PREDICTING BAD GPS

Never bother with RAIM or FDE? If you fly with a GPS in your panel, here's why you should care.

by John Ewing

GPS usually is more accurate than those old VORs, but real-world limitations lurk behind the pretty colors on the moving map. To fully appreciate when and why your GPS might not know where you are, you'll need a conceptual understanding of Receiver Autonomous Integrity Monitoring (RAIM) / Fault Detection and Exclusion (FDE).

Non-WAAS GPS units calculate their level of positional integrity. Using several sets of satellites, the GPS computes multiple navigational solutions and compares the results. If the results differ by more than what's allowed for the current phase of flight (en route, terminal, or approach), the receiver displays a RAIM-failure message. RAIM is an ongoing process to verify the integrity of the GPS position and shouldn't be confused with RAIM prediction.

Looking Ahead

RAIM prediction is a feature used by non-WAAS GPS receivers to forecast if enough satellites should be in view above the horizon at a particular location, at a particular date and time. But it is simply a forecast. Buried in the AIM (1-1-19-f(b)7 and 1-1-19-j) are recommendations to perform a RAIM prediction. Also, AC 90-100A (U.S. Terminal and En Route Area Navigation (RNAV) Operations) says that if you're planning to use a non-WAAS (TSO-C129) GPS for your navigation, you must do a RAIM check. Users of WAAS (TSO-C145/146) units need only check if there is an indication that WAAS coverage won't be available.

To do a RAIM calculation on a Garmin GNS 400- or 500-series GPS, scroll with the big knob on the lower right to the AUX pages, scroll with the small knob until you see the page with RAIM, enter cursor mode by pressing the small knob, scroll down to RAIM, and press ENTER. Now you can select the position and time (or use the present position and current time) and then press Enter to do a RAIM calculation.

They don't make it easy, do they? No wonder most pilots skip the RAIM prediction altogether. On the G1000, RAIM is in the system pages. With the Garmin GNS 480 and older Apollo GX-series navigators, it's usually a button push or knob twist off the Navigation page.

WAAS and FDE

A WAAS-enabled GPS receiver performs ongoing integrity monitoring, and if it discovers an inconsistency in a navigation solution, it allows six seconds to determine a correction. If the GPS receiver cannot correct the problem within six seconds, it will notify you that the position being reporting is unreliable.

Since WAAS provides the reliable accuracy required for vertical guidance (LPV and LNAV/VNAV approaches), you should check for WAAS NOTAMs like this one for Napa County, Calif., (KAPC):

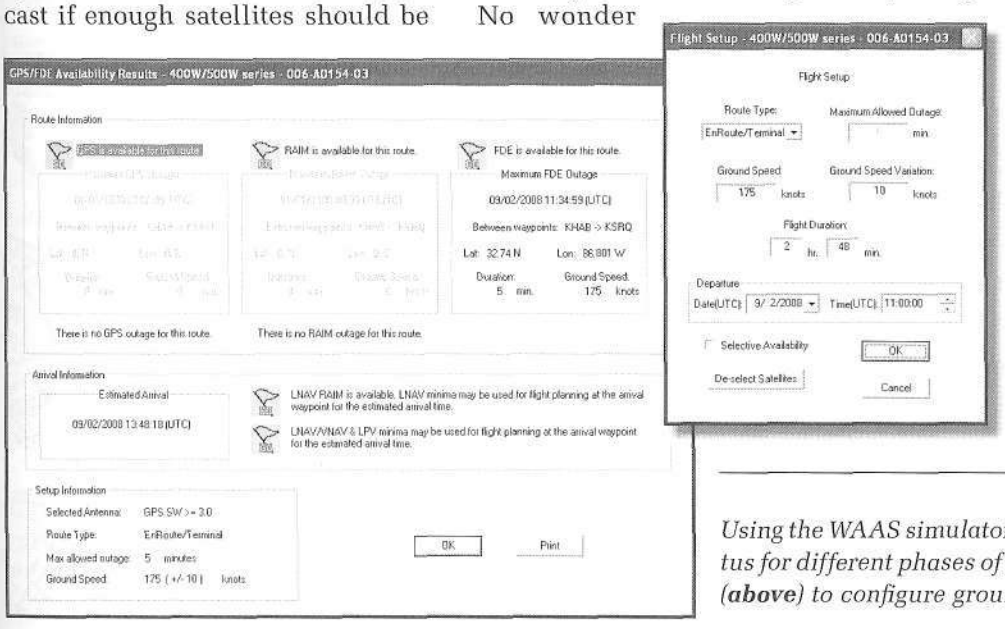
APC 07/034 APC WAAS LNAV/VNAV AND LPV MNM UNREL WEF 0607180554-0607180609

WAAS Unreliable NOTAM service should be available for all airports with LPV, LNAV/VNAV and LNAV approaches. There can also be NOTAMs that WAAS will be unavailable.

If WAAS availability is a potential problem, you can check it out with Garmin's 530/430 trainer (free download). It contains an FDE application that can predict GPS course integrity for specific flights.

To use the Trainer's FDE prediction application, enter a flight plan into the unit and load (but do not activate) the approach. Then launch the FDE program from the options menu. You may get a series of dialogs about downloading data. OK your way through these. (Note: you must have a live internet connection to make this work).

With data loaded, you'll see



*Using the WAAS simulator FDE program, you can see GPS status for different phases of your flight (**left**). Use the setup page (**above**) to configure ground speed and a wind allowance..*

an option that lets you to select the GPS antenna installed in your aircraft. If you don't know what model is installed, use the default A-33 model. Specify your departure date and time and then click the Setup button to specify your estimated ground speed and the type of route.

Click on OK and then click Calculate. The program shows GPS, RAIM and FDE status for your trip, and which RNAV approach minima you can use for planning purposes. Just like a RAIM prediction, this isn't a guarantee of what will (or won'tbe available when you actually arrive.

If you're out at some FBO and just need RAIM prediction for the next 24 hours, try raimprediction.net. If you do use the web site, don't assume a red area means no GPS approaches. The predicted outage must be at least five minutes long. Read the instructions for using the site.

By the Book

The Garmin 530W Pilot Guide and Reference has this to say about FDE: "Prior to navigation on U.S. RNAV routes, SIDs, and STARs (reference AC 91-100) all operation of Garmin WAAS-certified units must utilize the WFDE Prediction Program to determine RAIM availability ... All operators of Garmin WAAS-certified units should utilize the WFDE Prediction Program ... when planning an LNAV/VNAV or LPV approach."

Note that the "must" is only for SIDs, STARs, and Q- or T-routes. We also don't see an FAA mandate for this, so our read is that you only need to check using FDE or raimprediction.net if you see a WAAS unreliable NOTAM—or you're using a non-WAAS GPS.

The moral of the story is that GPS isn't bulletproof. Pilots should check the NOTAMS and do RAIM prediction or run the FDE application if appropriate. And always be ready with Plan B.

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WAAS CAN'T REALLY GO AWOL, CAN IT?

Actually, it can and it has. These images are from a period of solar storms in October of 2003. What you see is the vertical protection level (VPL) mapped out for much of North America.

It's hard to reproduce the charts well in black and white, but overall black is good. You can see a key at the bottom of the page. A VPL of 50 meters or less is required for LPV approaches. The LPV coverage area is shown by a white line cruising around the generally black area. LNAV/VNAV coverage generally follows the same line.

In the top image, from Oct. 24, 2003, at 12:06 p.m., the continental U.S. has LPV-level VPL. Just 30 minutes later (middle image), southern California, half of Arizona, most of New Mexico and half of Texas can't sustain LPV. Anyone beginning an approach in these areas would get a message from their GPS navigators telling them LPV wasn't available.

In the lower image, a much more severe solar storm five days later took down WAAS LPV and LNAV/VNAV for the entire country. The outage lasted for six hours. Few folks noticed back then, as WAAS equipment wasn't as common.

Events like this are rare, but they do happen. Even so, lateral navigation and LNAV approaches would still have been flyable. We've been in a low-solar-activity period for the past couple years, but things should heat back up soon. FDE wouldn't predict an outage like this, so the moral is to be ready for Plan B at all times, even with GPS.

—Jeff Van West