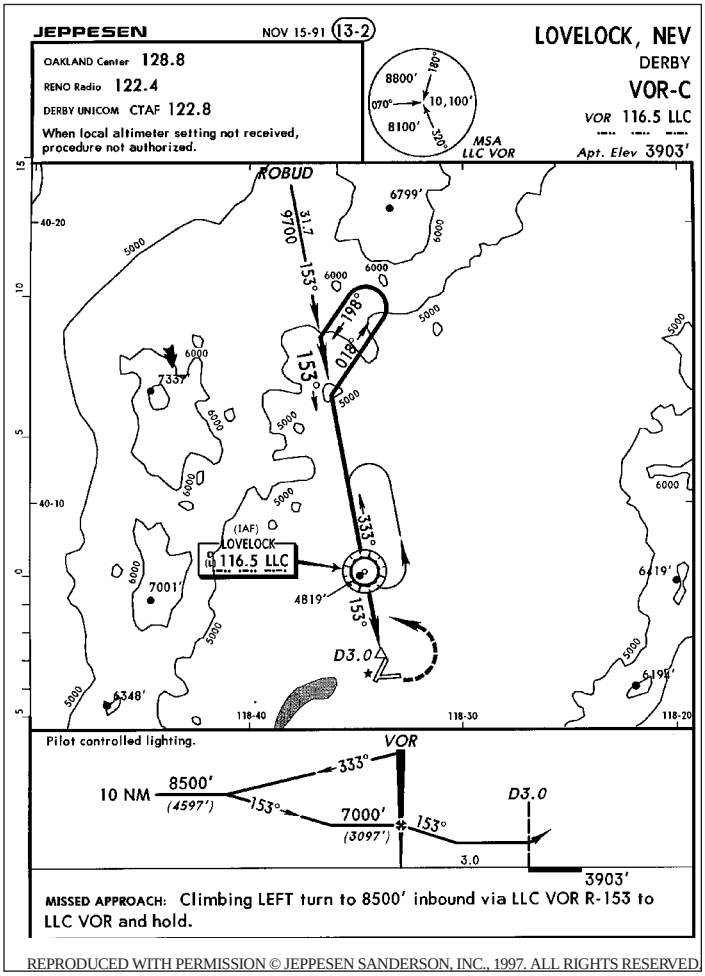

***Figure 6**. This IAP has a 31.7-mile feeder route that is exactly the final approach course. If ATC calls 10 miles from the VOR and provides you with an altitude that will allow descent in accordance with the IAP, then you could go straight-in.*