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Receiver Autonomous Integrity Monitoring (RAIM)



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What is RAIM?

- RAIM (Receiver Autonomous Integrity Monitoring) is a technology that enables GPS receivers to assess the integrity of satellite signals. It ensures the reliability of GPS-based navigation by detecting and alerting pilots to any anomalies in the satellite signals.
- RAIM is essential for ensuring safe and accurate aircraft operations, especially during critical phases of flight.

How RAIM Works

- RAIM functions by comparing multiple satellite signals to detect inconsistencies. A minimum of five satellites is required for fault detection, and six for fault detection and exclusion.
- The system performs consistency checks between position solutions obtained from different subsets of satellites. If discrepancies are found, RAIM alerts the pilot to potential navigation errors.

Fault Detection (FD)

- Fault Detection is a process within RAIM that identifies the presence of faulty satellite signals. By analyzing the consistency of satellite measurements, the system can detect anomalies that may affect navigation accuracy.
- Upon detection, RAIM alerts the pilot, prompting them to take appropriate action.

Fault Detection and Exclusion (FDE)

- FDE extends the capabilities of FD by not only detecting faulty signals but also excluding them from the navigation solution. This requires at least six satellites to isolate and remove the erroneous data, allowing the system to continue providing accurate navigation information.

Pilot Pre-Flight Procedures

- Pilots should perform predictive RAIM checks during pre-flight planning to ensure GPS integrity throughout the flight. Tools like AUGUR can be used to assess RAIM availability for specific routes and times.
- If predicted RAIM outages are identified, pilots must plan alternative navigation strategies.

5-Minute RAIM Outage Rule

- During an approach, if a RAIM failure occurs after the Final Approach Waypoint (FAWP), the system may continue operating without an alert for up to 5 minutes to allow completion of the approach.
- However, if the RAIM alert appears after the FAWP, the pilot must execute a missed approach immediately.

Pilot Actions During RAIM Outage

- In the event of a RAIM outage:
 - - Before flight: Delay, reroute, or choose alternative navigation methods if RAIM is predicted to be unavailable.
 - - In-flight: Monitor RAIM status and be prepared to execute contingency procedures.
 - - During approach: If RAIM alert occurs after FAWP, execute a missed approach immediately.

State Publications in AIP, AIC, and Advisory Circulars

- States should publish RAIM-related information in the following documents:
 - - Aeronautical Information Publication (AIP): Include RAIM availability, procedures, and requirements.
 - - Aeronautical Information Circular (AIC): Provide updates on RAIM procedures and any temporary changes.
 - - Advisory Circulars: Offer guidance on RAIM usage, pilot responsibilities, and best practices.

Conclusion

- RAIM is a critical component in ensuring the integrity of GPS-based navigation systems. Understanding its functions, including FD and FDE, is essential for flight safety.
- Pilots must be proactive in performing RAIM checks and be prepared to take appropriate actions during outages. States play a vital role in disseminating RAIM information through official publications.
- Advance RAIM

ARAIM Benefits Roadmap

- ARAIM likely to be only future GNSS Augmentation with redundant modes (single frequency or single constellation)
- Incremental Development
 - Current H-ARAIM, Service Type A with default ISM supports performance data collection to build up to:
 - V-ARAIM, Service Type B, enabler for AR37-11 globally

	GPS	GPS + GNSS 2	GPS + GNSS 2 + GNSS 3
Single frequency L1	Good coverage of RNP0.3 with RAIM	Robust worldwide coverage of RNP0.1 with ARAIM	Robust worldwide coverage of RNP0.1 with ARAIM
Dual frequency L1+L5	Good coverage of RNP0.1 with RAIM	Worldwide coverage of LPV 200 with ARAIM	Robust Worldwide coverage of LPV 200 with ARAIM

Note: RNP 0.1 is not a currently defined PBN Navigation Specification per Doc 9613, PBN Manual

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Action by Meeting

The meeting is invited to:

1. note the information presented; and take action, as appropriate.

Thank You

