International Civil Aviation Organization

The Thirteenth Meeting of Performance-Based Navigation Implementation Coordination Group (PBNICG/13)

(Bangkok, Thailand , 14 – 16 October 2026)

Agenda Item 6: State's Minimum Operational Network (MON)

Backup Navigation Facility (BNF) Implementation in Indonesia
(Presented by Indonesia)

SUMMARY

Indonesia regards the BNF as cornerstones of airspace resilience against GNSS disruption. The BNF strategy ensures continuous availability of conventional navigation infrastructure — DME/DME, VOR/DME, and ILS — to support reversion from PBN operations during GNSS outages. This paper presents Indonesia's comprehensive approach to ensuring airspace navigation resilience through an integrated framework comprising GNSS Radio Frequency Interference (RFI) mitigation, Backup Navigation Facility (BNF) development, and Minimum Operational Network (MON) planning. The paper highlights the 8 April 2026 Jakarta FIR GNSS interference event as a case study, describes the BNF/MON implementation status including DME/DME network optimization, VOR/DME retention strategy, and ILS preservation, and outlines the development of a proactive GNSS RFI monitoring application. Indonesia invites the meeting to note the information, endorse the integrated BNF/MON approach, and encourage regional collaboration on GNSS resilience.

1. INTRODUCTION

1.1 Indonesia has implemented Performance-Based Navigation (PBN) across its airspace since 2012, beginning with RNAV 1 SID/STAR at Soekarno-Hatta International Airport (WIII), followed by en-route RNAV routes and RNP approach procedures at numerous airports throughout the archipelago. The entire Indonesian airspace now operates on a PBN-based navigation concept, with GNSS as the primary navigation sensor.

1.2 However, the increasing reliance on GNSS as the sole source of positioning, navigation, and timing (PNT) information has created a critical vulnerability. ICAO Doc 9613 Volume I, Chapter 2, identifies GNSS as a potential single point of failure for PBN operations. Indonesia has experienced multiple GNSS interference events, culminating in a major incident on 8 April 2026 affecting 44 flights in Jakarta FIR.

1.3 In response, Indonesia has adopted a multi-layered resilience strategy comprising:

a. GNSS RFI mitigation through detection, reporting, and response;
b. Backup Navigation Facility (BNF) ensuring continuous availability of terrestrial navigation aids; and
c. Minimum Operational Network (MON) defines the minimum set of conventional NAVAIDS (VOR/DME & DME/DME) required for contingency operations during GNSS disruption.

1.4 This paper aligns with the PBNICG/13 agenda on GNSS interference and State BNF/MON implementation, and supplements the Working Paper previously presented at CNS SG/30 (July 2026) on GNSS RFI Mitigation and Resilience Readiness.

2. DISCUSSION

Backup Navigation Facility (BNF)/Minimum Operational Network (MON)

2.1 The BNF provides an independent terrestrial navigation capability for use when GNSS-based navigation is degraded or unavailable. The MON identifies the minimum facilities that must be retained and operational to support safe contingency operations; it is not intended to reproduce normal PBN capacity.

2.2 Current BNF/MON implementation status:

- DME/DME network optimization: ongoing coverage verification for Jakarta, Surabaya, Makassar, and Denpasar TMAs to ensure RNAV 1 DME/DME reversion capability during GNSS outage. DME/DME RNAV provides Area Navigation capability using distance measurements from two/more DME stations, per ICAO Doc 9613 Volume I Chapter 6

- VOR/DME retention: selective retention of strategically located VOR/DME stations to support limited RNAV applications and conventional routing during GNSS disruption. A formal VOR MON study is in progress to identify which stations constitute the minimum operational network.

- ILS preservation: all primary and secondary runway ends at major international airports retain ILS capability to ensure precision approach availability independent of GNSS.

- MON concept: designed as an independent contingency capability, not intended for full-capacity operations but as a recovery network enabling safe termination of flights during extended GNSS disruption.

PBN Routes Design and Resilience Integration

2.3 The Indonesian airspace structure integrates RNAV and RNP specifications, supporting flexible route spacing, parallel tracks, and PBN-based separation per ICAO Doc 9613 Volume I Chapter 4. En-route RNAV routes (Q-series) and RNP routes are designed with contingency conventional routes retained in parallel.

2.4 Airspace reversion strategy: pre-defined transition from PBN routes to conventional ATS routes, with optimized use of VOR/DME and DME/DME routing. ATC controllers are trained in mixed-equipage management and PBN-to-conventional reversion procedures.

2.5 ATC contingency procedures: controller training on GNSS RFI recognition, standard radiotelephony phraseology, and procedural separation application during surveillance degradation. AirNav Indonesia has incorporated GNSS RFI response scenarios into recurrent controller training programs.

2.6 Flight planning integration: NOTAM and ATIS dissemination of GNSS RFI status; pre-flight briefing on conventional routing contingencies; operator guidance on PBN capability documentation and reversion planning.

RAIM Availability and GNSS Integrity Monitoring

2.7 Receiver Autonomous Integrity Monitoring (RAIM) is a vital component of satellite-based navigation systems, particularly when utilizing GNSS signals for PBN operations. RAIM ensures the accuracy and reliability of PBN systems by monitoring the integrity of satellite-based navigation signals. It requires a minimum number of satellites (typically five or more) to be visible for accurate integrity checks. RAIM works by using the aircraft's GNSS receiver to analyze incoming satellite signals, checking whether the signals are consistent and accurate. If a signal is determined to be erroneous, RAIM flags it and issues an alert to the flight crew.

2.8 Challenges in RAIM availability across Indonesia include variability in GNSS signal availability in certain regions, satellite geometry considerations, and the need for specialized training for pilots, air traffic controllers, and maintenance personnel. Indonesia continues to monitor RAIM availability.

2.9 As Satellite-Based Augmentation Systems (SBAS) become more widely available, RAIM will work in conjunction with these systems to provide enhanced integrity. However, Indonesia does not currently have a national SBAS. GAGAN and MSAS edge coverage in western Sumatera and eastern Papua respectively is not sufficiently reliable for LPV minima. Indonesia continues to evaluate SBAS options, including potential national SBAS development.

GNSS RFI Monitoring Application - Building Proactive Detection Capability

2.10 Indonesia is developing a dedicated GNSS RFI monitoring application to complement and eventually transcend the current reactive reporting model. The application is designed around three core capabilities:

- Continuous automated signal monitoring - ground-based GNSS receiver stations at key aerodromes and en-route sites will continuously sample signal quality, registering anomalies without dependence on pilot or controller reports.
- Geospatial RFI mapping and correlation - detected interference signatures will be cross-correlated with ADS-B lost-track data from EFFORT and GPS Wise, generating near-real-time interference heat maps for ATS units.
- Automated alerting - threshold-triggered alerts to ATC supervisors and the National GNSS RFI Task Force, enabling faster NOTAM issuance and contingency activation.

2.11 This proactive detection approach directly addresses the identified limitation of the current reporting model - namely, that interference events are often detected only when aircraft report avionics anomalies, by which time safety margins may already be degraded.

2.12 Indonesia anticipates completing the design specification for the monitoring application by Q4 2026, with a prototype deployment targeted for the first half of 2027.

Alignment with Regional Guidance Material

2.13 Indonesia, as an active member of the ICAO APAC GNSS RFI and Data Link Disruption Ad Hoc Group, has reviewed the Draft Asia/Pacific Regional Guidance Material for GNSS RFI and Associated Data Link Disruption Coordination (Version 4). Indonesia supports:

- Reporting taxonomy and classification: the recommended classification dimensions (type, scope/impact, duration, source) for GNSS RFI events.

- Operational phraseology: consistent use of "flight crew" and "controller" throughout the document.
- NOTAM standardization: the proposed Q-code usage (QGWLF for jamming; QGWLO for spoofing) and harmonized NOTAM templates.
- Cross-border coordination: designation of national-level Points of Contact (POCs) for GNSS RFI matters at both ATS unit level and national frequency management level.
- Non-binding nature: Indonesia notes the non-binding character of the guidance and agrees that terms "shall" and "mandatory" should be avoided.

Challenges and Lessons Learnt

2.14 At 0040-0337 UTC on 8 April 2026, suspected GNSS jamming affected airspace within radial 000 degrees to 100 degrees from CGK VOR/DME, up to 200 NM. The event impacted 44 flights operated by seven operators (Batik Air 19, Garuda Indonesia 12, Pelita Air Service 7, Sriwijaya Air 3, Citilink 2, Lion Air 1). Impact summary:

- Aircraft affected: 44 flights across seven operators, primarily in descent phase to WIII.
- Avionics manifestations: predominantly ADS-B Reporting 1 and 2 intermittent faults (23 cases), with additional GPS 1 and 2 failures, IRS drift, and radio interference flags.
- GPS Wise monitoring: 112 flights tracked in the area; 39 flights exhibited bad Navigation Integrity Category (NIC), yielding a 34.8 percent anomaly rate.
- ATC mitigations: suspension of PBN approaches to Runway 24 WIII; reversion to ILS Runway 25L/R; terrestrial navaid routing (VOR/DME); increased separation standards.

2.15 Post event actions included NOTAM/PIREP advisory issuance, intensified pilot and ATC reporting protocols, joint AirNav Indonesia - DGCA investigation, and escalation to the National GNSS RFI Task Force for spectrum interference source localization.

2.16 Jakarta Air Traffic Service Center (JATSC) has modernized its ATS system. For the purpose of this paper, the key relevance is the ability of the ATS environment to support integrated surveillance monitoring, rapid identification of abnormal track/navigation behaviour, operational coordination, and post-event review during GNSS degradation.

2.17 Indonesia has established a multi-layered governance framework for GNSS RFI mitigation and navigation resilience through the 8 April 2026 Jakarta FIR GNSS Interference Event - Case Study.

- National GNSS RFI Task Force (Tim Nasional GNSS RFI) - coordinated by the Directorate General of Civil Aviation (DGCA) under the Ministry of Transportation, with cross-sector membership including AirNav Indonesia, National Cyber and Crypto Policy Agency, Military, and airport operators.
- DGCA letter AU.408/2/15/DRJU.DKPPU-2025 (22 January 2025) - mandates standardized GNSS disruption reporting by all Indonesian air operators and ATS units.
- EFFORT (Electronic Flight Data Recording and Reporting System) and GPS Wise - AirNav Indonesia's operational platforms for real-time flight monitoring, enabling post-event correlation of GNSS degradation reports with ADS-B track data.
- National reporting workflow comprises three stages: (a) real-time pilot/controller reporting via VHF and electronic means; (b) ATS unit initial assessment and

NOTAM/PIREP issuance; and (c) post-event analysis by the National GNSS RFI Task Force.

Conclusion and Recommendation

2.18 Indonesia has demonstrated that GNSS RFI is not a theoretical risk but an operational reality, as evidenced by the 8 April 2026 Jakarta FIR event affecting 44 flights. The combination of reactive reporting mechanisms, terrestrial backup NAVAIDS (BNN), and a minimum operational network (MON) provides a multi-layered resilience framework that enables safe continuation or orderly reversion of operations during GNSS disruption.

2.19 The BNN and MON are not substitutes for GNSS-based PBN, but rather essential contingency capabilities that preserve safety when the primary navigation service is degraded. Indonesia's approach - integrating RFI mitigation, BNN, MON, RAIM monitoring, and proactive detection technology - represents a holistic model for navigation resilience in a PBN environment.

2.20 Indonesia recognizes that GNSS resilience is a regional challenge requiring cross-border coordination, harmonized reporting, and shared situational awareness. Indonesia remains committed to active participation in the ICAO APAC GNSS RFI Ad Hoc Group and regional PBN implementation coordination.

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.

– – – – – – – – – – – – –

APPENDIX A
KNOWN GNSS RFI EVENTS - INDONESIA (as of July 2026)

Nr	*Date (UTC)*	*Latitude*	*Longitude*	*Severity/impact*	*Source / Flight*
1	21 Nov 2025 03:35	00°41'41"N	127°08'12"E	Lost signal	SJY693
2	21 Nov 2025 05:40	04°36'07"N	132°03'34"E	Lost signal	LNI949 & PK-OFI
3	22 Nov 2025 06:47	06°47'22"N	122°26'52"E	Lost signal	MDX373
4	22 Nov 2025 06:47	06°47'22"N	122°26'52"E	Lost signal	GIA683 & BTK6191
5	8 Apr 2026 00:40-03:37	CGK area	CGK area	Suspected jamming	44 flights (multi-operator)