Vectors To Hector

You'd better understand the different capabilities of center and approach radar when getting vectored.

By Wally Roberts

THERE ARE DAYS WHEN there's hardly a thunderstorm between the East and West Coasts of the U.S., except for perhaps a few nests of the ugly things way down in the South. On days like these, when a Los Angeles-based airline crew of yesteryear was on that last leg after a four-day trip, it was time to get home! So, on level off in the flight levels after launch from some faraway place like JFK, BOS, PHL, ORD or IAD, it was common to ask the center for "vectors to Hector."

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I don't recall whether a center controller from Chicago or points east ever granted such a request, but it was fun to ask. Everyone involved with high-altitude jet operations knows Hector VOR (located approximately 110 nm northeast of LAX in the desert is a major fix for LAX arrivals from the east. Besides, "vectors to Hector" is about the limit of poetic talent for most airline pilots.

This request, although usually denied in particular, would often result in a vector to some jet route fix several hundred miles down route. These so-called vectors were nothing more than an educated aim based on the collective experience of seasoned pilots and controllers. However, they saved the crew from the "arduous" task of tracking VOR radials for the next hour or so. Plus, the passengers are always happier when the wings remain perfectly level during cocktails and dinner. With the advent of advanced rnav airliners, long-range vectors have been replaced with requests to go direct to Hector or some other far-ahead waypoint—so much for pilot poetry.

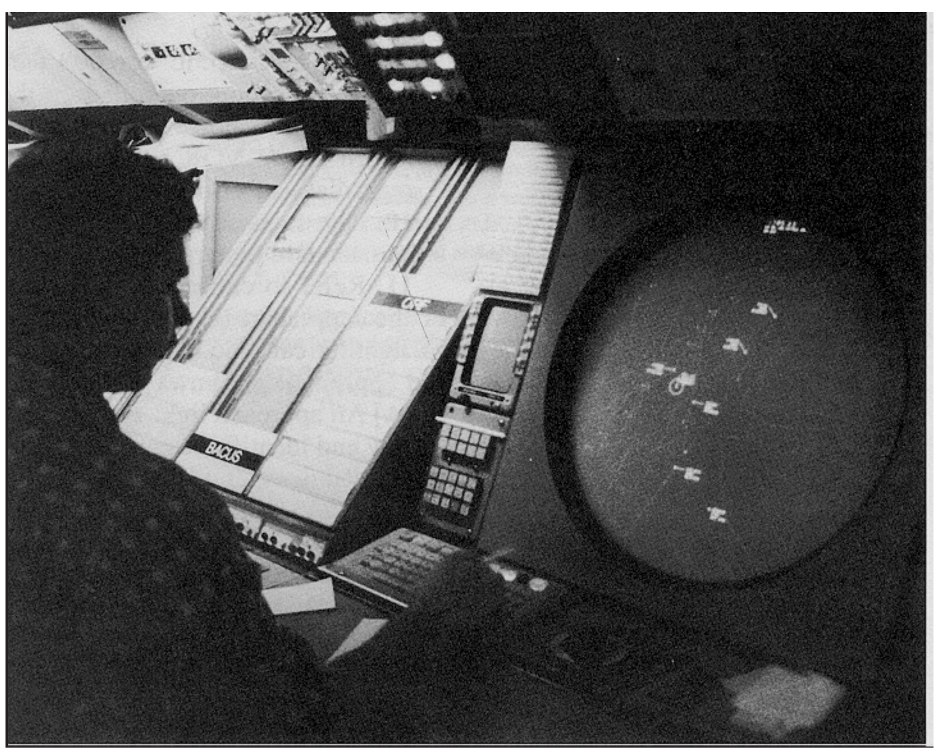
Differences in radar systems

It's important to understand that center and approach control vectors have differing capabilities and limitations. The antenna for an approach control radar system is typically located on or fairly near the primary airport served by the particular approach control facility. The antenna rotates faster than a center's radar antenna, but the approach control radar is only workable out to somewhere around 50 miles.

Center radar, however, is a mosaic of 3-15 long-range radar systems, each of which reaches out over 200 miles. Some centers also have the ability to display a major airport's approach control radar, but that is an exception to the general nature of center radar.

Approach control radar is updated more frequently than center radar, which means the approach controller can fine tune vectors better than a center controller. Also, the typical approach control vector is almost always within 40 miles of the radar antenna, whereas the center vector is beyond 40 miles most of the time.

This 40-mile limit is important, because it changes the separation standard that the controller must use. Within 40 miles of the antenna of an approach control radar, the minimum



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separation standard between IFR aircraft that aren't separated by altitude is three miles. Beyond 40 miles it's five miles. Except where special facility conditions exist, the minimum separation standard for center mosaic radar is five miles at all times (10 miles for those of you who fly above FL 600!).

Primary vs. secondary returns

Primary radar returns are what radar is about in its fundamental sense. The ATC radar sends out a lot of energy, and a small amount bounces off your airplane back to the ATC radar antenna. The smaller your airplane, and/or the further the distance to the radar site, the weaker the primary return is. Plus, the controller has no way of knowing which airplane is which, except by the process of elimination. Before the advent of civilian transponders, more than one misidentified airplane ended up in the side of a mountain. Primary radar is also known by the old timers as "skin-paint."

Secondary radar is what ATC *primarily* uses, and has used for more than 35 years. Secondary radar is the result of an active interrogation process between your transponder and a relatively small antenna mounted on top of the big, primary radar antenna. Not only does the transponder provide a virtually infallible (when used correctly) method of aircraft identification, it is far less degraded by distance or weather interference, and aircraft size is irrelevant to the quality of the target returned to ATC. This secondary/transponder system is also known as the "radar beacon" system.

WWII invention

In the early days, transponders didn't report altitude and they only had 64 codes. Nonetheless, the capability the early radar beacon system had was an immeasurable improvement over primary radar. (The radar beacon system was developed during World War II for identification of friends vs. foes, known early on as "IFF.")

Video maps

The ATC radar display has a wealth of information about airways, selected intersections/waypoints, airspace boundaries, and final approach courses of IAPs. There is so much information that it all cannot be displayed at once, so the controller has several select options. This video map information is a prerequisite for most radar vectoring services that controllers provide. Further, the controller can move the center of the radar display to any location covered by the radar, and he/she can home in on that location by reducing the covered range at this offset position. The further from the antenna all this occurs, the less accurate the display.

For a pilot, all the phrase "radar contact" means is that non-radar en route position reporting isn't required, and there is the potential that radar services such as a radar monitor or radar vector can be provided.

MVA vs. MIA

Minimum vectoring altitude (MVA) is an approach control term. The MVA assures at least 1,000 feet of vertical clearance over the highest obstacle that is less than three miles laterally (five miles beyond 40 miles from the radar site). The MVA also assures adequate radar and communications coverage.

Minimum instrument altitude (MIA) is the center rough equivalent of MVA, except the required vertical clearance becomes 2,000 feet in mountainous areas, and at least five miles of lateral clearance is required where vertical clearance isn't provided. The MIA need not provide either radar coverage or communications. In theory, a center controller could clear a non-radar identified aircraft off-route using the center's MIA chart. This requires a lot of attention and care on the part of the controller and could easily be misapplied, especially around high terrain. Most of the time, center MIAs are used more or less like approach control MVAs—with one exception: the center tends to use MIAs more for monitoring the off-route progress of a "direct-to" flight rather than actively provide vectors.

"Radar contact"

Before ATC can provide any type of radar service, the controller must have you in radar contact. For a pilot, all the phrase "radar contact" means is that non-radar en route position reporting isn't required, and there is the potential that radar services such as a radar monitor or radar vector can be provided. After radar contact is assured, a vector is not provided until and if the controller provides an assigned heading, and he/she should state the purpose of the vector. An initial vector often won't provide the direction to turn if a small turn is required. This is because the controller might not know your exact present heading and doesn't want to trigger a traffic-clogging big turn the long way around.

Types of radar vectors

What are the general classifications of radar vectors? The vector to Hector from far away is known as a center long-range vector. Such vectors are provided for the convenience of the flight crew, usually when the high-level weather is good and center airspace isn't saturated. From a controller's standpoint, such a long-range vector has little actual utility as a traffic management and separation tool. The following list is mine, but I'm sure most ATC types

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Vectors…

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wouldn't quibble with my classifications:

- Short-range vectors to the final approach course of an IAP.
- Delay vectors for traffic management and separation purposes.
- "Re-route" vectors to shortcut a segment of an airway or STAR.
- Shortcut vector to an early segment of an IAP where vector-to-final service isn't available.
- Weather avoidance vectors.

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- Departure vectors during climb to the MVA.
- Departure vectors above the MVA or MIA.
- Center long-range vector.

The above list is self-explanatory, but keep the following in mind:

Vectors to final: These always negate any published course reversal. The vector is supposed to be below the glideslope during an ILS and at an altitude compatible with the IAP during a non-precision IAP. The turn onto final should ideally be at a 20-30 degree angle, and at a position at least 1-2 miles prior to the FAF (unless you request a turn on at the FAF). Never intercept the final without being told to do so by the controller. If he/she plans to take you through the final, you should be so advised. If the controller doesn't, however, don't intercept. Maintain present heading and ask for clarification when time and communication permits.

Approach control should be able to provide "snappy" vectors to final all the time, but it varies with traffic saturation and controller proficiency. If you can handle the occasional slam-dunk, take it so long as it's safe to do so. Otherwise, you might end up number 20 in line again.

We supposedly have a first come/first served system, but the controller is obligated to keep the gaps at a minimum when there's a lot of traffic. When this occurs, don't gripe about your "rights" unless you feel the handling is unsafe. It's always better to argue on the ground in person or over the phone. In fact, unless something really unsafe happened, it's usually better to accept it all as part of the thrill of flying.

Shortcut vector to early IAP segment: This type of vector is typically done by the center or distant approach control in areas of limited radar coverage. Such a vector does not trigger the NoPT provisions of FAR 91.175(j). Unless the segment being intercepted or a subsequent segment meets non-vectored NoPT requirements, any required course reversal downstream of the early-segment vector still applies. In such cases, communicate your intentions, as such subtle nuances sometimes escape controllers.

Weather avoidance vectors: ATC radar was designed to separate airplanes from each other. Weather avoidance is solely the pilot's responsibility. With that in mind, ATC will help you avoid the big boomers when possible, but it isn't part of their primary job description (that's keeping IFR aircraft apart, right?!), and their radar is crude for weather at best.

Departure vectors below MVA: ATC can vector you below the MVA only when you're on an IFR departure or missed approach. Where it's flat, this is no big deal. Nearby mountains, however, can present a challenge for both pilot and controller. This is an area where the pilot must exercise the utmost in caution and all error should be on the conservative side. (See "Vectors Below the Hilltops," November 1995, *IFRR* for an in-depth look at vectors below the MVA.) ATC can also vector VFR aircraft below the MVA, but that's beyond the world of IFR operations.

Radar fixes on IAPs

It's tempting to ask ATC to call a fix on an IAP that might not otherwise be available. In fact, it's done quite a bit and often it's done when it shouldn't be. Center radar is marginally adequate for vectors to final (and not even that at some locations), but it's simply not good enough to call out step-down fixes along the intermediate or final segments of an IAP. Approach control radar is often up to the task, but only if the fix is on the controller's video map, has been flight inspected, *and* the fix is annotated "radar fix" on your approach chart.

There is one gray area, however: the FAF on an ILS. The current practice is to permit ATC to call the ILS FAF without it being on the approach chart as "radar fix," because all ILS FAFs are marked on the video map and flight inspected where approach control radar covers the ILS final approach course. Some pilots believe the note "Radar Required" on an approach chart implies radar fix authority for step-down fixes. Not so. "Radar Required" means either the IAP has no feeder or initial segment tie to the en route structure or the IAP is located in such extremely busy airspace that ATC won't authorize the approach unless they can at least radar monitor you along the approach.

Approach control radar coverage is often quite limited for secondary airports served by the approach control facility. Be alert to this and don't expect radar services as complete as those provided at the primary airport. There is no certain way for the pilot to know the limitations of terminal radar coverage at secondary airports except through experience. The "R" symbol on Jeppesen charts has no defined meaning as to the adequacy of radar coverage.

Center radar limitations

Where a center provides approach control-like radar services

(CENRAP), operate on the premise that vectors to final will be loose and sometimes downright inadequate. Be prepared to refuse a second pass at such services if there's a problem. Sometimes, it's simply safer to fly the full approach.

Other problem areas

Most of us have had the frustrating experience of a controller center) chomping at the bit about us not being on the airway centerline. Often, this will be accompanied by, "Turn left (or right) to rejoin the airway." Your first duty, of course, is to ensure you have the OBS set properly and you're correctly observing the regulatory change-over point. If all is in order, it's up to you to not turn away from what is a centered airway on your CDI. If you know you're right on, advise center that you indicate on-centerline. If the controller persists, politely advise you'll need a vector if ATC cannot accept your present track.

ATC procedures *previously* required controllers to issue a lost-com escape procedure when vectors would take you towards higher terrain. This requirement was deleted, not because it didn't enhance safety, rather because it overloaded communications. This is a real weak point in the system, and one yet to cause its future toll of human life.

It's your responsibility to know where the higher terrain is. This is a sore point with the FAA, because it represents a form of the ultimate conflict between the FAA's duty for safety and its mission to move traffic. Keep in mind the words in the AIM about vectors, especially No. 2 under pilot responsibilities:

"5-5-6. RADAR VECTORS

a. Pilot:

1. Promptly complies with headings and altitudes assigned to you by the controller;

2. Questions any assigned heading or altitude believed to be incorrect;

3. If operating VFR and compliance with any radar vector or altitude would cause a violation of any FAR, advises ATC and obtains a revised clearance or instructions.

b. Controller:

1. Vectors aircraft in Class A, Class B, Class C, Class D and Class E airspace:

(a) For separation;

(b) For noise abatement;

(c) To obtain an operational advantage for the pilot or controller.

2. Vectors aircraft in Class A, Class B, Class C, Class D, Class E and Class G airspace when requested by the pilot.

3. Vectors IFR aircraft at or above minimum vectoring altitudes.

4. May vector VFR aircraft, not at an ATC assigned altitude, at any altitude. In these cases, terrain separation is the pilot's responsibility."

Understand the limits

We're extremely fortunate in the U.S. to have a radar system that works well most of the time, due to the cooperative efforts of both controllers and pilots. You need to understand the system well enough, however, to understand when you're asking ATC for something the system wasn't designed or intended to provide.

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