



International Civil Aviation Organization

**THE TWELFTH MEETING OF PERFORMANCE BASED NAVIGATION
IMPLEMENTATION COORDINATION GROUP (PBNICG/12)**

Beijing, China, 16-18 December 2025

Agenda Item 6: RAIM understanding and implementation

RAIM IMPLEMENTATION IN AUSTRALIA
(Presented by Australia)

SUMMARY

This paper presents a brief overview of Australia's activities related to:
RAIM implementation, including the decision to remove RAIM
availability prediction indications from the current and future air traffic
management systems.

1. INTRODUCTION

1.1 This paper presents a brief overview of Australia's activities related to RAIM implementation, including the decision to remove RAIM availability prediction indications from the current and future air traffic management (ATM) systems.

2. DISCUSSION

Background

2.1 Automatic Dependent Surveillance – Broadcast (ADS-B) is an aircraft system that automatically broadcasts precise Global Navigation Satellite System (GNSS) position information via a digital data link. Receiver Autonomous Integrity Monitoring (RAIM) provides an integrity check for the aircraft's GNSS position information. From an air traffic management perspective, RAIM indicates the integrity of GNSS data which may be used by air traffic control (ATC) to apply:

- ADS-B based surveillance separation, and
- GNSS based procedural separation in the longitudinal and lateral dimensions.

2.2 When RAIM is lost, the position information is no longer subject to monitoring, and the accuracy of the information can degrade over time. The pilot should change to an alternative means of navigation when RAIM is lost for more than five (5) minutes and report this to ATC.

2.3 According to Australian Manual of Air Traffic Services (MATS), on receipt of a pilot report that 'GNSS UNAVAILABLE' (e.g. loss of RAIM or RAIM alert) ATC may not apply separation based upon GNSS reports, nor use ADS-B as basis for surveillance separation application.

Original approval of use of ADS-B by ATC for separation - including RAIM prediction

2.4 ADS-B separation was approved for ATC use in 2005, at that time, GNSS RAIM outage prediction display to ATC was added to the air traffic management system (Thales Eurocat). This provided controllers with graphical and textual information on areas where GPS satellite availability and geometry *may* be such that highly accurate aircraft position information (suitable for five (5) nautical mile separation services) could not be guaranteed. The predicted RAIM outage was displayed to controllers on the Eurocat Human Machine Interface (HMI), as generated by a RAIM Prediction Processor on receipt of a RAIM outage message.

2.5 When controllers received a predicted RAIM outage, the Australian Manual of Air Traffic Services (MATS) required ATCs to cease applying surveillance separation standards between aircraft using ADS-B only within the outage area. This MATS requirement applied when a RAIM event was *predicted*, not just when a RAIM event was *reported* by the pilot.

2.6 A safety case was completed in 2005 that led to this requirement. It should be noted that RAIM outage prediction in the enroute context is not required under Australian Civil Aviation Safety Regulations (CASR) Part 172.

2.7 Since ADS-B for ATM was introduced to Australia in 2005 the launch of additional satellites has resulted in increased redundancy to the minimum 24 required to triangulate a 4D position across the surface of the earth. This means that it has become significantly less likely that an aircraft won't have line-of-sight visibility to enough serviceable satellites to support its ability to perform RAIM.

Removal of ATC RAIM prediction separation requirement

2.8 Australia is currently in the process of developing/transitioning to a new air traffic management system – Civil Military Air Traffic System (CMATS). The original requirements for CMATS did not include RAIM prediction display requirements. During a systems requirement review the ATC project operations team made an assessment that a RAIM prediction display would not be required in either the current or new air traffic management systems.

2.9 In 2023 a safety case was produced to remove:

- input of RAIM availability predictions information to Eurocat (the current ATM system); and
- the requirement for air traffic controllers to apply alternative separation standards in an area of ADS-B only surveillance (no secondary radar surveillance – low density enroute) where RAIM outage is predicted.

2.10 The safety case also noted that the areas identified within Australia as 'high density airspace' – i.e. all Terminal Approach Areas (TMA) centred on state capital cities (Brisbane, Sydney, Melbourne, Canberra, Adelaide, Perth and Darwin) and associated surrounding enroute airspace is covered by Mode C and/or S secondary surveillance radars, as such loss of RAIM (predicted or actual) has a negligible effect on ATC separation.

2.11 The original 2005 ADS-B safety case that resulted in the requirement for RAIM prediction display was re-analysed in lieu of almost two decades of operational experience. In the years since the 2005 safety case, the availability of a GNSS service for aircraft position determination has proved sufficiently reliable that the International Civil Aviation Organisation (ICAO) performance-based navigation (PBN) framework has been adopted to modernise Australia's airspace system and deliver improvements in safety and operational efficiency. GNSS and other self-contained systems in aircraft support PBN in Australia, with GNSS now adopted as the primary navigation strategy.

2.12 Predictions of the health of the GPS constellation—in relation to its ability to support aircraft RAIM to ensure their positions are calculated with sufficient integrity for ATM— can be provided to Eurocat by the GPSRAIM system. Approximately 18 months' worth of these predictions were recorded over 2018–2021 for the purposes of re-examining the operational imperative of this augmentation to the use of ADS-B for ATC; specifically, to determine whether RAIM prediction needed to be sustained with the introduction of CMATS.

2.13 During the 18-month recorded period, there were 14 predicted RAIM outage events, 7 of which contained cells through which aircraft actually flew - the times and locations of the predicted RAIM outages coincided with low traffic density periods in those areas. The ADS-B data received from those (relatively) small number of affected flights as they passed through the predicted RAIM outages revealed no degradations in the reported accuracy of the aircraft position that would have resulted in the position not being able to be used for surveillance separation, nor a loss of the track entirely.

2.14 The hazards identified in the 2005 safety case for which RAIM outage prediction display to ATC was listed as a control, were also re-examined via hazard identification workshops, attended by operational and technical subject matter experts. The major hazard identified was associated with the risk of collision in the event of sudden (unpredicted) loss of RAIM (and therefore ADS-B identification) on an aircraft while it was subject to ATS surveillance system (5NM) separation. Combined with the fact that such a loss of RAIM would only have an effect in Australian low density enroute airspace (i.e. away from capital city airports) and that the RAIM prediction data analysis indicated that actual loss ADS-B surveillance in a RAIM predicted outage cell was so rare, using the 'Barrier model' it was determined that other existing risk controls were sufficient to continue to maintain an 'As Low As Reasonably Practical' risk rating.

2.15 The existing risk controls, that would continue to be required post removal of RAIM prediction, included:

- Australian MATS requirement for ATC to apply procedural separation standards on loss of surveillance for any reason (whether associated with a RAIM outage or not);
- ATC ongoing training, checking and standardisation requirements – ensuring that ATC existing procedural separation skillset is maintained;
- GPS RAIM forecast continuing to be available to pilots and ATC via the Australian pre-flight briefing service;
- Publication of a Notice-to-Airmen (NOTAM) if GPS RAIM forecast is unavailable;
- ATM system HMI change to aircraft track symbols to indicate ADS-B track below required figure of merit;
- ATM system HMI change to aircraft track symbols to indicate loss of ADS-B all together - and therefore the requirement for procedural separation; and
- Pilot requirement to report loss of RAIM as per Australian Aeronautical Information Publication (AIP) and a corresponding MATS requirement for ATC to discontinue reliance on GNSS/ADS-B data for that aircraft.

2.16 The safety analysis also identified one safety benefit associated with removal of RAIM prediction display – this being reduction in ATC workload to *unnecessarily* establish alternative separation standards.

2.17 On approval of the safety case, in November 2023 (to coincide with a major AIRAC date) the following changes were made to the air traffic management system (in conjunction with training and document notification requirements):

- RAIM prediction data display was removed from Eurocat
- Australian MATS, and local ATC procedures, were amended to remove the requirement for ATC to apply alternative separation standards in RAIM prediction areas.

Post Implementation Review

2.18 In March 2024 a post implementation review was conducted. The ATM Standards team (responsible for checking, training and document review) reported that the required procedure changes were implemented successfully.

2.19 Several individual ADS-B equipment failures occurred during the review period, they were managed in accordance with the new processes without incident. Technical analysis of the ADS-B losses indicated that one of the occurrences appeared to be a RAIM-related degradation. However, given the Figure of Merit settings for the previous RAIM prediction tool, it was confirmed that a RAIM outage prediction display would not have been generated for that occurrence, even if the capability had been retained in Eurocat.

3. ACTION REQUIRED BY THE MEETING

3.1 The meeting is invited to:

- a) note the information contained in this paper; and
- b) discuss any relevant matters as appropriate.

Summary of the paper to be included in the meeting report

Australia provided an update on the original approval for use of ADS-B for separation by ATC, including the associated requirement for RAIM prediction availability display in the air traffic management system and for ATC to apply procedural separation in that airspace. Australia's subsequent decision to remove the RAIM prediction display (and associated ATC separation requirement) was discussed, focusing on the safety case arguments that were used to support this decision. A report on the associated post implementation review was also presented.