सत्यमेव जयते

नागर विमानन मंत्रालय, भारत सरकार

MINISTRY OF CIVIL AVIATION, GOVERNMENT OF INDIA

भारतीय विमानपत्तन प्राधिकरण

AIRPORTS AUTHORITY OF INDIA

ICAO APAC SBAS-GBAS IMPLEMENTATION WORKSHOP FOR AIRSPACE USERS

"Enhancing airport accessibility and safety on final approach with SBAS and GBAS"

14th to 16th October 2025

Bengaluru, India

ICAO Documentation on SBAS/GBAS

Dr. Soniya Nibhani
Regional Officer, ANS Implementation
ICAO APAC Office

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Key Agenda Items

01 Introduction to ICAO APAC Office

02 ICAO APAC Office Working Structure

03 GANP and GNSS ASBUs

04 GNSS Developments in ICAO

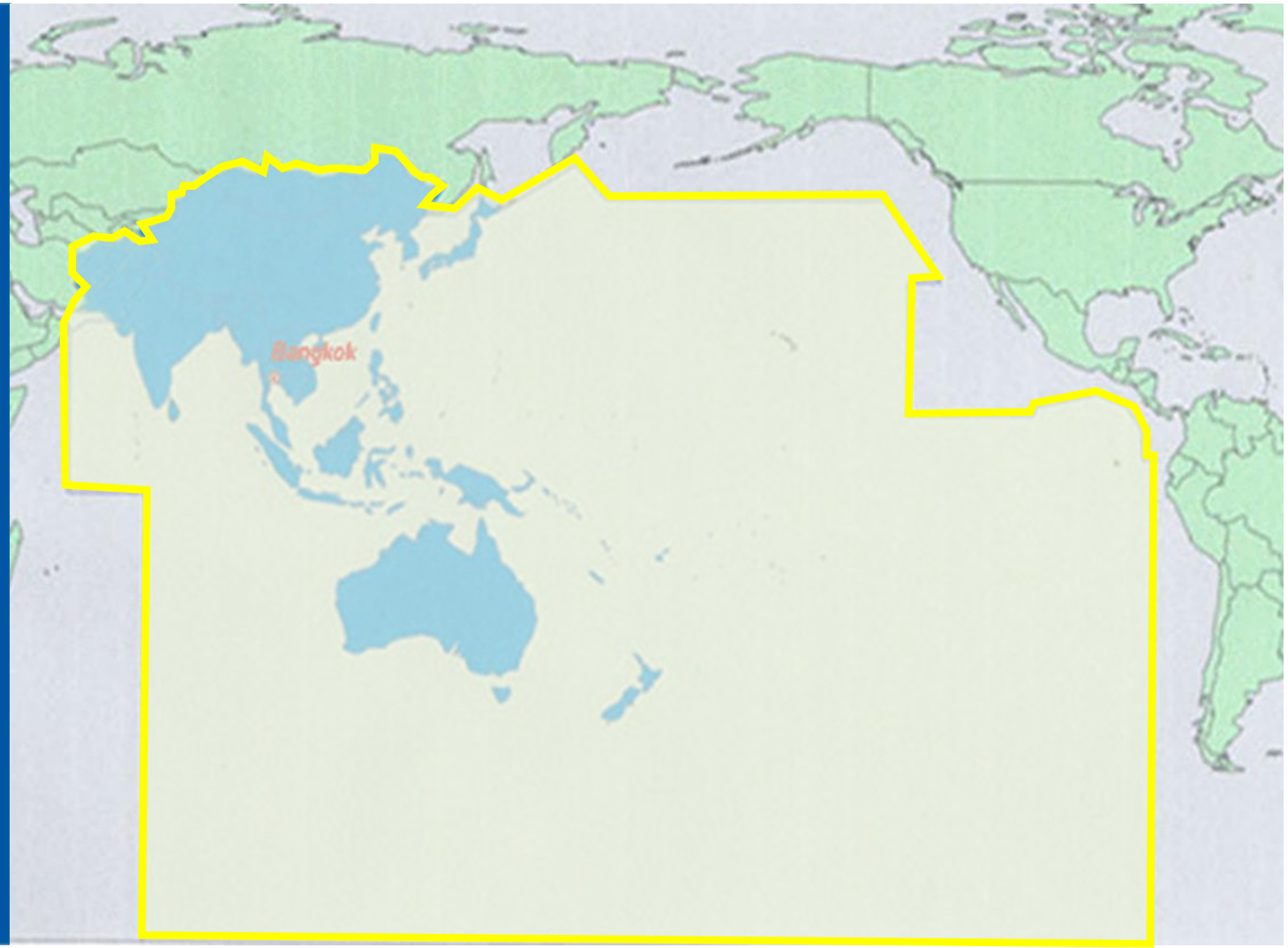
05 Relevant ICAO Provisions

06 Conclusion

Introduction to ICAO APAC Office

01

Introduction to ICAO Offices in Asia Pacific Region



Melbourne, AUS 1948

Bangkok, THA 1989

Beijing, China 2013

Nadi, Fiji 2024


ICAO
APANPIRG/35
Thirty-fifth Meeting of Asia and Pacific Air Navigation Plannning and Implementation Regional Group
25 - 27 NOVEMBER 2024
ICAO APAC Bangkok Thailand
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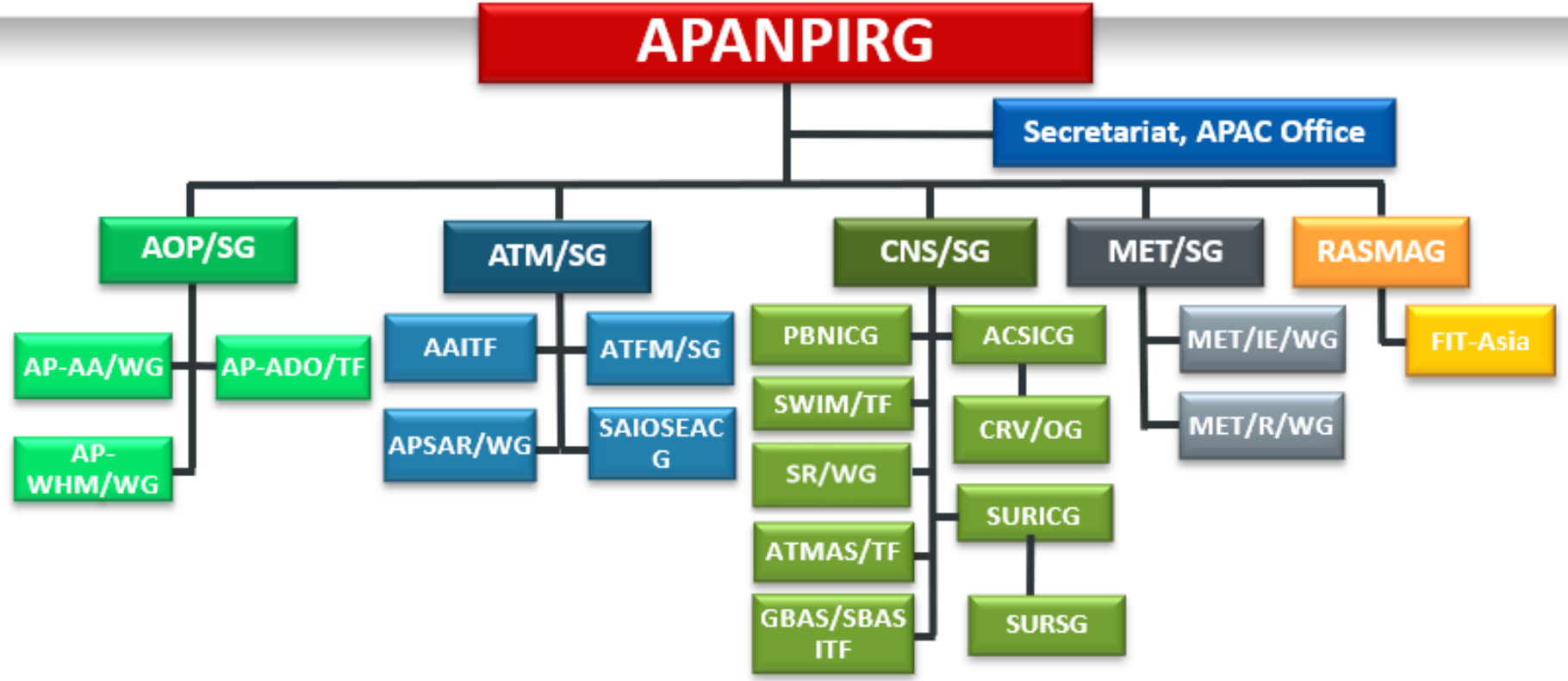
FREQUENTIS
FOR A SAFER WORLD
CHAIRMAN
SECRETARIAT
CHINA
CAMBODIA



AOP/SG	-	Aerodrome Operations and Planning Sub Group
AP-AA/WG	-	APAC Aerodrome Assistance Working Group
AP-ADO/TF	-	APAC Aerodrome Design and Operations Task Force
AP-WHM/WG	-	APAC Wildlife Hazard Management Working Group

ATM/SG	-	ATM Sub Group
AAITF	-	AIS - AIM Implementation Task Force
APSAR/WG	-	APAC Search and Rescue Working Group
ATFM/SG	-	ATFM Steering Group
SAIOSEACG	-	South Asia Indian Ocean and South East Asia ATM Coordination Group

CNS/SG	-	CNS Sub Group
PBNICG	-	PBN Implementation Coordination Group
SWIM/TF	-	System-Wide Information Management Task Force
SR/WG	-	Spectrum Review Working Group
ATMAS/TF	-	ATM Automation System Task Force
GBAS/SBAS ITF	-	GBAS/SBAS Implementation Task Force
ACSICG	-	Aeronautical Communication Services Implementation Coordination Group
• CRV/OG	-	Common Regional Virtual Private Network (VPN) Operations Group
SURICG	-	Surveillance Implementation Coordination Group
• SURSG	-	Surveillance Study Group

MET/SG	-	Meteorology Sub Group
MET/IE/WG	-	Meteorological Information Exchange Working Group
MET/R/WG	-	Meteorological Requirements Working Group

RASMAG	-	Regional Airspace Safety Monitoring Advisory Group
• FIT-ASIA	-	FANS Interoperability Team-Asia

03

GANP and GNSS ASBUs

GLOBAL AIR NAVIGATION PLAN

MULTILAYER STRUCTURE OF THE GANP

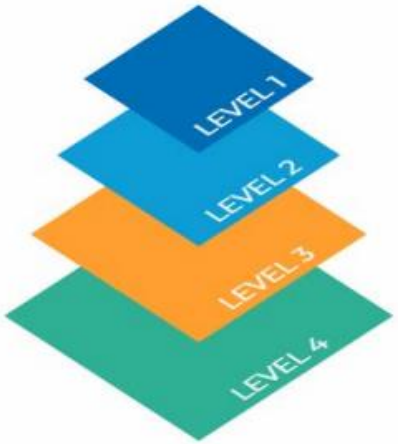
Click a level to navigate

GLOBAL STRATEGIC

GLOBAL TECHNICAL

REGIONAL

NATIONAL



GLOBAL STRATEGIC

Provides high-level strategic directions for decision makers to drive the evolution of the global air navigation system towards a common agreed vision.

GANP DOCUMENT

GLOBAL TECHNICAL

Supports technical managers in planning the implementation of basic air navigation services and new operational improvements in a cost-effective manner.

ASBUs & PF

AN-SPA

BBBs

REGIONAL

Addresses regional and sub-regional needs aligned with the global objectives.

- AFI ANP
- APAC ANP
- EUR ANP
- MID ANP
- NAM ANP
- NAT ANP
- CARSAM ANP

NATIONAL

Development by States, in coordination with relevant stakeholders, of air navigation plans aligned with regional and global plans.

NANP TEMPLATE

CBA CHECKLIST

https://www4.icao.int/ganpportal/

A42- Adoption of Eighth edition of the Global Air Navigation Plan (GANP)

- Reflecting the priorities of the 41st Assembly and aligning with the ICAO Strategic Plan 2026–2050.
- Highlights of the updated GANP:
  ✈️ Strengthened performance management
  🌍 Coordinated approach to environment and resilience
  🚀 New pathways for integrating emerging entrants
  🤖 Shared understanding of artificial intelligence

- An enhanced performance framework and revised ASBUs for regional and national planning.

A42- Outlook for the ninth edition of the GANP

- The Assembly also supported the outlook for the ninth edition of the GANP, and agreed that ICAO will:
  - Develop a minimum implementation path
  - Extend the GANP lifecycle to six years
  - Support States in implementing the GANP and developing national plans

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NAVS

NAVS-B0/1	Ground Based Augmentation Systems (GBAS)	Technology
NAVS-B0/2	Satellite Based Augmentation Systems (SBAS)	Technology
NAVS-B0/3	Aircraft Based Augmentation Systems (ABAS)	Technology
NAVS-B0/4	Navigation Minimal Operating Networks (Nav. MON)	Technology
NAVS-B1/1	Extended GBAS	Technology
NAVS-B2/1	Dual Frequency Multi Constellation (DF MC) GBAS	Technology
NAVS-B2/2	Dual Frequency Multi Constellation (DF MC) SBAS	Technology
NAVS-B2/3	Dual Frequency Multi Constellation (DF MC) ABAS	Technology

Global Navigation Satellite System Radio Frequency Interference (GNSS RFI)

A42-WP/34 TE/8

Loss of Control in-Flight (LOC-I)

Controlled flight into terrain (CFIT)

Mid-air Collision (MAC)

04

GNSS Developments in ICAO

GNSS evolutions in last several decades

GNSS Developments in ICAO

- **1991:** 10th Air Navigation Conference requested the initiation of an agreement between ICAO and GNSS-provider States concerning quality and duration of GNSS.
- **1993:** ICAO GNSS Panel established to develop SARPs in support of aeronautical applications of GNSS
- **1994/1996:** GPS/GLONASS offers from US/Russia
- **1999:** GNSSP completed the development of GNSS SARPS (applicable 2001)
- **2002:** GNSSP (subsequently renamed NSP) developed GNSS SARPs updates and enhancements
- **2003**: 11th Air Navigation Conference recommended a worldwide transition to GNSS-based air navigation and implementation of APV-I (SBAS)
- **2007**: 36th Assembly called for implementation of PBN RNAV and RNP and for implementation of APV BaroVNAV and/or APV I (SBAS) for all instrument runways by 2016
- **2010**: 37th Assembly confirmed and updated the commitment.
- **2012**: 12th Air Navigation Conference addressed issues of use of multiple constellations and GNSS vulnerabilities
- **2017**: Global Air Navigation Industry Symposium (GANIS, 11-13 December) revisited the issues
- **2018:** 13th Air Navigation Conference charted the way forward
- **2019:** The 40th Session of the Assembly considered a number of proposals with regard to CNS systems resilience and mitigation of harmful interference to GNSS.
- **2020:** ICAO sent State letter AN 7/5-20/89 on Strengthening of CNS systems resilience and mitigation of interference to GNSS.
- **2021:** Following preliminary review by the Air Navigation Commission, the proposed DFMC GNSS Annex 10 amendment material was sent for consultation by the State letter.
- **2022:** The ICAO Council recognized and accepted China's commitment to provide the BDS Open Service for civil aviation worldwide, meeting the requirements specified in the SARPs.

Performance Requirements for GNSS

Table 3.7.2.4-1 Signal-in-space performance requirements

Typical operation	Accuracy horizontal 95% (Notes 1 and 3)	Accuracy vertical 95% (Notes 1 and 3)	Integrity (Note 2)	Time-to-alert (Note 3)	Continuity (Note 4)	Availability (Note 5)
En-route	3.7 km (2.0 NM)	N/A	$1 - 1 \times 10^{-7}$/h	5 min	$1 - 1 \times 10^{-4}$/h to $1 - 1 \times 10^{-8}$/h	0.99 to 0.99999
En-route, Terminal	0.74 km (0.4 NM)	N/A	$1 - 1 \times 10^{-7}$/h	15 s	$1 - 1 \times 10^{-4}$/h to $1 - 1 \times 10^{-8}$/h	0.99 to 0.99999
Initial approach, Intermediate approach, Non-precision approach (NPA), Departure	220 m (720 ft)	N/A	$1 - 1 \times 10^{-7}$/h	10 s	$1 - 1 \times 10^{-4}$/h to $1 - 1 \times 10^{-8}$/h	0.99 to 0.99999
Approach operations with vertical guidance (APV-I) (Note 8)	16.0 m (52 ft)	20 m (66 ft)	$1 - 2 \times 10^{-7}$ in any approach	10 s	$1 - 8 \times 10^{-6}$ per 15 s	0.99 to 0.99999
Approach operations with vertical guidance (APV-II) (Note 8)	16.0 m (52 ft)	8.0 m (26 ft)	$1 - 2 \times 10^{-7}$ in any approach	6 s	$1 - 8 \times 10^{-6}$ per 15 s	0.99 to 0.99999
Category I precision approach (Note 7)	16.0 m (52 ft)	6.0 m to 4.0 m (20 ft to 13 ft) (Note 6)	$1 - 2 \times 10^{-7}$ in any approach	6 s	$1 - 8 \times 10^{-6}$ per 15 s	0.99 to 0.99999

NOTES.—

1. The 95th percentile values for GNSS position errors are those required for the intended operation at the lowest height above threshold (HAT), if applicable. Detailed requirements are specified in Appendix B and guidance material is given in Attachment D, 3.2.
2. The definition of the integrity requirement includes an alert limit against which the requirement can be assessed. For Category I precision approach, a vertical alert limit (VAL) greater than 10 m for a specific system design may only be used if a system-specific safety analysis has been completed. Further guidance on the alert limits is provided in Attachment D, 3.3.6 to 3.3.10. These alert limits are:

05

Relevant ICAO Provisions

ICAO Navigation Systems Panel (NSP)

- Was established in 2003
- Composed of 30 members from States and organizations.
- NSP members & advisors are experts involved in design, development, planning, implementation and operation of aeronautical navigation systems
- To develop, as required, SARPs and guidance material pertaining Radio navigation. It should also Monitor the development and implementation of aeronautical navigation systems and facilities in order to facilitate worldwide coordination of implementation;

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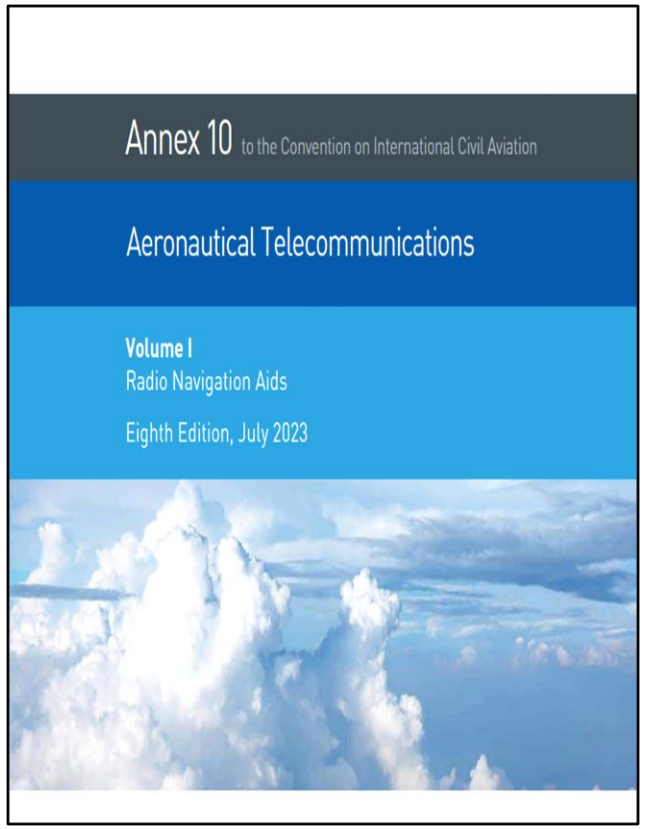
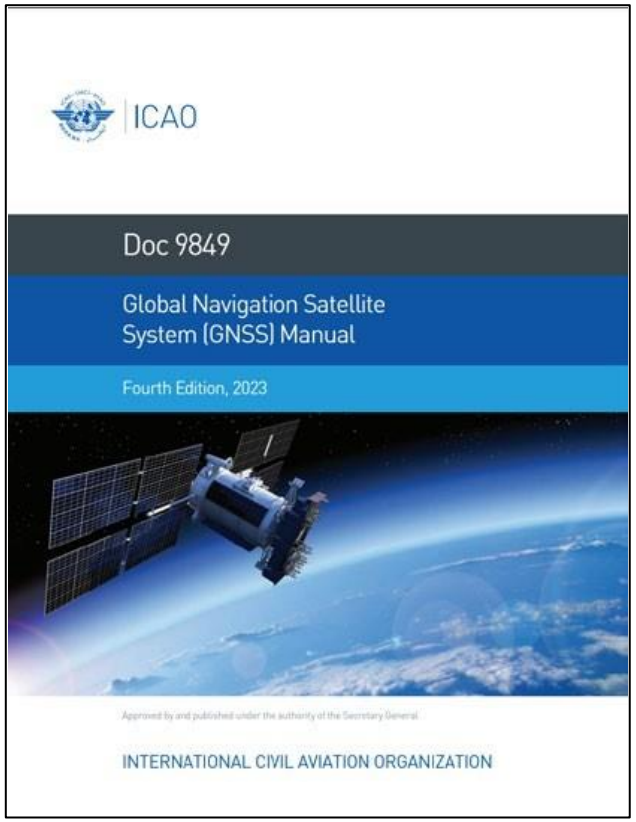
Relevant ICAO Provisions



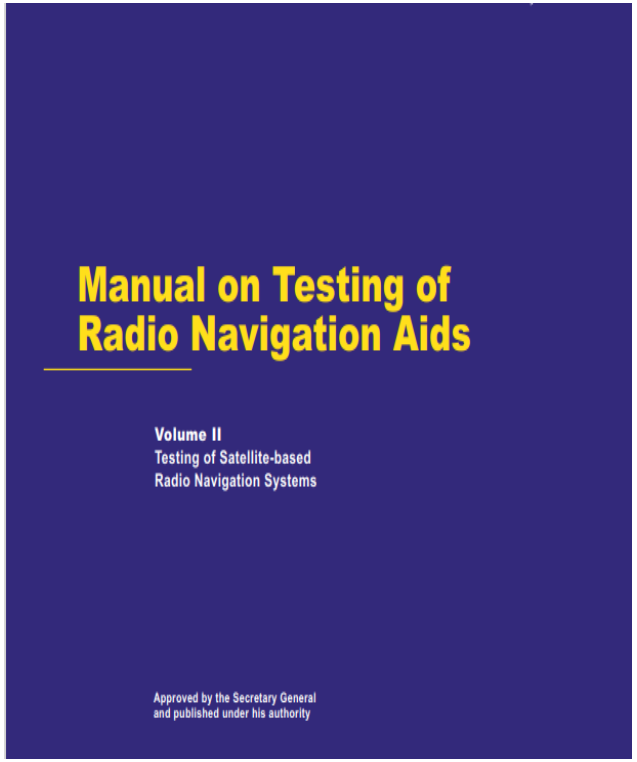
Annex 10, Vol I



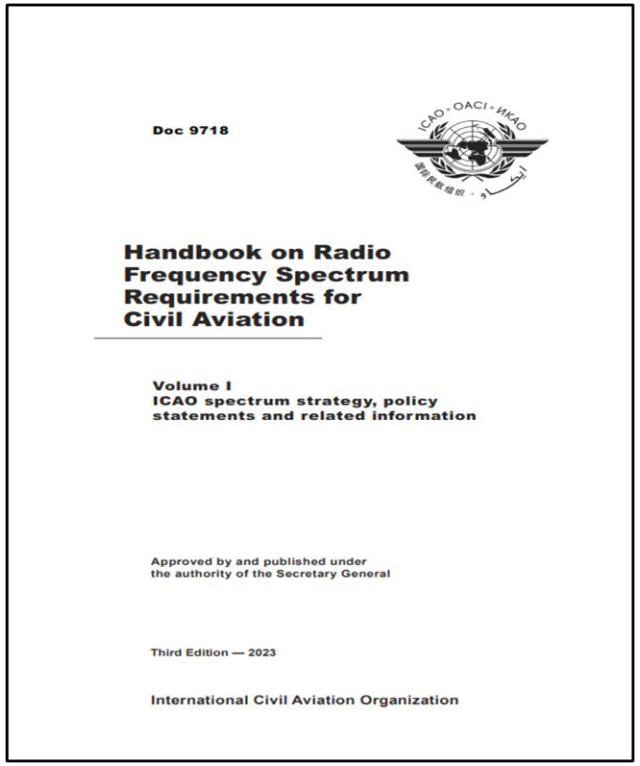
ICAO Doc 9849, Global Navigation Satellite System (GNSS) Manual

ICAO Doc 8071, Vol I, Testing of Ground based Radio Navigation Systems

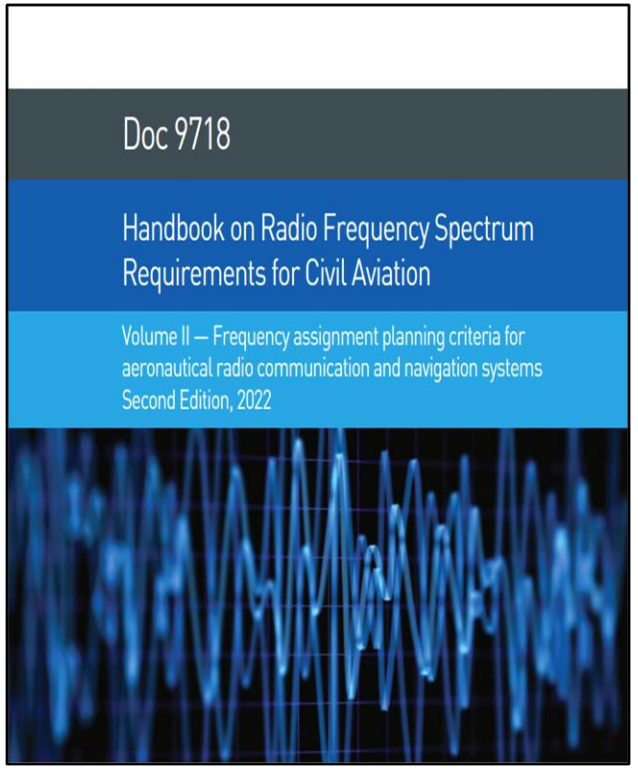
Relevant ICAO Provisions



ICAO Doc 8071, Vol II, Manual on Testing of satellite based Radio Navigation Systems



ICAO Doc 9718, Handbook on Radio Frequency Spectrum Requirements for Civil Aviation



ICAO Doc 9718 Vol II, Frequency assignment criteria for aeronautical radio communication & navigation systems

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ICAO 42nd Assembly

- New concept called “Digital Operational Reporting Information Service” - enables real-time and systemic collection and dissemination of GNSS interference events.
- A42-WP/190 and A42-WP/423- the need for more targeted research into the performance of GBAS, especially in equatorial and low-latitude regions
- Need for enhancement of SBAS resilience in equatorial and low-latitude regions.
- **Resolution 24/3: Consolidated statement of continuing ICAO policies and practices related to a global air traffic management (ATM) system and communications, navigation, and surveillance/air traffic management (CNS/ATM) systems-** superseded Assembly Resolution 41-8, Appendix C

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Fourteenth Air Navigation Conference (AN-CONF/14)

Event Details

Date: 26 Aug 2024 - 06 Sep 2024

Location: Montréal , CANADA

Venue: ICAO HQ,999 Robert-Bourassa Boulevard

Recommendation 2.2/2 – Addressing GNSS interference & contingency planning

That States:

a) ensure that effective global navigation satellite system radio frequency interference mitigation measures are implemented, based on measures developed by ICAO and industry, including the need to maintain a sufficient network of conventional navigation aids

b) ...

c) work with industry to identify means to make aircraft systems more resilient to radio frequency interference events.....

That ICAO:

e) continue to assess the impact of GNSS interference on aviation safety and continuity of civil aviation operations and define adequate mitigation measures**, while reminding States of their obligations;**

f) develop **a standardized** implementation package to assist and guide States in implementing effective **GNSS RFI** mitigation measures**, including optimization and rationalization of conventional navigation aids, ...**

g) .....

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Awareness Activities

- The AN-Conf/14 requested ICAO to continue awareness activities and noted the planned Regional Workshops

  - ✓ EUR/MID Radio Navigation Symposium, Feb 2024
  - ✓ ACAO/ICAO Radio Navigation Workshop, Feb 2025
  - ✓ ICAO APAC Radio Navigation Symposium, 7-9 April 2025
  - ✓ ICAO NAM/SAM Radio Navigation Workshop, 2-4 September 2025

International Civil Aviation Organization | Organisation de l'aviation civile internationale | Organización de Aviación Civil Internacional | Международная организация гражданской авиации | منظمة الطيران المدني الدولي | 国际民用航空组织

Tel.: +1 514-315-1872

30 April 2024

Ref.: E 3/5-24/54

Subject: Aviation safety concerns regarding interference to the Global Navigation Satellite System (GNSS)

Action required: a) disseminate guidance material; and b) implement recommendations, as applicable

Sir/Madam,

1. I have the honour to bring to your attention the concerning escalation of jamming and spoofing activities targeting the global navigation satellite system (GNSS), which have been increasingly observed recently in various regions globally. GNSS, as one of the main enablers for performance-based navigation (PBN), provides navigation guidance for all phases of flight, from enroute through to precision approach. By providing accurate position and timing information, GNSS enables several systems critical to the safety of flight.

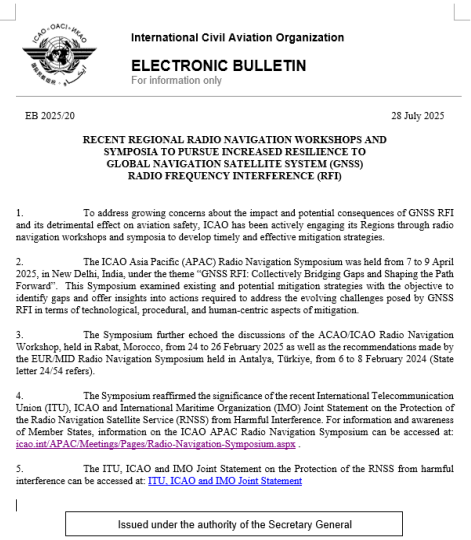
2. Since 2003, the International Civil Aviation Organization (ICAO) has been actively developing recommendations and guidance concerning GNSS Radio Frequency Interference (RFI). It is pertinent to recall ICAO Assembly Resolution A41-8, Appendix C: *Ensuring the resilience of ICAO CNS/ATM systems*, which serves as the latest ICAO policy on GNSS resilience.

3. To bring attention to the critical issue of GNSS interference, and to foster discussions on the management of GNSS vulnerabilities and potential mitigation measures against GNSS RFI, ICAO recently convened the ICAO EUR/MID Radion Navigation Symposium from 6 to 8 February 2024 in Antalya, Turkey. One important outcome of this symposium is the attached list of recommendations regarding Stakeholders' continued efforts towards ensuring safe, reliable, and resilient air navigation.

4. I would like to take this opportunity to refer to recent safety-related publications by the European Union Aviation Safety Agency (EASA), Safety Information Bulletin No. 2022-02R2 and the Federal Aviation Administration (FAA), Safety Alert for Operators (SAFO 24002).

ICAO EUR/MID Radio Navigation Symposium (Feb 2024)

- ICAO organized a Radio Navigation Symposium with the focus on GNSS RFI for ICAO EUR & MID Regions.
- SL dated 30 April 2024 circulated the outcome of the symposium and requested States to disseminate the guidance material and implement recommendations, as applicable.



International Civil Aviation Organization

ELECTRONIC BULLETIN

For information only

EB 2025/20 28 July 2025

RECENT REGIONAL RADIO NAVIGATION WORKSHOPS AND SYMPOSIA TO PURSUE INCREASED RESILIENCE TO GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) RADIO FREQUENCY INTERFERENCE (RFI)

1. To address growing concerns about the impact and potential consequences of GNSS RFI and its detrimental effect on aviation safety, ICAO has been actively engaging its Regions through radio navigation workshops and symposia to develop timely and effective mitigation strategies.

2. The ICAO Asia Pacific (APAC) Radio Navigation Symposium was held from 7 to 9 April 2025, in New Delhi, India, under the theme "GNSS RFI: Collectively Bridging Gaps and Shaping the Path Forward". This Symposium examined existing and potential mitigation strategies with the objective to identify gaps and offer insights into actions required to address the evolving challenges posed by GNSS RFI in terms of technological, procedural, and human-centric aspects of mitigation.

3. The Symposium further echoed the discussions of the ACAO/ICAO Radio Navigation Workshop, held in Rabat, Morocco, from 24 to 26 February 2025 as well as the recommendations made by the EUR/MID Radio Navigation Symposium held in Antalya, Türkiye, from 6 to 8 February 2024 (State letter 24/54 refers).

4. The Symposium reaffirmed the significance of the recent International Telecommunication Union (ITU), ICAO and International Maritime Organization (IMO) Joint Statement on the Protection of the Radio Navigation Satellite Service (RNSS) from Harmful Interference. For information and awareness of Member States, information on the ICAO APAC Radio Navigation Symposium can be accessed at: icao.int/APAC/Meetings/Pages/Radio-Navigation-Symposium.aspx .

5. The ITU, ICAO and IMO Joint Statement on the Protection of the RNSS from harmful interference can be accessed at: ITU, ICAO and IMO Joint Statement

Issued under the authority of the Secretary General

EB 2025/20

ICAO APAC Radio NAV Symposium examined existing and potential mitigation strategies with the objective to identify gaps and offer insights into actions required to address the evolving challenges posed by GNSS RFI in terms of technological, procedural, and human-centric aspects of mitigation.

Electronic Bulletin (EB2025/20) was published on 28 July 2025, includes link to the Symposium's webpage, for information and awareness of Member States

NSP Action Plan (AN-Conf/14, Rec. 2.2/2)

- Developed additional NOTAM Codes for GNSS RFI – work is ongoing to update relevant ICAO provisions
- **Offline RFI reporting**: Typical reporting done through pilots, ATC, ANSPs or States towards ICAO.
- Setting up such a centralized database at the ICAO level is unnecessary and could be done at the national/ regional level.
- Solutions for near-realtime interference reporting be organized at the State or Regional level.

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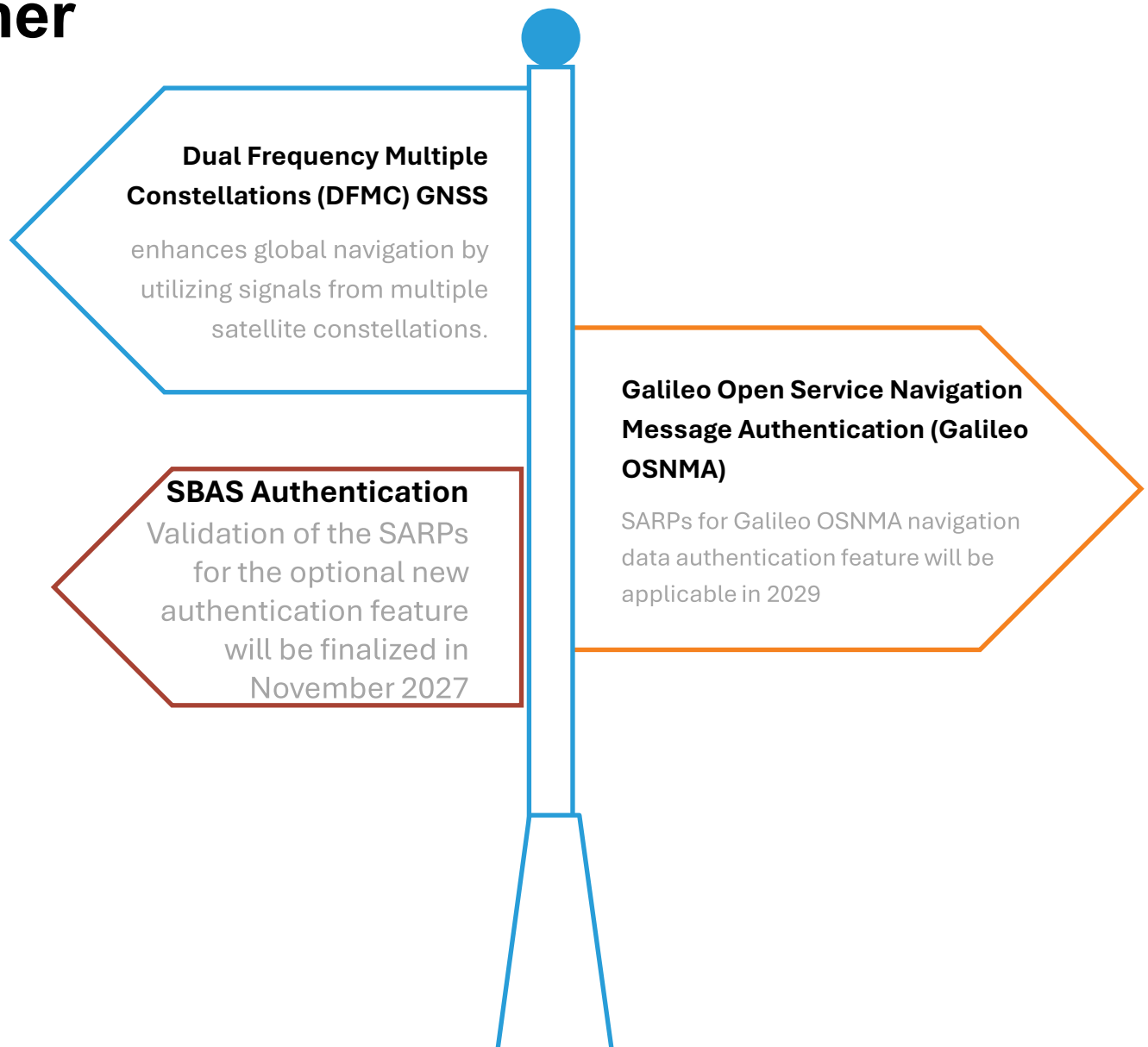
DFMC GNSS and other upcoming updates



Conclusion

- NSP will continue assessing the impact of GNSS interference, focusing on identifying effective mitigation measures, the development of relevant guidance material, and the exchange of GNSS interference information.
- ICAO recently initiated new concepts to mitigate GNSS RFI, complementary PNT (C-PNT) as a long-term solution, and Resilient Nav operational Network (NAV RON) that is planned for rollout in 2027
- States and industry should align their efforts with ICAO's initiatives by securing the necessary resources and remaining fully committed to advancing globally-agreed initiatives.
- Collaboration between ICAO, ITU and other relevant organizations should continue to prioritize the development of timely solutions for this significant concern.

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Thank You!

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