NACC/WG/11 — NE/15
14/09/26

Décimo Primera Reunión del Grupo de Trabajo de Norteamérica, Centroamérica y el Caribe (NACC/WG/11)

Ciudad de Guatemala, Guatemala, del 21 al 25 de septiembre de 2026

Cuestión 5 del Orden del Día: **Modernización de las comunicaciones, navegación y vigilancia/gestión del tránsito aéreo (CNS/ATM), transformación digital y ciberseguridad para los servicios de navegación aérea (ANS)**

PRESENTACIÓN DEL CONCEPTO DE OPERACIONES PARA LAS AYUDAS PARA LA NAVEGACIÓN EN LA REGIÓN CAR

(Presentada por la Secretaría)

RESUMEN EJECUTIVO

Esta nota de estudio presenta la primera versión del Concepto de Operaciones (CONOPS) para las ayudas para la navegación (NAVAID) en la Región Caribe (CAR). El CONOPS proporciona un marco regional para modernizar y racionalizar la infraestructura de navegación convencional, implementar progresivamente la navegación basada en la performance (PBN) habilitada por el sistema mundial de navegación por satélite (GNSS), y establecer una Red Operacional Mínima (MON) que preserve la resiliencia operacional durante una degradación o interrupción del GNSS. Antes de su finalización, se solicita a todos los Estados y Territorios CAR que examinen el documento, proporcionen información pertinente sobre misiones y operaciones, verifiquen y aprueben la información sobre los equipos NAVAID aplicable a su Estado o Territorio, y presenten recomendaciones para mejorar la integridad técnica y operacional del CONOPS

Acción:	Acciones sugeridas bajo el ítem 4 de la presente nota.
Objetivos Estratégicos:	• Todos los vuelos son seguros y protegidos • La aviación es sostenible en términos medioambientales • Movilidad fluida, accesible y confiable • Ningún país se queda atrás
Referencias:	• Plan Mundial de Navegación Aérea de la OACI, séptima edición (GANP) • Anexo 10 de la OACI — Telecomunicaciones aeronáuticas, Volumen I • Documentos 8071, 9613, 9849 y 10066 de la OACI

1. Introducción

1.1 El Plan Mundial de Navegación Aérea de la OACI (GANP) promueve una capacidad futura armonizada de navegación basada en la navegación de área (RNAV) y la navegación basada en la performance (PBN), sustentada principalmente por el GNSS. Aunque el GNSS aporta importantes beneficios en materia de seguridad operacional, capacidad y eficiencia, sigue siendo vulnerable a la interferencia de radiofrecuencia, incluidas la interferencia intencional (*jamming*) y la suplantación de señales (*spoofing*), así como a efectos ionosféricos y otros efectos de propagación.

1.2 Por consiguiente, la transición hacia operaciones en las que el GNSS sea el medio primario en la Región CAR debe incluir una estrategia coordinada de resiliencia. Determinadas ayudas terrestres para la navegación deberían conservarse, modernizarse u optimizarse cuando cumplan una función operacional, de seguridad operacional o de contingencia demostrada. El CONOPS adjunto a esta nota apoya esta transición regional.

2. Discusión

2.1 El CONOPS describe la planificación, utilización, modernización y racionalización de la infraestructura VOR, DME, NDB e ILS en la Región CAR. También aborda la aumentación del GNSS, la capacidad DME/DME, la integración de la PBN, los aeropuertos MON, la respuesta ante interferencias del GNSS, la gestión de la información aeronáutica, las dependencias de vigilancia y la coordinación entre las partes interesadas operacionales.

2.2 La arquitectura propuesta utiliza la PBN habilitada por GNSS durante las operaciones normales y mantiene una capacidad terrestre de reversión, dimensionada adecuadamente, para casos de degradación o interrupción del GNSS. La racionalización no significa la eliminación indiscriminada de las NAVAID. Cada decisión debería considerar la necesidad operacional, la evaluación de la seguridad operacional, la disponibilidad de procedimientos, los requisitos de tránsito y de flota, las dependencias transfronterizas, la condición del ciclo de vida, la mantenibilidad, la resiliencia y las alternativas validadas.

2.3 El plan de transición e implementación comprende cuatro fases:

- Evaluación (2025–2026): establecer la línea de base de la infraestructura y su condición, evaluar la dependencia de la PBN y el GNSS, modelar la cobertura DME/DME, identificar posibles aeropuertos MON y recopilar datos sobre interferencias del GNSS (Casi completada)
- Racionalización y diseño de reversión (2026–2027): determinar qué instalaciones deberían conservarse, modernizarse, reubicarse, añadirse o retirarse del servicio, y definir la MON CAR inicial
- Integración (2027–2028): armonizar la infraestructura con los procedimientos PBN, las contingencias ATC, los procesos AIM/NOTAM, la capacidad de respaldo de vigilancia, el monitoreo del GNSS, la notificación de interferencia de radiofrecuencia (RFI), la instrucción y la ATFM/CDM
- Monitoreo y mejora continua (2028 en adelante): monitorear el rendimiento, analizar los sucesos, mantener la notificación regional y examinar periódicamente la MON.

2.4 La implementación exige medidas coordinadas de las autoridades reguladoras de los Estados, las divisiones CNS de los ANSP, las dependencias ATS y AIS/AIM, las autoridades aeroportuarias, los diseñadores de procedimientos, los explotadores de aeronaves, las autoridades del espectro, las FIR adyacentes, la OACI y GREPECAS. No debería retirarse ninguna NAVAID crítica hasta que se haya evaluado el impacto operacional y se haya validado, publicado y comunicado a los usuarios una alternativa aceptable.

2.5 La primera versión del CONOPS se adjunta a esta nota de estudio ***(por el momento, disponible únicamente en inglés)***. Constituye orientación regional y no sustituye las Normas y Métodos Recomendados de la OACI, los Procedimientos para los Servicios de Navegación Aérea ni los procesos aplicables de reglamentación y aprobación de la seguridad operacional de los Estados.

3. Validación regional y grupo de trabajo ad hoc

3.1 La validación por todos los Estados y Territorios CAR es necesaria para asegurar que el CONOPS refleje el entorno regional completo de navegación, incluida la infraestructura nacional, las dependencias operacionales, las necesidades de contingencia, la capacidad de implementación y los requisitos transfronterizos. Cada Estado y Territorio debería examinar el documento y proporcionar la información derivada de misiones técnicas, inspecciones, evaluaciones y actividades de implementación pertinentes; verificar la exactitud, el estado actual y la aplicabilidad de la información relativa a su espacio aéreo, aeródromos y equipos NAVAID; confirmar o aprobar formalmente la información de los equipos bajo su responsabilidad; identificar información faltante, desactualizada o incorrecta; y formular recomendaciones técnicas, operacionales y editoriales para mejorar el CONOPS y sus apéndices de apoyo.

3.2 La Reunión debería establecer un grupo de trabajo ad hoc, con la participación de los Estados CAR interesados, los ANSP, los órganos técnicos pertinentes del NACC/WG y la Oficina Regional NACC de la OACI, para consolidar los comentarios, resolver las cuestiones técnicas y operacionales y preparar una versión completa del CONOPS para su validación regional y presentación mediante el mecanismo de aprobación correspondiente.

3.3 El grupo de trabajo ad hoc debería completar y elaborar, como mínimo, los siguientes apéndices de apoyo:

- Apéndice A: Mapa de la red de NAVAID, que presente la distribución regional, la cobertura y las dependencias transfronterizas de las instalaciones propuestas para su conservación, modernización, racionalización o inclusión en la MON
- Apéndice B: Configuración del sistema y datos técnicos, que consolide las características de las instalaciones, el estado operacional, los volúmenes de servicio, el monitoreo, la redundancia, la energía eléctrica, la inspección, el mantenimiento y la información del ciclo de vida
- Apéndice C: Cronograma de implementación (Gantt), que defina las actividades, los hitos, las responsabilidades, las dependencias y los periodos indicativos de implementación para la evaluación, racionalización, integración y monitoreo, y
- Apéndice D: Procedimientos de contingencia, que describa las medidas regionales y nacionales ante la degradación o interrupción del GNSS, la falla de una NAVAID, la notificación, la respuesta ATC, la coordinación AIM/NOTAM, los efectos sobre la vigilancia, la coordinación entre FIR y la recuperación.

3.4 Tras concluir el proceso de examen, verificación y consolidación, la Secretaría debería distribuir el CONOPS revisado y sus apéndices de apoyo a todos los Estados y Territorios CAR para su validación final. La versión revisada debería incorporar los datos verificados de los equipos, los resultados pertinentes de las misiones y las recomendaciones recibidas de los Estados, Territorios y ANSP. Los Estados deberían utilizar el marco validado para apoyar las evaluaciones nacionales y los planes coordinados de modernización y resiliencia de la navegación.

4. Acción sugerida

4.1 Se invita a la Reunión a:

a) tomar nota de la primera versión del Concepto de Operaciones para las ayudas para la navegación en la Región CAR adjunta a esta nota de estudio;
b) acordar que se requiere la validación de todos los Estados CAR antes de finalizar el CONOPS
c) establecer un grupo de trabajo ad hoc para completar el CONOPS y elaborar el Apéndice A — Mapa de la red de NAVAID, el Apéndice B — Configuración del sistema y datos técnicos, el Apéndice C — Cronograma de implementación (Gantt) y el Apéndice D — Procedimientos de contingencia
d) solicitar a los Estados CAR y a los ANSP que designen especialistas apropiados en navegación, operaciones, AIM, diseño de procedimientos y planificación de contingencias para participar en el grupo de trabajo ad hoc
e) examinar el CONOPS y proporcionar a la Oficina Regional NACC de la OACI comentarios técnicos y operacionales, información pertinente de misiones y datos nacionales dentro del plazo acordado por la Reunión
f) apoyar la validación regional final a través de los órganos técnicos pertinentes del NACC/WG y del mecanismo aplicable del GREPECAS
g) alentar a los Estados y Territorios a completar o actualizar sus inventarios de NAVAID, evaluaciones operacionales y de seguridad operacional, análisis de cobertura DME/DME, evaluaciones de dependencia del GNSS e identificación de instalaciones y aeropuertos MON
h) solicitar a los Estados y Territorios que identifiquen información faltante, desactualizada o incorrecta y formulen recomendaciones para mejorar el contenido técnico, la aplicabilidad operacional, la coordinación regional, la hoja de ruta de implementación, las disposiciones de contingencia y los apéndices de apoyo del CONOPS
i) asegurar que la racionalización o retiro del servicio de las NAVAID se coordine con las partes interesadas afectadas y cuente con alternativas validadas, evaluación de la seguridad operacional, publicación AIM, instrucción y procedimientos de contingencia, y
j) aprobar el siguiente proyecto de conclusión:

Proyecto de conclusión

<table>
<tr><td colspan="4">PROYECTO DE CONCLUSIÓN
NACC/WG/11/XX VALIDACIÓN Y FINALIZACIÓN DEL CONOPS SOBRE AYUDAS PARA LA NAVEGACIÓN EN LA REGIÓN CAR</td></tr>
<tr><td colspan="3">Qué:
a) que los Estados, Territorios y ANSP CAR examinen y validen el CONOPS sobre ayudas para la navegación en la Región CAR, verifiquen la exactitud y el estado actual de la información sobre NAVAID y proporcionen información y recomendaciones técnicas, operacionales, de misiones y de implementación pertinentes

b) que un grupo de trabajo ad hoc consolide los aportes recibidos y complete el CONOPS, incluidos el mapa de la red de NAVAID, los datos técnicos, la hoja de ruta de implementación, los procedimientos de contingencia y la MON regional CAR

c) que la Secretaría distribuya el CONOPS revisado para su validación regional final y complete la primera versión examinada regionalmente a más tardar el 30 de diciembre de 2026, y

d) que la Secretaría organice un taller para familiarizar al personal ANS pertinente con el CONOPS validado, su implementación y las responsabilidades asociadas de los Estados.</td><td>Impacto esperado:
☐ Político / Mundial
☒ Interregional
☐ Económico
☐ Ambiental
☒ Operacional/Técnico</td></tr>
<tr><td colspan="4">Por qué:
Para asegurar que el CONOPS sea exacto, completo, operacionalmente aplicable y aceptado por todos los Estados y Territorios CAR; que la información sobre los equipos NAVAID sea verificada por las autoridades responsables; que se incorporen los resultados pertinentes de las misiones técnicas y evaluaciones nacionales; que se corrija la información faltante o desactualizada; y que se consideren las recomendaciones de los Estados para mejorar el documento, sus apéndices técnicos, la hoja de ruta de implementación, los procedimientos de contingencia y el desarrollo de una MON regional CAR resiliente.</td></tr>
<tr><td>Cuándo:</td><td>15 de diciembre de 2026</td><td>Estado:</td><td>☐ Válido / ☐ Invalidada / ☐ Completado</td></tr>
<tr><td>Quién:</td><td>☒ Estados ☒ OACI ☐ Otro:</td><td colspan="2">Todos los Estados y Territorios CAR</td></tr>
</table>

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2026

Concept of Operations (CONOPS) for Navigation Aids (NAVAIDs) - CAR Region

Caribbean (CAR) Region -Rationalization and evolution of the ground-based navigation aid infrastructure

First version (DRAFT)

ICAO NACC REGIONAL OFFICE

COMMUNICATION, NAVIGATION, SURVEILLANCE AND SPECTRUM (CNSS)

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Disclaimer

This Concept of Operations (CONOPS) for Navigation Aids (NAVAIDs) has been developed as regional guidance to support States, Territories, Air Navigation Service Providers (ANSPs), and other relevant stakeholders in the planning, implementation, operation, modernization, and rationalization of navigation infrastructure.

This document is intended for guidance and planning purposes only and does not replace, amend, or supersede any provisions contained in the Convention on International Civil Aviation, ICAO Standards and Recommended Practices (SARPs), Procedures for Air Navigation Services (PANS), or other applicable ICAO documentation. In the event of any inconsistency between this CONOPS and applicable ICAO provisions, the official ICAO provisions shall prevail.

The implementation of any concept, recommendation, technical solution, or operational arrangement described in this CONOPS remains subject to each State's applicable regulatory framework, safety assessment processes, operational requirements, infrastructure needs, and formal approval by the competent authorities.

References to specific technologies, systems, architectures, or implementation approaches are provided for technical and operational context and should not be interpreted as an endorsement of any particular manufacturer, supplier, product, or commercial solution.

As navigation technologies, ICAO provisions, operational requirements, and regional priorities evolve, this CONOPS should be periodically reviewed and updated to maintain its technical and operational relevance.

Document Control – Version History

Version	Date	Prepared / Updated by	Description of Changes	Reviewed by	Approval / Status
1.0	30-July-2026	COCESNA ECCAA ICAO NACC REGIONAL OFFICE	Initial draft developed for internal review. alignment with ICAO Annex 10, Volume I (Eighth Edition, including Amendment 94), ICAO Doc 9849, Global Navigation Satellite System (GNSS) Manual, Fifth Edition (2025), including Corrigendum No. 1.	ICAO NACC REGIONAL OFFICE	Draft
1.1	30-August-2026	ICAO NACC REGIONAL OFFICE	ICAO Doc 8071, Manual on Testing of Radio Navigation Aids, Volume I - Testing of Ground-based Radio Navigation Systems, Sixth Edition (Advance unedited, 2026), and Volume II - Testing of Satellite-based Radio Navigation Systems, Fifth Edition (2007),.	ICAO NACC REGIONAL OFFICE	Draft
1.3	07-September-2026	ICAO NACC REGIONAL OFFICE	Version 135 - Updated September 2026 for ICAO Doc 9613, Performance-based Navigation (PBN) Manual, Fifth Edition (2023), including Corrigendum No. 1, and ICAO Doc 10066, Procedures for Air Navigation Services - Aeronautical Information Management (PANS-AIM), First Edition (2018), consolidated through Amendment No. 4 and updated with Amendment No. 5 (approved 22 April 2026; applicable 26 November 2026), limited to provisions relevant to NAVAIDs.	ICAO NACC REGIONAL OFFICE	Draft for Review

Concept of Operations (CONOPS) for Navigation Aids (NAVAIDs)

Chapter 1 - Introduction

This CONOPS document describes the operational concept for the planning, use, and rationalization of the use of conventional navigation aids (VOR, DME, NDB, and ILS) in the CAR region in alignment with the ICAO Global Air Navigation Plan (GANP v8) and regional initiatives such as the Minimum Operational network (MON) and GNSS transition roadmap.

The Global Air Navigation plan (GANP) has the objective of a future harmonized global navigation capability based on area navigation (RNAV) and performance- based navigation (PBN) supported by the global navigation satellite system (GNSS).

GNSS provides the foundation for PBN and supports positioning, navigation and timing applications across all phases of flight. The current GNSS environment is evolving toward dual-frequency, multi-constellation (DFMC) capability, with GPS, GLONASS, Galileo and BDS and augmentation through ABAS, SBAS and GBAS. Despite its high availability and operational benefits, GNSS remains vulnerable to radio-frequency interference (RFI), including jamming and spoofing, and to ionospheric and other propagation effects. The navigation architecture must therefore be designed for resilience rather than assuming uninterrupted GNSS availability.

Where there is a high degree of reliance on GNSS, States and ANSPs shall plan mitigation against loss or degradation of service. Depending on the operational environment, mitigation may include GNSS-independent navigation means, radar/SSR-supported ATC intervention, procedural measures, inertial capability, and a suitably dimensioned terrestrial reversion infrastructure. Special attention is required where ADS-B is the only surveillance source because ADS-B position normally depends on GNSS.

The use of conventional navigation aids (VOR, DME, NDB, and ILS) will be evolving to that of providing reversionary navigation service as a backup solution to GNSS navigation.

This evolution offers the opportunity for the rationalization of some terrestrial infrastructure and retaining only a minimal operational network (MON) which is designed to efficiently provide reversion service.

Understanding the operational role of the navaids is essential to estimating the operational impact of an infrastructure change.

1.1 Scope

- Systems included (e.g., VOR/DME/ILS network, backup MON, GNSS augmentation).
- Airspace or geographical coverage.
- Stakeholders involved (ANSPs, ATC units, CNS maintenance, military coordination, etc.).

1.2 Conventional Navigation Aids description and their operational roles

1.3.1 Non-directional Radio Beacons (NDB)

These are Low frequency/Medium frequency (LF/MF) radio beacons which transmits non directional signals whereby aircraft with automatic direction-finding equipment can determine bearing and 'home' to the NDB station. NDB transmitters operate in the frequency range 190-1750 KHz and transmit a continuous carrier which is modulated by either a 400 or 1020 Hz tone, these tones are coded using morse code which is used to identify the transmitters. Traditionally, NDBs have been used for enroute navigation and also in terminal areas supporting non precision approaches.

Radio beacons are subject to disturbances such as lightning, precipitation and static which may result in erroneous bearing information. ADF receivers do not have a 'flag' to warn pilots when erroneous bearing information is received. In addition, the bearing information provided by NDBs is inherently less accurate than those provided by VORs.

1.3.2 NDB operational roles

NDBs do not support PBN operations, and their use in conventional procedures for en-route navigation, terminal areas, or approach aids is generally considered obsolete. An increasing number of aircraft no longer provide ADF capability on-board.

1.3.3 VHF Omni Range (VOR)

VOR stations operate the 108 to 117.95 MHz band; their VHF carriers are modulated with two 30 Hz tones to provide bearing information. In addition to the navigation signals the VOR carrier is modulated with either morse code or voice identification.

VORs are used for enroute navigation and also in terminal areas supporting non precision approaches.

The accuracy of the VOR course alignment is on the order of about +/- 1°. VORs are subject to line -of -sight restrictions and course distortions such as bends, roughness, and scalloping which can limit the use in mountainous areas.

1.3.4 VOR operational roles

The only PBN navigation specification supported by VOR, provided a co-located DME is present, is RNAV 5, based on VOR/DME.

VORs are still used in conventional procedures for en-route navigation, terminal areas, and approach aids.

1.3.5 Distance Measuring Equipment (DME)

Distance measuring Equipment (DME) operates on the two-way ranging principal whereby the 'round trip time' of UHF radio pulses in the 960-1215 MHz band transmitted between an airborne interrogator and ground transponder are converted to units of distance (nautical miles) between aircraft and the ground station. Distance information provided by the DME is SLANT RANGE distance and not the horizontal distance between the aircraft and the ground station. DME accuracy can be better than 1 NM.

DME stations are normally co-located with VOR stations to provide bearing and distance information in the so-called Rho-Theta system which is the basis for VOR/DME navigation. DME can also provide the so-called Rho-Rho navigation using trilateration or Multilateration between two or more DME stations which is the basis for DME/DME navigation.

1.3.5 DME operational roles

DME/DME fully supports PBN operations based on RNAV 1, RNAV 2, and RNAV 5 navigation specifications.

DMEs (when collocated with VORs) are still used in conventional procedures for en-route navigation, terminal areas, and approach aids.

1.3.6 Instrument Landing System (ILS)

ILS was designed to provide an approach path for exact alignment of an aircraft on final approach to a runway.

The basic components of an ILS are the Localizer equipment, UHF Glide Path equipment, and appropriate means to verify glide path verification checks.

The Localizer transmitter operates on one of 40 ILS channels in the 108.10 to 111.95 MHz band and provides course guidance to the runway centerline.

The Glide path transmitter operates on one of 40 ILS channels within the band 329.15 to 335 MHz and provides descent information for navigation down to the lowest authorized decision height specified in the approved ILS approach procedure.

DME when used with an ILS system provides continuous distance to threshold information this enables glide path verification checks. In this application DME is used in lieu of Marker beacons.

ILS Facility Performance Category I – An ILS which provides guidance information from the coverage limit of the ILS to a point where the localizer course intersects the glide path at a height of 60m (200 ft) or less above the horizontal plane containing the threshold.

ILS Facility Performance Category II - An ILS which provides guidance information from the coverage limit of the ILS to a point where the localizer course intersects the glide path at a height of 30m (100 ft) or less above the horizontal plane containing the threshold.

ILS Facility Performance Category III - An ILS which provides guidance information from the coverage limit of the ILS to, and along, the runway surface.

1.3.7 ILS Operational roles

ILS is not a PBN infrastructure, ILS will remain the primary means of navigating in low visibility operations (CAT II/III). RNP APCH to LPV minima may replace ILS CAT I approach provided that the appropriate SBAS coverage is locally available.

1.3.8 Global Navigation Satellite System (GNSS)

GNSS consists of multiple satellite constellations (space segments), ground monitoring stations (Control segments), and the end user equipment (User segments).

The current satellite constellations are:

- GPS
- GLONASS
- BEIDOU
- GALILEO

The primary GNSS signals of themselves are not sufficient to meet aviation requirements of integrity, hence augmentation systems are necessary.

GNSS augmentation is a method of improving – 'augmenting' the core GNSS constellations performances in the areas of integrity, continuity, accuracy and availability. Augmentation works by providing information that is external to the core GNSS signals into the user position solution.

Augmentation systems can be classified as follows.

a) Satellite Based Augmentation System (SBAS) – SBAS augments core GNSS constellations by providing integrity and correction information, as well as providing additional ranging signals. Examples of SBAS systems are the European Geostationary Navigation Overlay Service (EGNOS) and the Wide Area Augmentation service (WAAS). SBAS provides horizontal and vertical guidance and can support LPV approaches.
b) Ground Based Augmentation System (GBAS) – GBAS systems aim at enhancing GNSS services during the approach and landing phases of flight. A GBAS ground station is usually located at or near the airport being served, this ground station monitors the core constellation signals and broadcasts locally relevant pseudo-range corrections, integrity parameters and approach definition data to aircraft in the terminal area via VHF data broadcast (VDB).

   GBAS supports CAT I and CAT II/III precision approaches and the provision of GBAS positioning service in the terminal area. A single GBAS ground installation may provide guidance for up to 49 approaches on a single frequency within its VDB coverage.

c) Aircraft Based Augmentation System (ABAS) – ABAS is an avionics implementation that processes core constellation signals with information on board the aircraft. One form of ABAS is receiver autonomous integrity monitoring (RAIM), RAIM can provide fault detection and isolation of failed satellites; RAIM supports terminal, en-route, and non-precision approaches.

GNSS currently provides the most accurate source of positioning that is available on a global basis, GNSS can support all PBN specifications for oceanic, en-route, terminal, and approach phases of flight.

GNSS signals currently have high availability, GNSS signals, however, are vulnerable to jamming (unintentional and intentional), spoofing, and ionospheric disturbances. Until GNSS signals become more resilient and hence less vulnerable to the above phenomena, then a network of conventional ground-based aids needs to be maintained as a contingency measure.

1.4 Minimum Operational Network (MON)

Minimum Operational Network refers to the minimum Navaid infrastructure needed to provide the required level of service for both normal operations and contingency operations when GNSS service is unavailable.

1.5 Airspace/Geographical coverage

The geographical area covered by this CONOPs document includes the following FIRs in the CAR region.

Region	State
Caribe	Antigua and Barbuda
Caribe	Bahamas
Caribe	Barbados
Centroamérica	Belize
Centroamérica	Costa Rica
Caribe	Cuba
Caribe	Dominica
Caribe	Dominican Republic
Centroamérica	El Salvador
Caribe	Grenada
Centroamérica	Guatemala
Caribe	Haiti
Centroamérica	Honduras
Caribe	Jamaica
Norte América	Mexico
Centroamérica	Nicaragua
Caribe	Saint Kitts and Nevis
Caribe	Saint Lucia
Caribe	Saint Vincent and the Grenadines
Caribe	Trinidad and Tobago
French Antilles	Guadeloupe
	Martinique
	Saint Barthélemy
	Saint Martin
	Saint Pierre et Miquelon
Netherlands	Aruba
	Curaçao
	Sint Maarten
	Bonaire
	Saba
	Sint Eustatius
United Kingdom	Anguilla
	Bermuda
	British Virgin Islands
	Cayman Islands
	Montserrat
	Turks and Caicos Islands
United States	Puerto Rico
	Virgin Islands

1.5.1 Stakeholders

The stakeholders identified in this document will include ANSPs (ATC units, CNS maintenance), Regulatory authorities, airspace users, and industry partners.

1.5.2 Alignment with ICAO Annex 10, Volume I

This CONOPS applies the ICAO Annex 10, Volume I framework for radio navigation aids. Annex 10 recognizes GNSS as the most suitable infrastructure to support PBN and establishes that the role of conventional navigation aids is evolving toward a reversionary terrestrial infrastructure capable of maintaining safety and an adequate level of operations when GNSS is unavailable. The regional MON concept in this document is therefore a service-continuity concept rather than a requirement to preserve the existing inventory of facilities.

The rationalization strategy shall maintain at least the current safety level, facilitate PBN implementation, preserve global interoperability, allow coordinated regional flexibility, encourage appropriate PBN equipage, and take account of economic, operational and technical factors. Changes to NAVAID provision require coordinated airspace planning, procedure design, regulatory consideration and consultation with affected airspace users.

For approach and landing, the CONOPS recognizes that there will not be a rapid or complete transition from ILS to GNSS. ILS should continue where operationally required and economically beneficial, while GNSS with augmentation (ABAS, SBAS and GBAS, as applicable) may support APV and precision approach operations. Adequate redundancy and protection of the radio-frequency spectrum are essential when terrestrial aids are withdrawn.

1.5.3 Alignment with ICAO Doc 9849, Fifth Edition (2025), including Corrigendum No. 1

This CONOPS also applies the operational implementation and resilience guidance in ICAO Doc 9849. Doc 9849 treats GNSS as a key technical enabler for PBN, ADS-B, ADS-C and common timing, while emphasizing that implementation decisions require safety, operational and business-case analysis and coordinated planning with aircraft operators.

For CAR regional planning, GNSS resilience shall be addressed as an integrated CNS/ATM issue. The availability of GNSS-independent navigation, surveillance and communications, traffic density, outage duration and geographical extent, aircraft equipage, airport accessibility and ATC procedures shall be considered when defining the MON and associated contingency arrangements.

The CONOPS adopts the Doc 9849 rationalization principle that the objective is not to preserve the existing inventory of conventional aids, but to evolve toward a minimum operational network capable of maintaining an acceptable level of continuity and efficiency during GNSS disruption. Rationalization should preferably be linked to equipment life-cycle decisions and coordinated with PBN implementation, procedure redesign and operator equipage.

DME is recognized as a particularly important terrestrial complement to GNSS for suitable RNAV operations. DME network planning shall consider geometry, coverage, spectrum compatibility, station density, aircraft equipage and operational requirements. VOR/VOR-DME may be retained where needed for residual conventional capability, while ILS is expected to remain the principal conventional precision-approach backup to GNSS-based approaches for the foreseeable future.

GNSS RFI mitigation shall be managed as a continuous risk-management process comprising threat monitoring, risk assessment and deployment of mitigation measures. States shall support effective GNSS spectrum protection, prohibit harmful interference, coordinate with telecommunications/spectrum, military and security authorities, establish reporting and response processes, and retain essential conventional infrastructure where operationally beneficial.

1.5.4 Alignment with ICAO Doc 8071 - Testing and Inspection of NAVAIDs

This CONOPS incorporates the NAVAID-specific testing and inspection framework of ICAO Doc 8071. Volume I provides the principal basis for ground and flight testing of conventional ground-based radio navigation systems, including VOR, DME, ILS and NDB. Volume II is applied only where satellite-based navigation services are part of the NAVAID architecture, specifically ABAS-, SBAS- and GBAS-supported procedures and GBAS ground/VDB verification.

For conventional NAVAIDs, the State-approved programme shall distinguish site proving, commissioning/categorization, periodic and special inspections as applicable. The programme shall combine ground measurements with flight inspection according to the parameter being verified, maintain correlation between ground and airborne measurements where such correlation is used, and preserve traceability of test equipment calibration.

Nominal flight-inspection periodicity from Doc 8071 Volume I shall be used as the planning baseline unless the State has an approved, documented modification supported by equipment stability, reliability history, monitoring capability, operational criticality and safety analysis. The nominal periodicity is 12 months for VOR and 180 days for ILS. NDB and DME programmes shall use the facility-specific ground and flight requirements in Chapters 5 and 3 respectively, with special inspections whenever faults, environmental changes, interference, major maintenance or other conditions could affect signal-in-space performance.

Where conventional VOR or DME infrastructure supports PBN, infrastructure assessment and flight inspection shall be linked so that the minimum set of facilities expected to support equipped users is identified and the signal coverage actually relied upon by the PBN operation is verified. In particular, VOR/DME use for PBN is limited to RNAV 5, while DME/DME is the principal conventional terrestrial infrastructure supporting RNAV operations alongside GNSS.

For GBAS, ground testing shall verify ground-subsystem performance and monitor operation at initial commissioning, following reconfiguration or corrective maintenance, and periodically when required by the manufacturer or State authority. Flight testing is required before commissioning for each runway/approach and after relevant procedure, configuration, site or maintenance changes, or when interference is suspected and cannot be cleared by ground testing. For SBAS and ABAS procedures, commissioning/special flight checks shall focus on procedure design correlation, continuous guidance and interference indications; any State-selected periodic checks shall be defined in the national programme.

1.5.5 Alignment with ICAO Doc 9613 - PBN Manual, Fifth Edition (2023), Corrigendum No. 1

This CONOPS applies ICAO Doc 9613 only to the aspects that directly affect NAVAID planning and service provision. Under the PBN concept, the navigation application is enabled by the combination of the navigation specification and the available NAVAID infrastructure. Conventional ground-based NAVAIDs include DME and VOR, while space-based NAVAIDs include GNSS elements. The infrastructure must provide the positioning sources permitted by the applicable navigation specification.

NAVAID infrastructure planning shall be integrated with PBN implementation planning. States and ANSPs shall assess infrastructure requirements for both normal and contingency operations, define the intended level and duration of service during outages, and coordinate any withdrawal of conventional NAVAIDs as an airspace change with procedure designers, operators, regulators and other affected stakeholders.

For RNAV 5, the permitted positioning sources include VOR/DME, DME/DME, INS/IRS and GNSS, and the ANSP shall assess whether the infrastructure is sufficient for the proposed operation, including reversionary modes. For RNAV

1 and RNAV 2, the standardized infrastructure criteria are based on GNSS, DME/DME and DME/DME integrated with an approved inertial system. Gaps in DME coverage can interrupt position updating unless approved inertial integration provides sufficient continuity.

For RNP 2, RNP 1 and Advanced RNP, GNSS is the required baseline positioning source in Doc 9613, while use of DME/DME may be permitted only where specifically authorized by the State and the applicable navigation specification criteria are satisfied. RNP APCH, RNP AR and RNP 0.3 depend on GNSS-based positioning as specified by Doc 9613. NDB is not a PBN positioning source.

Navigation service monitoring shall distinguish between the status of an individual NAVAID and the status of the PBN navigation service. For conventional routes or ILS, loss of the beacon can directly imply loss of service. For RNAV/RNP supported by multiple ranging sources, loss of one DME does not necessarily mean loss of the navigation service because service depends on redundancy, geometry and avionics capability. Therefore, DME/DME-supported applications shall identify critical DME facilities and required redundancy, and these facilities shall receive appropriate operational-status monitoring, maintenance priority and AIM publication.

The Doc 9613 Corrigendum No. 1 dated 14 April 2024 has been considered as part of the consolidated Fifth Edition source. Only corrigendum material relevant to the NAVAID-focused scope of this CONOPS is applied; aircraft-system, crew-authorization and procedure-design provisions that do not alter NAVAID infrastructure requirements are outside this update.

1.5.6 Alignment with ICAO Doc 10066 - PANS-AIM

This CONOPS applies ICAO Doc 10066 only to aeronautical information management provisions that directly affect the origination, quality assurance, publication, exchange and operational-status reporting of NAVAID information. The objective is to ensure that technical changes to VOR, DME, ILS/LOC, NDB, GNSS, SBAS and GBAS are translated into accurate, traceable and timely aeronautical information for operational users.

For NAVAID information, States and ANSPs shall maintain a controlled data chain from the technical data originator (normally CNS/engineering, procedure design or an authorized service provider) to AIS/AIM and the next intended user. NAVAID data shall be subject to applicable accuracy, resolution, integrity, traceability, timeliness, completeness and format requirements, with metadata sufficient to identify the organizations involved, the action performed, and the date and time of the action.

The AIP/eAIP shall identify radio navigation aids in the appropriate GEN, ENR and AD sections. At minimum, en-route NAVAIDs shall be reflected in GEN 2.5 and ENR 4.1, while radio navigation and landing aids supporting terminal and instrument-approach operations shall be reflected in AD 2.19 (and AD 3.18 for heliports). Where the same facility supports both en-route and aerodrome/heliport operations, it shall be described in both the ENR and AD portions, as applicable.

The AIP data set, where provided, shall include the applicable radio navigation aid properties, including type, identification, name, aerodrome/heliport served, hours of operation, magnetic variation, frequency/channel, position, elevation and other facility-specific attributes. The data set may replace certain textual AIP sections only when its availability is clearly referenced in the AIP in accordance with PANS-AIM.

Temporary unserviceability, restrictions or changes affecting the operational use of a NAVAID shall be coordinated between CNS, ATS and AIS/AIM and promulgated through NOTAM when operationally required. Permanent or planned changes to NAVAID infrastructure and associated procedures shall be managed through the applicable AIP

Amendment/AIP Supplement and AIRAC process so that technical implementation and operational publication remain synchronized.

Amendment No. 5 to Doc 10066, approved on 22 April 2026 and applicable on 26 November 2026, updates the definitions of area navigation, navigation specification and performance-based navigation. For this NAVAID-focused CONOPS, the relevant effect is the explicit linkage between a PBN application and the availability of GNSS signal-in-space and/or other NAVAID infrastructure within the airspace concept. This amendment is treated as a forward-applicability update and does not alter the technical performance requirements for individual NAVAID facilities.

Chapter 2 - Operational Environment

Describe the operational context where the NAVAIDs will be used:

- *Airspace structure (en route, terminal, approach).*
- *Traffic characteristics (density, types of operations).*
- *Integration with CNS/ATM systems (GNSS, ADS-B, ATFM, surveillance).*
- *Environmental, terrain, or interference factors.*
- *Current status and deficiencies of navigation services.*

2.1 Airspace Structure

2.1.1 Regulatory and planning framework

The airspace structure in the CAR region is defined and harmonized under the Electronic Regional Air Navigation Plan (eANP) CAR/SAM (Volumes I–III), which serves as a bridge between the SARPs, the GANP, and States' national plans, setting service/procedural requirements and modernization paths (ASBU). GREPECAS is the regional group responsible for its development and maintenance.

As complementary material, the Regional Supplementary Procedures (Doc 7030) for the CAR area supplement Annexes 2/6/10/11, PANS-ATM (Doc 4444) and PANS-OPS (Doc 8168) on regional operational issues. In parallel, the NAM/CAR RPBANIP and the work of the ANI/WG guide the PBN transition (RNAV/RNP routes en route and in TMAs, and RNP APCH approaches).

For PBN design/implementation, ICAO manuals (Doc 9613 and Doc 9992) are used; they detail RNAV/RNP specifications by phase of flight and the methodology for designing routes, SIDs/STARs, and instrument procedures.

2.1.2 En-route structure

FIR/UIR organization and the ATS network. The CAR en-route network rests on multiple adjacent FIRs (e.g., Santo Domingo, Piarco, La Habana, San Juan, Kingston, Port-au-Prince, as well as the Central America FIR and the Mexico FIR), with lower/upper ATS routes linking island and continental TMAs and the flows to NAM/SAM and the Atlantic. States' AIPs publish ENR 2.1 with FIR/TMA/CTA limits and ENR 3 with details of ATS routes, levels, lateral limits, and significant points—for example, in the Dominican Republic (Santo Domingo FIR).

Classification and service provision. Airspace classification and description (classes A–G, separation/service requirements) are published in each AIP's ENR 1.4.

PBN applications en route. Depending on the CNS environment and State policy, the en-route network is designed with RNAV 5/RNAV 2 on lower/upper airways; separation criteria, equipment, and procedural requirements are governed by Doc 9613, with additional guidance from the RPBANIP for the transition and performance.

2.1.3 Terminal structure (TMAs)

TMA design and sectorization. CAR TMAs typically overlay coastal/island terrain and international overflight corridors, which calls for PBN SIDs/STARs and sectorization aligned with seasonal traffic. The airspace and TMA concept model promoted by ICAO NACC proposes harmonized templates for arrival/departure flows, connectivity with upper/lower routes, and common rules for level use, facilitating seamless flow across adjacent FIRs.

Publication and classification. Each TMA's characteristics (lateral/vertical limits, airspace class, units and frequencies) are published in ENR 2.1.

PBN applications in TMAs. Terminal operations align with RNAV 1 / RNP 1 on SIDs/STARs, with CCO/CDO profiles where feasible, in accordance with Doc 9613/9992. Regional harmonization under the RPBANIP prioritizes coherent specifications and the progressive transition from conventional procedures.

2.1.4 Approach structure

PBN framework for approach. Regional policy (RPBANIP/NACC) drives the implementation of RNP APCH (LNAV and LNAV/VNAV) and, where complexity/terrain requires it, RNP AR APCH, with the necessary approvals and mitigations. States publish these procedures in the AIP (AD 2 and instrument charts), while retaining conventional procedures for contingency and continuity.

Technical and operational criteria. Doc 9613 sets the navigation specifications and operational requirements (aircraft/operator) for each application (RNP APCH, RNP AR). Doc 9992 guides the integration of PBN approaches with departures/arrivals to minimize conflicts in complex TMAs.

2.1.5 Design/management implications for the CONOPS

- **Inter-FIR PBN harmonization**: Use the NACC TMA concept model and RPBANIP guidance to ensure continuity of specifications (RNAV 5/2 en route; RNAV/RNP 1 in TMAs; RNP APCH/RNP AR), with clear connectivity from route-SID/STAR-IAP.
- **AIM publication and transparency**: Keep ENR 2.1/ENR 3/ENR 1.4 up to date, and coordinate SUP/NOTAM regionally for sectorization changes, route updates, or radar/ADS-B capability changes, in line with the eANP and Doc 7030.
- **Capacity and efficient profiles**: Prioritize CCO/CDO and segregated PBN routes (arrivals/departures) to mitigate conflicts and reduce emissions/noise, per Doc 9992/9613.
- **Resilience and reversion**: Maintain conventional procedures and alternate routes (VOR/DME/NDB where applicable) as the regional MON; align the transition with the RPBANIP to minimize disruption.

2.2 Traffic characteristics (density, types of operations).

2.2.1 Overview and flows

Traffic patterns in the CAR are structured around north–south and east–west flows that connect NAM, CAR and SAM, in addition to a dense intra-island and intra-Central American network.

ICAO's NACC Office, through the ATFM Task Force and the ASBU framework, has strengthened demand/capacity data analysis and regional coordination (including the use of CADENA to share near-real-time information). The group highlights the need for seasonal reviews and performance measurement frameworks to manage peaks and congestion, especially during the tourism high seasons typical of the Caribbean.

2.2.2 Density and seasonal variability

Traffic density concentrates in tourism-focused TMAs (e.g., island destinations in the Caribbean and Mexican hubs) and in regional connection nodes.

Top Busiest Routes (High Priority)

Route	Description	Primary Airports
Miami (MIA) – San Juan (SJU)	One of the highest-density corridors; heavy commercial & cargo.	MIA, SJU
Miami (MIA) – Nassau (NAS)	Frequent commercial, business, and GA operations.	MIA, NAS
Miami (MIA) – Havana (HAV)	Major U.S.–Cuba corridor; dense airspace.	MIA, HAV
Miami (MIA) – Punta Cana (PUJ) / Santo Domingo (SDQ)	High seasonal traffic; core route to Dominican Republic.	MIA, PUJ, SDQ
San Juan (SJU) – St. Maarten (SXM) / Antigua (ANU)	Key eastward regional flow.	SJU, SXM, ANU
Panama City (PTY) – Kingston (KIN) / Montego Bay (MBJ)	Connects Central America to northern CAR; heavy Copa and interline ops.	PTY, KIN, MBJ
Bogotá (BOG) – Punta Cana (PUJ)	Important South America–Caribbean leisure route.	BOG, PUJ
Mexico City (MEX) – Havana (HAV)	Dense regional connection; strategic north-south route.	MEX, HAV

Moderate / Developing Routes (Medium Priority)

Route	**Description**	**Primary Airports**
Kingston (KIN) – Port-au-Prince (PAP)	Regional link; limited alternates en route.	KIN, PAP
Havana (HAV) – Georgetown (GEO)	Sparse coverage; long overwater stretch.	HAV, GEO
Punta Cana (PUJ) – San Juan (SJU)	Medium density; overwater routing.	PUJ, SJU
San Juan (SJU) – Port of Spain (POS)	Moderate flow; essential for regional connectivity.	SJU, POS

Low Traffic / Sparse Coverage Routes (Low Priority but Operationally Sensitive)

Route	**Description**	**Primary Airports**
Curacao (CUR) – Paramaribo (PBM)	Sparse ATC coverage; limited alternates.	CUR, PBM
Port of Spain (POS) – Barbados (BGI)	Lower density but critical for contingency coverage.	POS, BGI
Havana (HAV) – Providenciales (PLS)	Long overwater; low frequency, but limited diversion options.	HAV, PLS
Belize City (BZE) – Grand Cayman (GCM)	Low flow but strategically located between Central America and CAR.	BZE, GCM

2.2.3 Predominant types of operations

Scheduled commercial transport (domestic and international). This accounts for the bulk of traffic at major hubs and destinations in the Caribbean/Mesoamerica, linking island TMAs with continental centers and long-haul routes.

Tourist charters and seasonal operations. Critical for island-resort connectivity and demand peaks.

Air cargo (dedicated and belly). Dedicated cargo and belly cargo sustain regional supply chains. In the Dominican Republic, the JAC reports Amerijet as the most active all-cargo airline in 2024 (931 flights), illustrating the role of integrators and specialized operators in Caribbean–North America consolidation.

General and business aviation (GA/BA), air taxi, and inter-island services. GA/BA and inter-island services (turboprops/light jets) are structural in the Caribbean and Central America, supporting point-to-point connectivity and access to smaller islands.

2.2.4 Operational features that affect service provision

- **Marked tourism seasonality**: need for ATFM plans with time-based review (pre-season, high season, post-event) and KPIs for capacity, efficiency, and predictability.
- **Heterogeneous fleets and stage lengths** (very short inter-island, medium/long haul): requires flexible management of levels and separation, as well as robust en-route/TMA connectivity.

2.3 Integration with CNS/ATM systems (GNSS, ADS-B, AIM, ATFM, surveillance)

2.3.1 GNSS as the "hub" in the CNS/ATM ecosystem

GNSS is the primary navigation source for PBN in en-route, terminal, and approach phases (RNAV/RNP; RNP APCH), with requirements, performance, and mitigations defined in Annex 10, Volume I and the GNSS Manual (Doc 9849), in close relation to the PBN Manual (Doc 9613). This covers availability, continuity, integrity, and phase-of-flight usage criteria, as well as the link to terrestrial alternatives (VOR/DME/ILS) for contingencies.

Beyond positioning, GNSS provides time synchronization to ground infrastructures (surveillance data fusion, time-stamping in ATS networks), an aspect captured in Annex 10, Volume IV and in the Surveillance Manual (Doc 9924), which emphasize time coherence for surveillance-based separation.

2.3.2 GNSS-primary" PBN and augmentations

The PBN Manual (Doc 9613) guides the selection of RNAV/RNP by phase of flight and how PBN design relies on GNSS while retaining conventional procedures for continuity.

Along the NAM/CAR boundary, WAAS (SBAS) enhances performance (e.g., LPV) across much of Mexico and parts of the Caribbean, which affects the publication of RNP APCH with LPV minima and cross-border operational continuity reviews (FAA publishes monitoring and operational status).

Implication: the CAR PBN portfolio should remain SBAS-agnostic at the regional level, leveraging LPV where coverage exists and maintaining DME/DME and conventional reversions elsewhere.

2.3.3 Surveillance: functional dependency on GNSS and degradation pathways

ADS-B OUT (1090ES) broadcasts onboard-computed positions (normally GNSS), enabling surveillance-based separation and data fusion with SSR/MLAT. Standards and operational use are framed by Annex 10, Volume IV, PANS-ATM (Doc 4444), and the Surveillance Manual (Doc 9924).

States/ANSPs in the sub-region (e.g., COCESNA) have ADS-B integration (terrestrial and, in remote/oceanic areas, space-based ADS-B), strengthening surveillance coverage and resilience when GNSS operates nominally.

Operational conclusion: if GNSS degrades at the aircraft or regional level, ADS-B quality/validity may be affected; ATS centers must switch to alternate surveillance modes (SSR/MLAT) or procedural control and adjust separation minima, in line with Doc 9924/Doc 4444 and NACC plans.

2.3.4 AIM/SWIM: how "GNSS status" flows into operations

PANS-AIM (Doc 10066) and Annex 15 underpin data management and notification (AIP, amendments, SUP, NOTAM) to communicate GNSS interference, unavailability, or capacity changes.

With SWIM (Doc 10039), GNSS status (alerts, monitoring, restrictions) can be exposed as an interoperable service (AIXM/FIXM/IWXXM) to ATC, ATFM, and operators, accelerating the operational reconfiguration cycle during GNSS events.

2.3.5 ATFM/CDM: using "GNSS status" to balance demand–capacity

The ATFM Manual (Doc 9971) defines how, in CDM, restrictions/contingencies (including GNSS loss or degradation) are incorporated to adjust routes, levels, and regulations. In the CAR, CADENA (CANSO) serves as the regional ATFM/CDM network to share information and coordinate tactical measures; recent reports document coordination for contingencies (e.g., hurricanes), which extends to GNSS incidents.

Recommended practice: when NOTAMs are issued for GNSS RFI or degradations are detected, ATFM should publish a flow plan (alternate routes, level caps, TMIs) and coordinate with ACC/TMA the application of PBN/conventional reversions until recovery.

2.3.6 GNSS interference and service continuity

NACC urges States to mitigate GNSS RFI and, in parallel, maintain a sufficient network of radio aids and airspace capacity for degradation periods—this is the foundation of the MON approach in this CONOPS. NACC has also promoted workshops on interference detection and assessment to standardize reporting and response.

Golden rule: GNSS failure or degradation is not equal to regional navigation service failure. Service continues through:

- a MON (DME/DME, VOR/ILS) engineered for RNAV 1/2/5 in contingency;
- alternate surveillance (SSR/MLAT) with appropriate separation;
- AIM/NOTAM/SWIM to inform;
- ATFM/CDM to modulate demand;
- ATS procedures for reconfiguration (Doc 4444).

2.4 Environmental/terrain/interference context

Mountains and island topography constrain line-of-sight for DME and VOR; dense coastal urban areas raise RFI risk. Space-weather disturbances in equatorial latitudes can degrade GNSS ionospheric performance, reinforcing the need for MON coverage and robust reversion procedures.

The CAR region (Mexico, Central America, and the Caribbean) combines islands with steep relief, mountain ranges close to aerodromes, and extensive coastal and maritime areas, which conditions the siting, coverage, and performance of conventional radio navigation aids and requires signal protection and resilience plans against severe weather events and radio-frequency disturbances.

2.4.1 Terrain influence on the coverage and usability of VOR/DME/ILS

The line-of-sight required by VOR and DME, together with terrain shadowing and multipath (reflections), can create unusable sectors or minimum service altitudes higher than standard.

For ILS/LOC/GP, the presence of terrain, buildings, or nearby reflective surfaces can induce guidance errors due to multipath. ICAO requires protection of ILS critical and sensitive areas to safeguard signal-in-space integrity and continuity; when these areas are infringed, the system may go out of tolerance or shut down.

2.4.2 Coastal effects and the marine environment

In coastal/island environments typical of the Caribbean, propagation paths over the sea can favor reflections and indirect paths that especially affect ILS localizer/glide path and, under certain conditions, NDB (e.g., coastal refraction and nocturnal phenomena). Therefore, siting and protection criteria for antennas in Annex 10, Volume I and flight inspections per Doc 8071 are essential to confirm that coverage, alignment, and integrity parameters meet tolerances in the aerodrome's real environment.

2.4.3 Severe weather and natural disasters (hurricanes/tropical storms)

Tropical cyclones are a critical factor in the region. The NACC regional contingency strategy aims to increase resilience of navigation capabilities/ANS services against interruptions or potential interruptions from these events, promoting pre-emptive withdrawal plans, site hardening (wind/flood), backup power, and rapid restoration.

2.4.4 RF interference and ionospheric disturbances (GNSS and the wider CNS environment)

The interference environment affects CNS as a whole. ICAO/NACC urges States to mitigate RF interference in GNSS and, in parallel, maintain a sufficient network of radio aids and airspace capacity for periods of GNSS degradation, which reinforces the MON concept and the conventional contingency reversion in this CONOPS. The region also participates in interference detection/assessment workshops to standardize reporting and operational response.

In the equatorial ionospheric environment (present in parts of Central America and the Caribbean), ICAO's GNSS Manual (Doc 9849) describes scintillation and ionospheric variability, which demand contingency procedures and monitoring/notification (NOTAM/PIREP), and strengthen the need for operational verification of conventional alternatives.

2.4.5 Implications for design, operations, and verification

- Siting and geometry: In mountainous TMAs or islands, engineer dual-DME coverage and publish unusable sectors or altitudes where applicable; coordinate frequencies to minimize interference.
- ILS signal protection: Establish and enforce critical and sensitive areas, with periodic verification and testing after physical-environment changes (construction, new structures).
- Inspection and validation: Apply Doc 8071 for coverage, alignment, and integrity testing of VOR/DME/ILS, tailoring campaigns by risk (post-storm, construction, environmental changes).
- Weather contingencies: Pre-emptive withdrawal and restoration procedures after hurricanes; coordination with NACC's regional response strategy and assurance of AIM publication (NOTAM/SUPP) throughout the event.
- Interference and GNSS: Implement spectrum monitoring/reporting, NOTAM templates, and GNSS-loss exercises; sustain a terrestrial MON sufficient for operational continuity in line with NACC recommendations.

2.5 Current status and deficiencies

Aging NDBs and some VORs persist; DME distributions are uneven (gaps at low altitudes, islands/over-water). Where SBAS coverage is partial or evolving, regional planning must remain SBAS-agnostic while designing PBN that does not assume ubiquitous SBAS. The infrastructure strategy therefore emphasizes DME densification and selective retention/optimization of VOR/ILS consistent with a MON concept.

The feedback received from the states indicated that the following were the main problems encountered in the operations and maintenance of radio navigation aids in the CAR region:

- Not having sufficient spare parts needed for timely repairs. In some cases, spare parts on station are less than the manufacturer's recommended spares list.
- Procurement of spares is often a lengthy process leading to either loss of redundancy or equipment being out service. Sending LRUs for factory repairs is also a lengthy process.
- Annual Flight Inspection missions are often expensive.
- States have been experiencing difficulties in attracting qualified technical staff and providing adequate technical training on specific equipment to enable technical staff to perform required preventative and corrective maintenance.
- Ground based Navaids prone to prolonged outages after natural disasters (Especially tropical cyclones). Equipment is usually withdrawn from service once storm warnings are issued for the state.
- Mountainous and hilly terrain are constraints to optimally site navaids and affect the performance of navaids often causing restrictions to be placed on the facilities.
- Older navaids technologies provide limited service, e.g. IFPs based NDBs may not provide the required minimums, also separations based on NDBs may not provide optimal use of airspace.
- The cost of acquiring test equipment used for the ground calibration of navaids can be significant.
- States have enquired about the procedure to decommission older navaids, notably NDB systems.
- The replacement of older systems is often met with extensive procurement processes and long lead times.

Chapter 3 – Operational Need

3.1 Maintain safe navigation capability during GNSS disruptions

The role of conventional navigation aids will evolve toward a reversionary terrestrial infrastructure for GNSS and, where required, toward supporting users not yet equipped or approved for GNSS-based PBN. Rationalization shall be coordinated with PBN implementation and equipment life cycles, while retaining the minimum terrestrial capability needed to maintain safety and an adequate level of operations during GNSS unavailability.

Each Navaid can fulfil different operational roles depending on the operational requirements.

3.1.1 During normal operations conventional navaids support:

- PBN applications as a primary PBN position source
- PBN applications as a secondary position source to GNSS
- Conventional procedures (e.g. either in an environment where no PBN procedures exist; or to support non PBN equipped aircraft)

3.1.2 During contingency operations conventional NAVAIDs support, as applicable:

- PBN applications as a backup positioning source due to GNSS outage
- Conventional procedures as a means of reversion during a GNSS outage

In order to plan the evolution of the navaid infrastructure, it is important to have a thorough picture of the type of operation that can be supported by each type of conventional Navaid. This understanding will enable to develop both and optimization and decommissioning plan of navaids as well as a coordinated evolution to a reversionary conventional infrastructure.

The following table identifies which Conventional navaids support which PBN specification.

PBN Specification	GNSS	DME/DME	VOR/DME	NDB
RNAV 10	O			
RNAV 5	O	O	O	
RNAV 2 & 1	O	O		
RNP 4	R			
RNP 2	R	SA		
RNP 1	R	SA		
Advanced RNP	R	SA		
RNP APCH	R			
RNP AR	R			
RNP 0.3	R			

Doc 9613 NAVAID infrastructure legend: R = required positioning source; O = optional positioning source permitted by the navigation specification; SA = DME/DME may be used only with specific State authorization and subject to the applicable navigation specification criteria. At least one permitted NAVAID/positioning source is required for the promulgated navigation application where a choice exists.

The following table identifies roles in PBN, opportunities and solutions for conventional navaids

Navaid	Role in PBN	Opportunities and Solutions
NDB	NDB has no role in PBN	Except where no other alternative is available due to constraints such as operator fleet, terrain, safety, or financial limitations: a) The use of NDBs as en-route navigation aids or terminal area markers is generally obsolete b) NDBs used to support SID/STAR should be replaced by RNAV waypoints c) NDBs used as locators to assist in ILS intercept operations should be replaced with RNAV waypoints d) The use of NDB to support missed approach operations should be discouraged except where local safety cases require a non-GNSS missed approach capability e) NDBs used as a non-precision approach aid should be withdrawn f) Therefore, the retention of NDB based ATS routes and procedures is not recommended. However, if a need for NBDs is identified in the airspace concept, the reason must be fully explored and justified. Additionally, the required facilities (including co-located DMEs) should be identified.
VOR	VOR has limited role in PBN supporting only RNAV 5, if collocated with a DME	No new stand-alone VOR facilities should be implemented. However, VORs may be retained to serve the following residual operational purposes: a) As a reversionary navigation facility b) To provide navigation, crosschecking and situational awareness, especially for terminal areas c) For VOR/DME inertial updating where DME/DME updating is not available d) For non-precision approaches, as long as users are not equipped for RNP approaches and if no other suitable means of precision approach is available e) For conventional SID/STAR to serve non-PBN-capable aircraft. f) As required to support the operations of State aircraft; and g) To support procedural separation (as detailed in Doc 4444) In order to provide DME-based RNAV capabilities, those locations which are retained for VOR should normally be equipped with a co-located DME. The main residual operational role of the VOR is to allow the operation of non- capable PBN aircraft during the transition to PBN, as well as providing alternate means of navigation during contingency operations. This role may be envisaged both for er-route/TMA and for approach operations
DME	DME/DME fully supports PBN operations based on RNAV 1, RNAV 2, and RNAV 5 navigation specifications. Consequently, DME/DME (for equipped aircraft) is the most suitable current terrestrial PBN capability. DME/DME provides a fully redundant capability to GNSS for RNAV applications, and a suitable reversionary capability for RNP applications requiring an accuracy performance of +/- NM (95 percent) laterally, where supported by an adequate DME infrastructure.	Plan the evolution of DME infrastructure by considering the following: a) Where a terrestrial navigation reversion capability is required, a DME network capable of supporting DME/DME navigation should be provided, where possible b) The DME network design should consider cost-savings opportunities where possible, such as the withdrawal from a site if an associated VOR is removed, or the possibility to efficiently set up new DME stand-alone sites where other ANSP CNS assets are located Consequently, DME/DME is the most suitable current conventional PBN capability. DME/DME provides a fully redundant capability to GNSS for RNAV applications, and a suitable reversionary capability for RNP applications requiring an accuracy performance of +/- 1 NM (95 percent) laterally, where supported by an adequate DME infrastructure.

Annex 10 rationalization principles to be applied in the CAR region include the following:

- NDB: NDBs have no substantive role in PBN other than limited position cross-checking/situational awareness. Except where no viable alternative exists because of fleet, financial, terrain or safety constraints, their en-route, terminal and non-precision approach roles should be replaced by RNAV/PBN solutions and rationalized.
- VOR/VOR-DME: VOR/DME can support RNAV 5, but its use as the principal PBN infrastructure is discouraged. A residual VOR or VOR/DME capability may be retained where required for users without suitable DME/DME capability or as part of the reversion concept.
- DME/DME: DME/DME supports RNAV 1, RNAV 2 and RNAV 5 and is the preferred current terrestrial PBN reversion capability where adequate geometry and coverage can be provided. Network design should fill operationally significant gaps, exploit cross-border/TACAN facilities where agreements permit, and avoid excessive investment for low-altitude coverage.
- Geographic limitations: consistent DME/DME service may not be practical at very low altitudes, in terrain-constrained areas, on small islands or over water. The CAR MON shall therefore be performance- and scenario-based rather than based on a uniform facility-density target.
- Reversion scenarios: infrastructure evolution shall be accompanied by operational reversion scenarios that consider aircraft equipage, INS capability, surveillance, communications, ATC capacity, common-mode failures and any resulting operational restrictions.

Based on the considerations above, the need to consult aircraft operators and regional stakeholders, and to ensure safety, efficiency, and cost- effectiveness of the proposed solutions, the strategy is to:

a) Rationalize NDB and VOR and associated procedures.
b) Align rationalization planning with equipment replacement cycles and PBN implementation planning.
c) Replace approaches without vertical guidance with vertically guided approaches.
d) Where terrestrial navigation reversion capability is required, evolve the existing DME infrastructure towards providing a PBN infrastructure complementary to GNSS
e) Provide residual capability based on VOR (or VOR/DME if possible) to cater to airspace users not equipped with suitable DME/DME avionics, where required.

It was initially expected that the rationalization of legacy navigation infrastructure would have been a consequence of a top-down process where the implementation of PBN and GNSS within volumes of airspace would result in navigation aids being made totally redundant so they could be switched off.

An alternate strategy, a bottom-up approach should be considered as at the end of each navigation aid's economic life, an opportunity exists to consider if a limited PBN implementation to alleviate the need for the replacement of the facility is more cost-effective than the replacement of the navigation aid.

Chapter 4 Operational Objectives

Introduction

This chapter sets measurable, time-bound objectives to deliver a resilient, interoperable, and performance-based navigation service for the CAR region (Mexico, Central America, and the Caribbean). The objectives align with ICAO's CAR/SAM eANP (Vol. I–III) and the ASBU framework, and are traceable to Annex 10, Doc 9613 (PBN Manual), Doc 8071 (Testing of Radio Navigation Aids), Doc 4444 (PANS-ATM), PANS-AIM (Doc 10066), and State AIP/eAIP publications. The strategy is GNSS-primary for PBN, with a Minimum Operational Network (MON) of terrestrial aids for reversion; AIM/eAIP data flows, ATFM/CDM processes, and remote control and monitoring (RCMS) complete the operational backbone.

4.1 En-route terrestrial reversion backbone: operationally sufficient DME/DME coverage

Objective. Establish and validate an operationally sufficient DME/DME terrestrial reversion backbone for designated CAR airspace and contingency routes, prioritizing areas where adequate geometry can be achieved and recognizing that uniform dual-DME coverage may not be practical over water, on small islands, at very low altitude or in terrain-constrained environments.

Rationale. Annex 10, Volume I, Attachment H identifies DME/DME as the most suitable current terrestrial PBN capability for RNAV 1, RNAV 2 and RNAV 5 and encourages its use where a terrestrial reversion capability is required, subject to operational feasibility and cost-effectiveness.

Doc 9613 requires the ANSP to assess the NAVAID infrastructure for the proposed operation, including reversionary modes. For RNAV 1 and RNAV 2, route design shall account for the performance achievable with GNSS, DME/DME and DME/DME/inertial positioning. Where DME is the only source used for position updates, coverage gaps can prevent updating; approved inertial integration may permit extended gaps, but this shall be supported by the applicable aircraft/navigation specification criteria.

For DME/DME-supported RNAV 1 applications, the regional design objective should provide adequate redundancy wherever operationally practicable. Two independent DME pairs capable of supporting positioning along the required flight path provide full redundancy; a common DME shared between the two pairs provides limited redundancy; and a single usable pair means each station in that pair is a critical NAVAID whose outage may remove the DME/DME navigation service for that segment.

KPIs & milestones.

- Percentage of designated reversion airspace/route segments with validated DME/DME geometry and coverage: target to be established after the regional baseline assessment.
- Percentage of designated contingency route segments supportable by DME/DME (RNAV 1/2/5 as applicable): target to be established from operational requirements and fleet equipage analysis.

4.2 Contingency precision: maintain ILS at designated alternate/contingency aerodromes

Objective. Maintain ILS at designated alternates/contingency aerodromes to ensure continuity under GNSS degradations.

Rationale. Annex 10 Vol. I defines ILS performance, monitoring, and protection; Doc 8071 sets tolerances and flight-inspection intervals.

KPIs & milestones.

- 100% of designated alternates with operational ILS.

4.3 End-to-end interoperability and monitoring via RCMS

Objective. Achieve centralized interoperability and monitoring of CNS/ATM (COM/NAV/SUR) using a Remote Control & Monitoring System (RCMS) with SNMP-based integration, event traceability, and consistent time-stamping.
Rationale. Annex 10 requires surveillance/alarms and performance control for facilities and NAVAIDs.
KPIs & milestones.

- ≥ 95% of critical CNS elements remotly monitored by year.
- ATFM/CDM integration: automatic CNS-status feed available in CADENA events.

4.4 Rationalize NDBs in line with PBN implementation and the MON strategy

Objective. Progressively withdraw NDBs whose operational function can be safely replaced, while preserving necessary services where no viable alternative exists because of user-fleet, financial, terrain or safety constraints. Rationalization shall be coordinated with PBN procedure implementation, facility life cycles and the regional MON.
Rationale. Annex 10, Volume I, Attachment H states that NDBs have no substantive role in PBN and that their en-route, terminal-marker, SID/STAR, ILS-locator and non-precision approach functions should generally be replaced, subject to justified exceptions.

KPIs & milestones.

- 100% of NDBs reviewed through a documented operational/safety assessment by the agreed regional milestone; withdrawal targets to be established State-by-State based on available alternatives and approved transition plans.
- Zero aerodromes left without a published IFR approach after withdrawal (RNAV or conventional).

4.5 Annex 10 service assurance for retained NAVAIDs

Objective. Ensure every retained MON or operationally significant NAVAID is subject to periodic ground and flight testing, timely operational-status dissemination, suitable power supply and continuity arrangements commensurate with its operational use.

KPIs. Percentage of retained facilities within approved inspection validity; percentage of critical status changes communicated to ATS/AIM within the State-defined time objective; percentage of MON facilities with tested backup-power/continuity arrangements.

4.6 AIM and eAIP publication interoperable with ATFM/CDM

Objective. Keep AIP/eAIP current (ENR/AD), with timely SUP/NOTAM and structured data per PANS-AIM (Doc 10066), enabling downstream use by CADENA for ATFM measures.

KPIs.

- AIRAC compliance ≥ 99%; time-to-reflect CNS changes < 1 AIRAC cycle; ATFM consumption of AIM data in CADENA events.

4.7 Regional ATFM/CDM coordination

Objective. Integrate CNS status (from RCMS/AIM) into CADENA teleconferences, issuing TMIs and alternate route/level scenarios for contingencies (e.g., ILS outages, NDB withdrawals, DME works).

KPIs.

- CAR State participation coverage in CADENA; reaction time from CNS alert → TMI issuance; average delay per event.

Chapter 5 – Operational Cocept

Describe *how* the system will operate. Include:

- **System architecture** (types of NAVAIDs, configuration, backup).
- **Operational modes** (normal, degraded, maintenance, contingency).
- **Operational workflow:** flight procedures → ATC use → maintenance → reporting.
- **Interfaces with other systems:** Flight Procedures (PBN), surveillance, ATC automation.
- **Tailoring of ICAO requirements:** Annex 10, Doc 8071, Doc 9849, etc.

Include a block diagram or flow diagram showing the interaction of users and systems.

5.1 General Operational Concept

The CAR regional navigation infrastructure shall be developed under a **GNSS-primary, PBN-enabled and MON-resilient operational concept**. Under this concept, GNSS will be used as the principal navigation source for modern Performance-Based Navigation (PBN) operations, while a rationalized network of conventional ground-based navigation aids will be retained, modernized or selectively enhanced to provide continuity of IFR operations during GNSS degradation, interference, outage or contingency events.

The purpose of this chapter is to describe how the navigation system will operate in the CAR region, how conventional NAVAIDs and GNSS-based services will complement each other, how the Minimum Operational Network (MON) will support resilience, and how operational, maintenance, reporting and contingency processes will be coordinated among States, ANSPs, operators and other stakeholders.

The operational concept is based on the following principles:

1. **GNSS as the primary navigation enabler for PBN operations.**

   GNSS shall be the main navigation source for RNAV and RNP operations in en-route, terminal and approach environments, subject to aircraft capability, procedure design, regulatory approval and service availability.

2. **Conventional NAVAIDs as a resilient backup and transition layer.**

   VOR/DME, DME/DME and ILS/LOC facilities shall continue to support conventional operations, non-GNSS equipped aircraft, contingency operations and the regional MON.

3. **MON as the regional safety net**

   The MON shall not be understood as the preservation of all legacy NAVAIDs. It shall be a right-sized, technically justified and operationally validated network of conventional navigation infrastructure capable of supporting safe IFR continuity when GNSS is unavailable or unreliable.

4. **Progressive rationalization of legacy infrastructure**

   Obsolete or low-benefit facilities, particularly NDBs, shall be progressively decommissioned when safety, operational continuity, user equipage and procedure availability permit. Retention shall be justified through safety and operational analysis.

5. **Regional harmonization and cross-border interoperability**

   The CAR region contains multiple FIRs, island chains, oceanic segments, mountainous terrain and cross-border traffic flows. Navigation infrastructure planning shall therefore be coordinated regionally, not only nationally.

6. **Risk-based implementation**

   Decisions on commissioning, renewal, retention or decommissioning of NAVAIDs shall be based on safety assessments, traffic needs, airspace design, PBN implementation status, aircraft equipage, environmental risks, lifecycle costs and MON requirements.

7. **Integrated operational information flow**

   Flight procedures, AIM, ATC automation, surveillance, ATFM/CDM, maintenance systems and GNSS interference reporting shall operate as a coordinated information ecosystem.

5.2 System Architecture

5.2.1 Architecture Overview

The CAR regional navigation system shall consist of five interrelated layers:

1. **Space-based navigation layer**

   GNSS constellations and augmentations supporting RNAV/RNP, RNP APCH, *SBAS-based procedures and GBAS-based GLS approaches where implemented (in future).*

2. **Ground-based conventional NAVAID layer**

   VOR, DME, VOR/DME, DME/DME-capable infrastructure, ILS/LOC and, where temporarily justified, NDB facilities.

3. **Aircraft avionics layer**

   GNSS receivers, SBAS-capable receivers, GBAS-capable multimode receivers, FMS, DME/DME-capable RNAV systems, VOR/ILS receivers and onboard monitoring/alerting functions.

4. **Operational control and information layer**

   ATC systems, ATC automation, surveillance, AIM/AIP/NOTAM, ATIS/D-ATIS, ATFM/CDM and SWIM-compatible information services where available.

5. **Monitoring, maintenance and safety assurance layer**

   NAVAID monitoring systems, RCMS/NMS platforms, flight inspection, ground inspection, GNSS performance monitoring, GNSS RFI reporting, maintenance records, safety assessments and post-event lessons learned.

The architecture shall be designed to support both **normal operations** and **contingency operations**, ensuring that no single navigation source becomes an unacceptable point of failure for the regional air navigation system.

5.2.2 Navigation Infrastructure Components

The CAR region network of navigation aids is envisioned to comprise the following systems:

- SBAS, where coverage and aircraft equipage support operational use;
- GBAS/GLS, where implemented and approved;
- VOR and DVOR;
- DME and DME/DME-capable networks;
- VOR/DME;
- ILS/LOC;
- GNSS;
- NDB, only where temporarily justified;
- Associated monitoring, maintenance and reporting systems.

Infrastructure planning shall include:

- Installation of new facilities where operationally justified;
- Modernization or replacement of critical existing facilities;
- Relocation or optimization of facilities affected by terrain or siting constraints;
- Decommissioning of obsolete facilities;
- Designation of MON facilities and MON airports;
- Assessment of DME/DME geometry;
- Validation of coverage at required altitudes;
- Integration with PBN procedure design and ATC operations.

The decision to install, retain, modernize or decommission any facility shall be made on a case-by-case basis by the respective State or ANSP, coordinated regionally where cross-border impacts exist.

5.3 Conventional NAVAID Architecture

5.3.1 NDB

NDBs provide non-directional bearing information to aircraft equipped with ADF receivers. However, NDB technology provides limited accuracy and is not aligned with the long-term PBN evolution of the region. NDBs do not support modern RNAV/RNP specifications and are increasingly unsuitable for efficient airspace design, optimized separation, low-minima instrument procedures and resilient regional operations.

In the CAR operational concept, NDBs shall be treated as **legacy systems**. Their continued use shall be considered only when:

- No practical alternative procedure is available;
- Terrain, geography or infrastructure constraints require temporary retention;
- The NDB supports a unique contingency function;
- The facility is needed for a defined transition period;
- Aircraft equipage in the affected operational environment still requires it;
- Decommissioning would create an unacceptable safety or access impact.

NDB retention shall require a documented justification, including:

- Operational need;
- Traffic affected;
- Procedure dependency;
- Availability of PBN, VOR/DME, DME/DME or ILS alternatives;
- Maintenance status and spare parts availability;
- Flight inspection status;
- Safety assessment;
- Planned end-state and transition timeline.

NDBs shall not be retained solely because they remain installed. Where NDBs are no longer operationally necessary, States should develop a phased decommissioning plan, coordinated through AIM and AIRAC cycles, ensuring that affected procedures are withdrawn, replaced or redesigned.

When an NDB is co-located with other infrastructure, such as DME or an aerodrome navigation site, the full site may still remain valuable for future DME, VOR/DME or monitoring infrastructure. In such cases, decommissioning the NDB does not necessarily imply abandoning the site.

5.3.2 VOR and VOR/DME

VOR facilities provide azimuth guidance and remain relevant for conventional en-route navigation, terminal procedures and non-precision approaches. When co-located with DME, VOR/DME facilities can also support RNAV operations where aircraft avionics and applicable navigation specifications allow their use as sensor inputs.

In the CAR region, VOR/DME facilities shall serve four main purposes:

1. **Conventional navigation support**

   VOR/DME facilities shall support conventional routes, arrivals, departures and approaches where PBN procedures are not yet available or where non-PBN aircraft must be accommodated.

2. **Secondary navigation source**

   During normal GNSS-primary operations, VOR/DME may serve as a secondary navigation source for appropriately equipped aircraft.

3. **MON infrastructure**

   Selected VOR/DME facilities shall form part of the MON where they provide meaningful coverage, support cross-border route continuity, feed contingency procedures or support designated MON airports.

4. **GNSS contingency reversion**

   During GNSS degradation, VOR/DME facilities may support conventional navigation, procedural control, vectoring references, holding, diversions and access to airports with conventional procedures.

During normal operations, VOR/DME facilities may support:

- Conventional en-route navigation;
- Terminal conventional procedures;
- Non-precision approaches;
- RNAV operations where permitted by the aircraft system and procedure design;

- Backup positioning to GNSS;
- ATC vectoring and situational awareness references;
- Training and transition operations.

During degraded or contingency operations, VOR/DME facilities may support:

- Reversion from GNSS-based PBN to conventional navigation;
- Navigation to designated MON airports;
- Contingency routes;
- Non-GNSS holding and arrival procedures;
- Conventional non-precision approaches;
- Recovery from GNSS interference events.

VOR/DME retention shall be prioritized where the facility:

- Supports high-density traffic flows;
- Provides coverage across FIR boundaries;
- Supports island-to-island or mainland-to-island connectivity;
- Enables access to alternate aerodromes;
- Supports MON coverage objectives;
- Has acceptable maintainability and lifecycle support;
- Can be protected from physical, environmental and spectrum risks.

Facilities with overlapping coverage, low operational usage, poor maintainability or limited MON value may be candidates for rationalization or decommissioning.

5.3.3 DME and DME/DME

In applying Doc 9613, DME/DME service planning shall identify the actual DME pairs used to support each relevant RNAV application, the geometry and coverage available along the route or procedure, and any DME whose loss would cause the navigation service to become unavailable. Such facilities shall be designated as critical NAVAIDs for the affected application.

Where two independent DME pairs can provide positioning throughout the required flight path, the application has full DME redundancy. Where the pairs share a common DME, redundancy is limited. Where only one pair can provide positioning, both stations are critical. This classification shall be reflected in maintenance priority, outage coordination, NOTAM/AIP information and contingency planning.

DME provides slant-range distance information between an aircraft and a ground transponder. When two or more suitable DME stations are available, aircraft RNAV systems may calculate position using DME/DME, subject to avionics capability, geometry, signal coverage, procedure design and operational approval.

In the CAR operational concept, DME/DME is a critical element because it provides a GNSS-independent positioning capability for selected RNAV operations. It is particularly relevant in terminal airspace and high-density route structures where the region seeks to maintain operational continuity during GNSS degradation.

DME/DME shall be planned as:

- A secondary positioning source during normal GNSS-primary operations;
- A backup source for selected RNAV operations during GNSS degradation;

- A key component of the MON where geometry permits;
- A complement to VOR/DME and ILS at designated airports;
- A means to reduce dependency on legacy NDB infrastructure.

However, DME/DME shall not be assumed to be available everywhere. Its feasibility depends on:

- Number and location of DME facilities;
- Geometry between DME stations and aircraft flight paths;
- Altitude of operation;
- Terrain masking;
- Island geography and over-water routes;
- DME transponder capacity;
- Frequency/channel assignment;
- Signal-in-space coverage;
- Aircraft equipage and FMS capability;
- Operational approval for DME/DME RNAV use.

In continental or dense terminal environments, DME/DME may provide robust RNAV support. In island chains, oceanic segments or mountainous terrain, DME/DME may be more difficult due to geometry limitations and limited siting options. Therefore, each State and ANSP shall perform DME/DME coverage and geometry assessments before relying on DME/DME as part of the MON.

During normal operations, DME/DME may support:

- RNAV 1 terminal operations where infrastructure and avionics permit;
- RNAV 2 or RNAV 5 en-route operations where applicable;
- Bbackup positioning to GNSS;
- Continuity for SID/STAR operations;
- Reduction of dependency on VOR radials or NDB procedures;
- Operational resilience in high-density TMAs.

During GNSS degradation or outage, DME/DME may support:

- Continued RNAV operations where approved;
- Navigation to a MON airport;
- Contingency SID/STAR operations;
- ATC-managed re-routing;
- Reduced but safe traffic flows;
- Tactical recovery from localized GNSS interference.

The regional DME/DME architecture should include:

- Identification of critical DME pairs;
- Modelling of DME/DME coverage at operational altitudes;
- Identification of DME gaps;
- Publication of DME limitations where necessary;
- Procedures to manage DME outages affecting RNAV availability;
- Monitoring of DME status through centralized maintenance platforms;

- Coordination of channel planning to avoid interference;
- Regional prioritization of DME modernization.

A DME facility should be considered a MON candidate when it contributes to one or more of the following:

- DME/DME RNAV coverage in terminal airspace;
- Backup navigation for major traffic flows;
- Access to alternate or contingency airports;
- Cross-border continuity;
- Support for high-density or high-complexity airspace;
- Reduction of risk during GNSS outage.

5.3.4 ILS and Localizer

ILS is not a PBN infrastructure, but it remains essential for precision approach operations, especially in low-visibility environments, high-traffic airports and locations where GNSS-based approach capability is not sufficient or not available to all users.

In the CAR operational concept, ILS/LOC facilities shall be retained selectively where they provide high operational value. The purpose of ILS in the future navigation environment is not to compete with GNSS-based approaches, but to complement them and provide a robust conventional precision approach capability.

ILS shall support:

- Precision approach operations;
- Low-visibility operations where approved;
- Access to major international airports;
- Conventional fallback during GNSS degradation;
- Support for non-SBAS or non-GBAS equipped aircraft;
- Operational continuity during RNP APCH, SBAS or GBAS unavailability;
- MON airport capability.

During normal operations, ILS may:

- Complement RNP APCH, LPV or GLS procedures;
- Provide precision approach capability to mixed-equipage fleets;
- Support high-traffic airports with established procedures;
- Enable stable operational minima;
- Support alternate aerodrome planning.

During contingency operations, ILS may:

- Provide the primary approach option when GNSS is unavailable;
- Support diversions to designated MON airports;
- Support traffic recovery after GNSS interference;
- Reduce operational disruption during SBAS or GBAS outages;
- Enable conventional approach capability when PBN procedures are suspended.

ILS retention or modernization should be prioritized where:

- Traffic volume is significant;
- Low-visibility operations are operationally important;
- The airport is a designated MON airport;
- No equivalent GNSS-based approach resilience exists;
- Terrain or weather makes precision approach capability critical;
- The facility supports regional alternate planning;
- Lifecycle support is available.

ILS decommissioning should only occur after:

- Safety assessment;
- Operator consultation;
- Evaluation of alternative procedures;
- Confirmation of user equipage;
- Assessment of weather and minima impacts;
- Completion of flight validation and publication changes;
- Availability of GNSS and/or conventional fallback alternatives.

5.4 GNSS-Based Services Architecture

5.4.1 GNSS

GNSS provides the primary positioning, navigation and timing capability for the CAR PBN environment. It enables RNAV and RNP operations in en-route, terminal and approach phases and supports modern aircraft navigation systems, ATC surveillance systems, aircraft tracking and operational efficiency.

GNSS supports:

- RNAV en-route operations;
- RNAV/RNP terminal procedures;
- RNP APCH;
- LNAV and LNAV/VNAV approaches where applicable;
- SBAS-based LP/LPV procedures where service is available;
- GBAS-based GLS procedures where implemented;
- ADS-B position reporting;
- Aircraft navigation databases and FMS operations;
- ATFM and airspace efficiency improvements.

However, GNSS signals are vulnerable to radiofrequency interference, including jamming, spoofing, unintentional interference, ionospheric effects, receiver anomalies and local masking. Therefore, GNSS shall be used as the primary navigation enabler, but not as the only resilience layer.

The operational concept requires that GNSS-based operations be supported by:

- Service availability assessment;

- Aircraft equipage and approval;
- RAIM/ABAS prediction where applicable;
- SBAS availability assessment where used;
- GBAS local performance monitoring where installed;
- GNSS RFI reporting procedures;
- ATC contingency procedures;
- AIM and NOTAM processes;
- MON fallback planning.

5.4.2 Satellite Based Augmentation System (SBAS) Future

SBAS provides satellite-based corrections and integrity information to improve GNSS performance and support approach procedures with vertical guidance where service availability, regulatory approval and aircraft equipage permit.

In the CAR region, SBAS shall be considered an important enabler for:

- APV operations;
- LP and LPV approach procedures;
- Improved access to airports without ILS;
- Lower minima where operationally justified;
- Reduced dependency on ground-based approach aids;
- Improved safety for runway ends currently served only by non-precision procedures.

SBAS implementation shall be based on:

- Verified service coverage;
- Aerodrome and runway prioritization;
- Aircraft equipage data;
- Operational benefits;
- Obstacle and terrain assessment;
- Procedure design and validation;
- Regulator approval;
- Maintenance of fallback procedures.

SBAS shall not automatically replace ILS or MON infrastructure. Rather, it shall complement the regional navigation system, especially at airports where installing or maintaining ILS is not economically or technically justified.

Where SBAS is available, States should prioritize:

- RNP APCH with LPV minima at suitable runway ends;
- LNAV/VNAV fallback minima where appropriate;
- Publication of clear chart notes;
- Operator consultation;
- Contingency procedures for SBAS unavailability;
- Integration with NOTAM and ATIS/D-ATIS.

5.4.3 Ground Based Augmentation Systema (GBAS)

GBAS provides locally generated GNSS corrections and integrity monitoring to support GLS approaches at equipped airports. A single GBAS installation may support multiple runway ends, subject to system configuration, procedure design and regulatory approval.

In the CAR region, GBAS should be considered selectively, particularly at airports where there is a strong operational, capacity, environmental or resilience business case. Candidate airports may include those with:

- High international traffic;
- Multiple runways;
- Need for flexible approach path design;
- Constraints affecting ILS siting;
- Desire to reduce ILS infrastructure dependency;
- Significant operational benefits from GLS;
- Operator fleet equipage capable of GLS.

GBAS implementation requires:

- Site survey;
- GNSS performance assessment;
- Ionospheric threat analysis;
- VHF Data Broadcast coverage assessment;
- Runway procedure design;
- Aircraft/operator equipage assessment;
- Regulatory approval;
- Maintenance and monitoring arrangements;
- Flight validation and operational trial;
- Integration with ATC procedures and AIM.

GBAS may support:

- GLS approaches;
- Multiple runway procedures from one ground station;
- Flexible final approach paths;
- Reduced ground infrastructure compared with multiple ILS installations;
- Improved approach availability for equipped aircraft;
- Resilience when used alongside ILS and RNP APCH.

Challenges include:

- Avionics equipage;
- Certification and approval complexity;
- Dependence on GNSS integrity;
- Oonospheric effects;
- VHF data broadcast coverage;
- Maintenance expertise;
- Business case justification;

- Operational training;
- Need for conventional fallback during GBAS outage.

GBAS shall therefore be implemented through a structured safety and operational approval process, not as a stand-alone technology deployment.

5.5 Minimum Operational Network Architecture

The MON is the conventional navigation safety net that enables continued IFR operations when GNSS services are unavailable, unreliable or intentionally degraded.

The MON shall be designed to answer the following operational question:

If GNSS becomes unavailable or unreliable in a defined airspace volume, can aircraft safely navigate, receive ATC service, proceed to a suitable airport and conduct an instrument approach using non-GNSS means?

The MON shall include selected combinations of:

- VOR/DME;
- DME/DME-capable infrastructure;
- ILS/LOC;
- Conventional instrument procedures;
- MON-designated airports;
- ATC contingency routes and procedures;
- Surveillance and communication support;
- AIM/NOTAM and ATFM/CDM processes.

The MON shall not necessarily provide the same capacity or efficiency as normal GNSS-primary operations. Its objective is to preserve safety and minimum operational continuity, not to fully replicate normal operations.

The MON design shall consider:

- Major traffic flows;
- International routes;
- FIR boundary transitions;
- Island connectivity;
- Alternate aerodrome access;
- Terrain and weather;
- DME/DME geometry;
- VOR/DME coverage;
- ILS/LOC availability;
- Infrastructure vulnerability to hurricanes and other natural hazards;
- Maintenance sustainability;
- Power and telecommunications resilience;
- ATC procedures and controller workload;
- Operator equipage.

MON airports should be selected based on:

- availability of at least one conventional instrument approach;
- runway length and operational suitability;
- rescue and firefighting capability;
- fuel and diversion capacity;
- geographic distribution;
- role in regional contingency planning;
- resilience of navigation, communication and surveillance infrastructure;
- ability to support international operations.

The MON shall be reviewed periodically, at least every three to five years, and after major events such as:

- GNSS interference events;
- Major NAVAID outages;
- Hurricanes or natural disasters;
- Significant airspace redesign;
- Airport closures or runway changes;
- Major fleet equipage changes;
- Introduction of SBAS or GBAS procedures;
- Decommissioning of key conventional facilities.

5.6 Operational Modes

The navigation system shall operate under five principal operational modes:

1. Normal mode;
2. Degraded mode;
3. Maintenance mode;
4. Contingency mode;
5. Recovery and return-to-service mode.

5.6.1 Normal Mode

Normal mode applies when GNSS, conventional NAVAIDs, surveillance, ATC automation and AIM information are operating within required parameters.

In normal mode:

- GNSS is the primary navigation source for PBN operations;
- Aircraft operate RNAV/RNP procedures as cleared;
- SBAS or GBAS procedures are used where published and available;
- DME/DME and VOR/DME may operate as secondary or backup sources;
- ILS remains available for precision approach operations;
- ATC applies normal separation minima;
- Surveillance systems provide normal coverage;
- AIM data and NOTAM information are current;
- NAVAID monitoring systems report normal status;
- Operators use approved navigation databases.

Normal mode shall support maximum system efficiency, including:

- Optimized routes;
- Continuous climb and descent operations where available;
- PBN SID/STAR structures;
- Flexible approach selection;
- Reduced controller and pilot workload.

5.6.2 Degraded Mode

Degraded mode applies when one or more navigation services remain available, but performance, continuity, integrity or availability is reduced.

Triggers may include:

- GNSS RFI reports;
- Jamming or spoofing indications;
- Multiple aircraft reporting GNSS anomalies;
- SBAS unavailability;
- GBAS outage;
- DME outage affecting RNAV availability;
- VOR/DME operating without redundancy;
- ILS degradation;
- Surveillance degradation related to GNSS-dependent ADS-B;
- Severe weather affecting navigation infrastructure;
- Power or telecommunications degradation.

In degraded mode:

- ATC shall assess operational impact;
- Pilots shall report anomalies using standard phraseology;
- ATC shall inform affected traffic;
- ATIS/D-ATIS may broadcast relevant operational limitations;
- NOTAM shall be issued when required;
- PBN procedures may be restricted or suspended;
- DME/DME or conventional procedures may be used;
- ATC may increase separation or provide vectors;
- ATFM/CDM measures may be applied;
- CNS personnel shall investigate technical causes;
- CAA and spectrum authorities may be notified for RFI events.

Degraded mode does not automatically imply system failure. It is a managed operational state intended to maintain safe operations at a reduced or modified level of service.

5.6.3 Maintenance Mode

Maintenance mode applies when planned or unplanned technical activities affect navigation service availability.

Maintenance mode may include:

- Scheduled preventive maintenance;
- Corrective maintenance;
- Flight inspection;
- Ground calibration;
- Software updates;
- Post-hurricane recovery works;

Maintenance mode shall be managed through:

- Maintenance planning;
- Operational coordination with ATC;
- NOTAM or AIP SUP publication when required;
- Assessment of affected procedures;
- Confirmation of alternate procedures;
- Coordination with operators;
- Service restoration testing;
- Maintenance records;
- Return-to-service authorization.

For MON facilities, maintenance planning shall be more restrictive because outages may reduce contingency capability. Planned maintenance of MON-critical facilities should avoid peak traffic periods, hurricane season risk periods and simultaneous outage of adjacent backup facilities.

5.6.4 Contingency Mode

Contingency mode applies when a major disruption requires the navigation system to operate under emergency or abnormal conditions.

Triggers may include:

- Wide-area GNSS outage;
- Confirmed GNSS interference affecting multiple flights;
- Spoofing event affecting aircraft navigation integrity;
- Hurricane or natural disaster affecting multiple NAVAIDs;
- Loss of multiple DME or VOR/DME facilities;
- Loss of ILS at a designated MON airport;
- Major surveillance failure;
- Cyber or telecommunications disruption;
- Military or security-related airspace restrictions.

In contingency mode:

- The MON shall be activated as required;
- ATC shall apply contingency procedures;
- PBN procedures dependent on unavailable GNSS may be suspended;
- Conventional routes, headings, vectors or procedural separation may be used;
- Traffic demand may be reduced through ATFM/CDM;
- Aircraft may be routed to MON airports;

- NOTAM and ATIS shall communicate limitations;
- CAA, ANSP, military and spectrum authorities shall coordinate response;
- Regional coordination through ICAO/CAR mechanisms may be required.

The objective of contingency mode is to preserve safety and essential IFR continuity, even if capacity is significantly reduced.

5.6.5 Recovery and Return-to-Service Mode

Recovery mode applies after a degraded or contingency event when services are being restored.

Recovery requires:

- Technical confirmation of service restoration;
- Validation of navigation signal performance;
- Review of alarms and maintenance records;
- Cancellation or revision of NOTAM;
- ATC confirmation of operational readiness;
- Operator notification where necessary;
- Post-event review;
- Lessons learned;
- Update of contingency plans if required.

For critical systems such as ILS, VOR/DME, DME and GBAS, return-to-service shall follow approved technical and operational procedures, including ground checks, flight checks where required and formal authorization by the responsible authority or ANSP.

5.7 Operational Workflow

The operational workflow links procedure design, ATC use, aircraft operations, maintenance, reporting and continuous improvement.

5.7.1 Flight Procedure Development and Publication

Instrument flight procedures shall be designed using GNSS as the primary sensor where appropriate, supported by DME/DME and conventional procedures as MON reversions.

The procedure development workflow shall include:

- Operational requirement definition;
- Traffic and airspace analysis;
- Navigation infrastructure assessment;
- Aircraft equipage assessment;
- PBN specification selection;
- Safety assessment;
- ATC operational review;
- Operator consultation;

The procedure portfolio should include:

- RNAV 5 or RNAV 2 routes where appropriate;
- RNAV 1 or RNP 1 SID/STAR procedures;
- RNP APCH procedures;
- LNAV and LNAV/VNAV minima;
- LP or LPV minima where SBAS is available;
- GLS procedures where GBAS is implemented;
- ILS/LOC procedures at selected airports;
- VOR/DME procedures where needed for MON;
- Contingency procedures for GNSS degradation.

5.7.2 Operational Use by ATS and Operators

During normal operations, ATS shall clear aircraft using published PBN and conventional procedures according to aircraft capability, traffic demand and service availability.

Operators shall ensure that:

- Aircraft are approved for the intended operation;
- Navigation databases are current;
- RAIM/ABAS predictions are performed where applicable;
- SBAS/GBAS capability is understood;
- Crews are trained on GNSS degradation response;
- Contingency procedures are included in operational documentation.

ATS shall ensure that:

- Clearances match available procedures and aircraft capability;
- Controllers understand GNSS-dependent and non-GNSS procedures;

The technical programme shall classify inspections as commissioning/categorization, periodic or special, as applicable. Special inspection shall be initiated when performance may have been affected by major maintenance, antenna or equipment changes, reported interference, new obstructions/construction, severe weather damage, abnormal monitor behaviour or other significant site/environment changes. Facilities shall not be returned to unrestricted operational service until required ground/flight checks have demonstrated acceptable performance and the responsible authority has authorized the status change.

- Degraded modes are communicated promptly;
- Separation minima are adjusted when required;
- ATFM/CDM measures are coordinated;
- NOTAM and ATIS information is consistent with operational reality.

5.7.3 Maintenance, Monitoring and Technical Response

ANSP CNS units shall monitor conventional NAVAIDs and, where available, GNSS-dependent systems through RCMS/NMS platforms or equivalent technical monitoring systems.

Technical response shall be prioritized based on operational impact. Outages affecting MON facilities, high-density routes, major airports or contingency airports shall receive higher priority.

Maintenance and monitoring shall include:

- Continuous facility status monitoring;
- Alarm management;
- Preventive maintenance;
- Corrective maintenance;
- Spare parts management;
- Flight inspection coordination;
- Ground test records;
- Periodic performance reports;
- Outage trend analysis;
- Hurricane preparedness and recovery plans;

GNSS degradation monitoring shall include:

- Pilot reports;
- ATC observations;
- Avionics alerts where reported;
- ADS-B anomalies;
- SBAS/GBAS status sources;
- GNSS reference receiver data where available;
- Spectrum monitoring where available;
- Correlation with NOTAM, military activity or known interference sources.

5.7.4 Reporting, ATFM/CDM and Continuous Improvement

All significant navigation events shall be recorded and reviewed. These may include:

- GNSS degradation;
- GNSS interference;
- Suspected spoofing;
- SBAS or GBAS outage;
- DME/DME unavailability;
- VOR/DME outage;
- ILS outage;
- MON airport navigation degradation;
- ATC contingency activation;
- Hurricane-related infrastructure loss.

Reports shall feed a continuous improvement cycle:

1. Event detection;
2. Initial operational mitigation;
3. Technical investigation;
4. Stakeholder notification;
5. Safety assessment;
6. Corrective action;
7. Publication update if required;

8. Training update if required;
9. Regional lessons learned.

ATFM/CDM mechanisms, including CADENA or equivalent regional coordination platforms, should be used to share operational status, coordinate flow measures, manage alternate routes, and support regional situational awareness during major GNSS or MON disruptions.

5.8 Interfaces with Other Systems

5.8.1 Interface with Flight Procedures and PBN

The interface between PBN procedures and NAVAID infrastructure shall be managed using the permitted positioning sources identified in ICAO Doc 9613. Each published RNAV/RNP application shall have a documented infrastructure basis identifying the positioning source(s) assumed for normal operation, any terrestrial reversion option, and the NAVAIDs that are operationally critical to maintaining the application.

For RNAV 5, the infrastructure basis may include GNSS, DME/DME or VOR/DME. For RNAV 1 and RNAV 2, the standardized terrestrial basis is DME/DME, with DME/DME/inertial integration where approved. For RNP 2, RNP 1 and Advanced RNP, GNSS is the baseline source and any DME/DME use requires specific State authorization. These distinctions shall be reflected in infrastructure assessments, procedure assumptions, outage impact analysis and AIM publications.

The navigation infrastructure and PBN procedure design processes must be fully integrated. The instrument procedures are designed with GNSS as the primary sensor, and with DME/DME and conventional procedures as the Minimum Operational Network (MON) reversions to ensure IFR continuity during GNSS degradations

PBN procedure designers require accurate information on:

- GNSS availability assumptions;
- SBAS service availability;
- GBAS service status;
- VOR/DME coordinates and performance;
- DME coordinates, service volumes and limitations;
- ILS/LOC operational status;
- NAVAID decommissioning plans;
- MON facility designation;

Any change to NAVAID infrastructure may affect published procedures. Therefore, commissioning, relocation, outage, withdrawal or decommissioning of a facility shall trigger a procedure impact assessment.

5.8.2 Interface with Surveillance Systems

Surveillance systems such as SSR, ADS-B and MLAT support ATC situational awareness and separation services. However, ADS-B position reporting may depend on GNSS. Therefore, GNSS interference can affect not only navigation but also surveillance performance.

When GNSS interference affects ADS-B, ATC may need to:

- Increase separation;

- Use SSR where available;
- Apply procedural control;
- Issue traffic advisories;
- Coordinate flow restrictions;
- Reroute aircraft away from affected areas.

5.8.3 Interface with ATC Automation

ATC automation systems shall be capable of supporting GNSS-primary and MON-reversion operations.

Automation should display or make available:

- Active navigation outages;
- GNSS degradation information;
- Suspended procedures;
- Available MON reversion procedures;
- Runway approach availability;
- NAVAID status;

5.8.4 Interface with AIM, NOTAM and ATIS

AIM is essential to ensure that operational users receive accurate and timely information.

ATIS/D-ATIS may be used for tactical dissemination of GNSS degradation or procedure unavailability information, especially in terminal areas.

Example messages may include:

- "GNSS unreliable within terminal area. RNAV approaches unavailable."
- "GBAS out of service. Use ILS runway XX."
- "Reports of GPS interference in the vicinity of the aerodrome. Advise ATC of navigation anomalies."
- "RNP approaches suspended. Conventional approaches available."

5.8.5 Interface with Spectrum Authorities and Security Agencies

GNSS interference cannot be managed by aviation authorities alone. It requires coordination with:

- Telecommunications regulators;
- Spectrum management authorities;
- Military authorities;
- Airport security;
- Law enforcement where illegal jamming is suspected;
- National cybersecurity entities where applicable;
- International coordination bodies when cross-border effects occur.

The GNSS RFI reporting procedure shall define:

- Who receives the initial report;
- Who validates the report;
- Who investigates the source;

- When the issue is escalated;
- How pilots and operators are informed;
- How the event is closed;
- How lessons learned are captured.

5.9 Tailoring of ICAO Requirements

The CAR CONOPS adopts a GNSS-primary PBN strategy while retaining a right-sized conventional MON to ensure operational continuity when GNSS is degraded. Local tailoring does not modify ICAO SARPs or PANS. Instead, it defines how ICAO provisions and guidance are applied regionally in a consistent, practical and risk-based manner.

5.9.1 Annex 10 — Radio Navigation Aids and Surveillance

Annex 10, Volume I shall be applied to the performance, siting, monitoring, tolerance and alarm requirements of radio navigation aids including VOR, DME, ILS and GNSS-related provisions.
CAR tailoring includes:

- Use of GNSS as the primary enabler for PBN;
- Retention of selected VOR/DME, DME and ILS facilities for MON;
- Prioritization of DME/DME coverage assessment in terminal areas;
- Retention of ILS at selected high-value or MON airports;
- Rationalization of NDBs through safety-based transition planning;
- Alignment of NAVAID status with AIM publication.

Annex 10, Volume IV shall be considered for surveillance-related elements, particularly SSR and ADS-B. Since ADS-B may depend on GNSS, surveillance contingency planning shall be coordinated with GNSS degradation procedures.

5.9.2 Doc 8071 — Testing of Radio Navigation Aids

ICAO Doc 8071 shall be used as the principal technical basis for inspection of retained NAVAIDs. Volume I applies to VOR, DME, ILS and NDB ground/flight testing; Volume II applies only to satellite-based NAVAID elements in this CONOPS, including ABAS/SBAS procedure checks and GBAS ground/VDB/flight testing. Inspection results shall be linked to facility operational status, return-to-service authorization and AIM/NOTAM publication.

Nominal flight-inspection intervals in Doc 8071 shall be the planning baseline (including 12 months for VOR and 180 days for ILS). Any modified programme or extended interval shall be approved and supported by documented analysis of stability, reliability history, ground-monitoring capability, operational criticality and safety risk. Special inspections shall be triggered whenever maintenance, interference, site/environment changes or abnormal performance could invalidate the previous inspection basis.

5.9.3 Doc 9849 — GNSS Manual

ICAO Doc 9849, Global Navigation Satellite System (GNSS) Manual, Fifth Edition (2025), including Corrigendum No. 1 dated 20 November 2025, shall guide GNSS implementation, operational use, performance assessment, resilience planning, degradation reporting, RFI mitigation and rationalization of conventional navigation infrastructure.

CAR application of Doc 9849 shall include the following principles:

- GNSS is the primary navigation enabler for PBN, but implementation shall account for vulnerabilities and common dependencies with ADS-B and other GNSS-based functions.
- Availability and continuity planning shall consider traffic density, conventional aids, independent surveillance, outage duration and geographical extent, flight procedures and ATC procedures.
- DME retention and optimization should form part of the GNSS-outage mitigation strategy where DME/DME RNAV is operationally feasible and supported by aircraft equipage.
- ILS should be retained at designated airports where operationally beneficial, particularly to preserve precision-approach capability during GNSS disruption.
- Rationalization shall use a life-cycle and operational-value approach. Avoiding replacement of facilities at end of life can provide significant economic benefit when PBN/GNSS alternatives and reversion requirements have been validated.
- The target end-state is a MON of conventional aids that supports an acceptable level of continuity and efficiency, rather than replication of normal GNSS-enabled capacity.
- GNSS interference and spoofing risk shall be continuously assessed. Detection may use pilot reports, avionics discrepancies, DME-DME/IRS comparisons, radar/SSR comparison with ADS-B, GNSS monitoring data and other CNS logs.
- States shall implement effective spectrum management and enforcement, report harmful interference affecting international civil aviation, regulate repeaters/pseudolites/spoofers/jammers, and strengthen civil-military coordination for activities that may affect GNSS.
- The regional RFI mitigation framework shall follow a continuous cycle of threat monitoring, risk assessment and deployment of mitigation measures, supported by event reporting, investigation, NOTAM/ATIS processes, contingency activation and lessons learned.
- GNSS monitoring should focus on operationally meaningful parameters and support investigation/escalation; it is not, by itself, a substitute for the integrity functions embedded in approved GNSS services and avionics.

The CAR region should maintain a harmonized GNSS interference database and use regional trend analysis to identify hotspots, recurring operational impacts, required mitigations and potential MON adjustments.

5.9.4 Doc 9613 — PBN Manual

ICAO Doc 9613, Performance-based Navigation (PBN) Manual, Fifth Edition (2023), including Corrigendum No. 1 dated 14 April 2024, shall guide the relationship between PBN applications and the NAVAID infrastructure that enables them. This CONOPS applies Doc 9613 only to NAVAID-related infrastructure, reversion, monitoring and publication requirements.

CAR application of Doc 9613 shall include the following NAVAID principles:

- PBN infrastructure decisions shall be driven by the navigation specification and the airspace concept rather than by preservation of individual legacy facilities.
- The ANSP shall assess NAVAID infrastructure sufficiency for normal and reversionary operation before implementing a PBN application or decommissioning a supporting facility.
- RNAV 5 may use GNSS, DME/DME or VOR/DME (and approved self-contained/inertial capability); loss of RNAV capability requires an alternative navigation source.

- RNAV 1 and RNAV 2 infrastructure planning shall use GNSS, DME/DME and DME/DME/inertial criteria. VOR/DME is not part of the standardized infrastructure criteria for these specifications.
- RNP 2, RNP 1 and Advanced RNP are GNSS-based under the standard specification; DME/DME use requires specific State authorization where provided for by Doc 9613. RNP APCH, RNP AR and RNP 0.3 use GNSS-based positioning.
- DME/DME applications shall identify critical DME facilities and redundancy. Full redundancy should, where practicable, be provided by two independent DME pairs; shared-station configurations provide limited redundancy; a single available pair makes both DMEs critical for that segment.
- Available NAVAID infrastructure and any facilities critical to RNAV operations shall be clearly identified in appropriate aeronautical publications and charts. Supporting navigation data shall meet applicable AIM/data-quality requirements.
- Navigation-service monitoring shall account for the fact that loss of one ranging source does not necessarily mean loss of an RNAV/RNP service. Monitoring shall focus on the operational status of critical facilities and on whether the remaining infrastructure still supports the intended navigation application.
- NAVAID infrastructure evolution shall be coordinated with PBN implementation. Removal of conventional NAVAIDs and associated procedures is an airspace change requiring stakeholder consultation and assessment of both normal and contingency service objectives.
- Alternative PNT/reversion planning may combine existing navigation sources such as DME, VOR and inertial capability; however, the retained infrastructure shall be justified by the required operational service rather than by a generic requirement to duplicate GNSS capacity.

5.9.5 Doc 8168 — PANS-OPS

PANS-OPS shall govern instrument flight procedure design, obstacle assessment, procedure validation and operational criteria.
CAR tailoring includes:

- Harmonized procedure design assumptions;
- Explicit charting of sensor requirements;
- Identification of fallback procedures;
- Validation of DME/DME-based operations where used;
- Integration of procedure design with MON planning;
- Safety assessment before removal of conventional procedures;
- Coordination of procedure changes through AIRAC.

5.9.6 PANS-ATM — Doc 4444

PANS-ATM shall govern ATS procedures, separation, phraseology, vectoring, contingency measures and coordination.
CAR tailoring includes:

- ATC procedures for GNSS degradation;
- Use of conventional navigation clearances during MON operations;
- Increased separation where required;
- Transition from PBN to conventional operations;
- Coordination between adjacent FIRs;
- ATFM/CDM measures during reduced capacity;
- Controller training for GNSS RFI scenarios.

5.9.7 PANS-AIM - Doc 10066 and NAVAID Data Governance

PANS-AIM shall govern the aeronautical-information lifecycle for NAVAID data used by this CONOPS. Technical status and configuration data originating from CNS/engineering shall not be considered operationally effective until the required coordination, quality control and publication actions have been completed.

CAR tailoring includes:

• Controlled origination and traceability of NAVAID data from the accountable technical originator to AIS/AIM and the next intended user;

- Application of aeronautical-data quality requirements, including accuracy, resolution, integrity, traceability, timeliness, completeness and format;
- Publication of the State NAVAID inventory in GEN 2.5 and of en-route facilities in ENR 4.1, including identification, frequency/channel, hours, coordinates, DME antenna elevation, operating authority and coverage, as applicable;
- Publication of GNSS elements used for en-route navigation in ENR 4.3, including the GNSS element, frequency where applicable, service/coverage area and remarks;
- Publication of terminal and approach radio navigation and landing aids in AD 2.19/AD 3.18, including facility type, supported operation, identification, frequency/channel, hours, antenna coordinates, DME/GBAS/SBAS elevation-related data, GBAS service volume and remarks, as applicable;
- Use of the AIP data set for radio navigation aid data where implemented, while maintaining clear references from any omitted textual AIP sections to the available digital data set;
- Timely NOTAM for temporary NAVAID outages, restrictions or changes and use of AIP Amendment/AIP Supplement/AIRAC for permanent or planned changes;
- Coordination among CNS, ATS, procedure design and AIS/AIM before commissioning, modification, decommissioning or return to operational service;
- Quality control to ensure that published NAVAID data and operational status are consistent with the approved technical configuration and the procedures that depend on the facility.

Chapter 6 - Roles and Responsibilities

Stakeholder	Responsibility	Description
ANSP CNS Division	Operation & maintenance	Maintain, calibrate, and monitor NAVAIDs.
AIS/AIM	Information management	Publish accurate data in AIP.
ATC	Operational use	Verify availability and report failures.
Aerodrome Authority	Infrastructure	Provide power, access, and physical protection.
ICAO NACC / GREPECAS	Oversight & coordination	Support regional alignment and performance reporting.

To effectively manage the network of ground-based navaids for the CAR region, roles and responsibilities are to be defined to determine which stakeholders will be responsible for various aspects of the network.

The ANSPs for the various states will be responsible for the maintenance, calibration, monitoring, verifying availability, reporting failures, and updating facility status information of the navaids.

A brief description of the roles and responsibilities of the various divisions of the ANSPs follows:

6.1 CNS divisions

The role of the CNS maintenance personnel is primarily to ensure that the navaids are installed and function in compliance with standards and recommended practices stipulated in Annex 10 Vol. I. This is done by ensuring that ground and flight testing are done in accordance with Doc 8071.

The roles and responsibilities of CNS maintenance personnel are listed below:

- Installation to include ensuring commissioning flight checks are done to determine that the facility can initially meet required standards and can support the instrument flight procedures designed.
- Preventative and corrective maintenance to correct faults and restore the facility to operations within specified tolerances.
- Supervision, monitoring and control to know and report in real time the status of the facility.
- Calibration and certification to ensure the facility continues to comply with specified standards. This includes ensuring all periodic flight inspections are done as per Doc 8071.
- Ensure all test equipment used in the calibration of the facilities are themselves periodically calibrated with traceability to specified standards.

6.2 ATS Units

The primary role of ATS units is in the operational use of ground-based aids. ATS units should verify the availability of the facilities and report failures to the CNS units.

It is a requirement for Aerodrome control towers providing aerodrome control service to be provided with information on the operational status of radio navigation services essential for approach, landing and take-off at the aerodrome with which they are concerned (Annex 10 Vol. I para 2.3.1)

6.3 AIS/AIM Units

AIS/AIM units shall publish and maintain quality-assured NAVAID information in the AIP/eAIP and, where implemented, the AIP data set. This includes the initial data at commissioning and all permanent changes to identification, facility type, frequency/channel, hours, coordinates, elevation, coverage, operating authority, supported operation and other applicable NAVAID attributes.

AIS/AIM units, in conjunction with CNS and ATS units, shall originate or process NOTAM for temporary changes in NAVAID status that are operationally significant. Permanent or planned changes shall be coordinated through AIP Amendment, AIP Supplement and AIRAC processes, as applicable. The publication workflow shall preserve traceability between the technical decision, the authorized data originator, the effective date and the information delivered to operational users.

6.4 Aerodrome Authority

The primary role of the Aerodrome Authorities will be to provide adequate infrastructure needed to support operations of the Navigation Aids sites, to include the following.

- Equipment shelters which should be weatherproof and vermin proof as well as temperature and humidity controlled
- Performance assurance shall be based on measurable facility-specific parameters and inspection requirements from Annex 10 and Doc 8071. The State inspection programme shall define the applicable tolerances, measurement uncertainty, inspection type and periodicity for each retained NAVAID.
- Inspection planning baseline: VOR flight inspection - nominally 12 months; ILS flight inspection - nominally 180 days; NDB and DME - facility-specific ground/flight schedules established from Doc 8071 and State-approved programmes. Any extension or modification shall be formally justified and documented.
- Accuracy, integrity, coverage, identification, monitor performance, standby equipment/power and other applicable parameters shall remain within the relevant Annex 10/Doc 8071 limits.

Coverage shall be verified over the operational service volume actually used by published routes and procedures, including areas where VOR/DME or DME/DME supports PBN.

Response to failure shall be governed by the applicable executive-monitor requirements and by immediate technical/ATS/AIM coordination when a facility is unavailable, degraded or under test.

Chapter 7 - Performance and Safety Requirements

Define measurable parameters (aligned with Annex 10 Vol. I/II and Doc 8071):

- **Availability:** ≥ 99.7% for en-route, ≥ 99.9% for ILS CAT I.
- **Accuracy and integrity:** within ICAO limits.
- **Coverage:** [specify distances, altitudes].
- **Response to failure:** automatic alarm within X seconds.
- ICAO Doc 8071 Volume I is the principal inspection reference for conventional NAVAIDs in this CONOPS. It defines the ground and flight testing to be accomplished for VOR, DME, ILS and NDB and provides the facility-specific parameters, tolerances, uncertainties and inspection types used to demonstrate continued compliance with Annex 10.

The inspection programme shall include commissioning/categorization, periodic and special inspections as applicable. Ground and flight testing are complementary: ground measurements should be used where they provide the most accurate or repeatable determination, while flight inspection verifies signal-in-space performance and operational coverage in the actual environment. Where ground measurements are substituted for airborne measurements, appropriate correlation shall be established and maintained.

The following tables summarize the principal NAVAID tests used by this CONOPS. The detailed requirements and tolerances in the current applicable edition of Doc 8071 and Annex 10 remain controlling; State programmes may adopt modified inspection intervals only through a documented, risk-based process.

7.1 Tests

ICAO Annex 10, Volume I, Chapter 3 contains the technical specifications for standard radio navigation aids. Facilities retained for international air navigation shall comply with the applicable specifications, while their continued operational suitability is verified through the State-approved inspection and maintenance programme.

Periodic ground and flight testing shall be conducted for radio navigation aids available for international air navigation. Detailed testing methods and periodicity should be established using ICAO Doc 8071 and the applicable guidance in Annex 10, Volume I, Attachment C.

The following tables list the tests that are performed on standard radio navigation aids to ensure performance and safety compliance with ICAO standards and recommended practices as detailed annex 10 and doc 8071.

NDB

Parameter	Annex 10 reference	Doc 8071 reference	Test periodicity	Tolerance	Comments/References
Rated coverage	Annex 10 Vol. I 3.4.2	Doc 8071 Vol. I 5.3	State programme / flight inspection	Operationally required coverage	Flight inspection; include airway/holding/approach coverage where applicable.
Carrier frequency	Annex 10 Vol. I 3.4.4.2	Doc 8071 Vol. I 5.2.3	12 months	±0.01% (±0.005% for >200 W above 1 606.5 kHz)	Ground test.
Identification / keying	Annex 10 Vol. I 3.4.5	Doc 8071 Vol. I 5.2 / 5.3	State programme	Clearly audible, proper keying and correct coding	Ground and flight inspection to limit of coverage, as applicable.
Antenna current	-	Doc 8071 Vol. I 5.2.4	6 months	±30% of value set at commissioning	Ground test.
Modulation depth	Annex 10 Vol. I 3.4.6.2	Doc 8071 Vol. I 5.2.5	6 months	85% to 95%	Ground test.
Modulation frequency	Annex 10 Vol. I 3.4.5.4	Doc 8071 Vol. I 5.2.6	6 months	1 020 ±50 Hz or 400 ±25 Hz	Ground test.
Power-supply frequency modulation	Annex 10 Vol. I 3.4.6.5	Doc 8071 Vol. I 5.2.7	As required	<5% modulation depth	Ground test.
Carrier level change during modulation	Annex 10 Vol. I 3.4.6.4	Doc 8071 Vol. I 5.2.9	6 months	<0.5 dB for beacons with <50-mile coverage; <1.5 dB for greater coverage	Ground test.
Audio distortion	-	Doc 8071 Vol. I 5.2.10	As required	≤10% distortion	Ground test.
Monitor system	Annex 10 Vol. I 3.4.8.1	Doc 8071 Vol. I 5.2.11	6 months	Alarm for 3 dB decrease; alarm for loss of or continuous modulation	Ground test; remote monitor may use field strength.
Standby equipment	-	Doc 8071 Vol. I 5.3	Commissioning / periodic as applicable	Comparable to main equipment	Ground/flight check as applicable.

VOR

Parameter	Annex 10 reference	Doc 8071 reference	Test periodicity	Tolerance	Comments/References
Carrier Frequency	Vol 1 para 3.3.2	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	± 0.002%	Verified by ground testing
Pattern accuracy	Vol 1 para 3.3.3.2	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	Within applicable Annex 10/Doc 8071 tolerance	Verified by flight testing
Coverage	Vol 1 para 3.3.4	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	-107 dBW/m²	Verified by flight testing
Modulations of Navigational signals	Vol 1 para 3.3.5	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	28% - 32%	Verified by ground and flight testing
9960 Hz Deviation	Vol 1 para 3.3.5.1	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	16 ± 1	Verified by ground and flight testing
Voice and Identification	Vol 1 para 3.3.6	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	Clear	Verified by ground and flight testing
Identification speed	Vol 1 para 3.3.6.5	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	7 WPM	Verified by ground testing
Identification repetition	Vol 1 para 3.3.6.5	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	≥ 2times/min	Verified by ground testing
Identification Tone	Vol 1 para 3.3.6.5	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	1020 ± 50 Hz	Verified by ground testing
Integrity monitoring	Vol 1 para 3.3.7	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	See note 1	Verified by ground and flight testing
Rotation	Vol 1 para 3.3.1.1	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	Correct	Verified by ground flight testing
Sensing	Vol 1 para 3.3.1.3	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	Correct	Verified by flight testing
Polarization	Vol 1 para 3.3.3.1	Doc 8071 Vol. I Ch. 2	12 months nominal flight-inspection baseline / ground checks per State programme	Within applicable Annex 10/Doc 8071 tolerance	Verified by flight testing

Note 1: The executive monitoring should cause radiation to cease if a) the monitor detects a bearing change by more than 1°, or b) the monitor detects a reduction of the navigation signals by 15%.

DME

Parameter	Annex 10 reference	Doc 8071 reference	Test periodicity	Tolerance	Comments/References
Coverage	Vol 1 para 3.5.3.1.2	Vol 1 para 3.3.5-3.3.8	Commissioning / periodic per State-approved programme	≥ -89 dBW/m²	Verified by flight testing
Accuracy	Vol 1 para 3.5.3.1.3	Vol 1 para 3.3.9	Commissioning / periodic per State-approved programme	Within applicable Annex 10/Doc 8071 system-accuracy tolerance (main delay most accurately calibrated by ground measurement)	Verified by flight testing
TX Freq Stability	Vol 1 para 3.5.4.1.2	Vol 1 para 3.2.4	Ground test per State-approved programme	0.001%	Verified by ground testing
TX Pulse Spectrum	Vol 1 para 3.5.4.1.3	Vol 1 para 3.2.5	Ground test per State-approved programme		
TX Pulse Shape	Vol 1 para 3.5.4.1.3	Vol 1 para 3.2.6	Ground test per State-approved programme	Rise time ≤ 3µs; Duration 3.5 µs: Decay time ≤3.5 µs	
TX Pulse Spacing	Vol 1 para 3.5.4.1.4	Vol 1 para 3.2.7	Ground test per State-approved programme	X-chan 12µs; Y-chan 30µs	
TX Peak Power	Vol 1 para 3.5.4.1.5	Vol 1 para 3.2.8	Ground test per State-approved programme	Peak EIRP that yields -89dBw/m² in service area	
TX Pulse Pair Power Variation	Vol 1 para 3.5.4.1.5.4	Vol 1 para 3.2.9	Ground test per State-approved programme	Pulse difference of a pair ≤ 1dB	
TX PRF	Vol 1 para 3.5.4.1.5	Vol 1 para 3.2.10	Ground test per State-approved programme	≥ 700 pps	
RX Freq Stability	Vol 1 para 3.5.4.2.2	Vol 1 para 3.2.11	Ground test per State-approved programme	0.001%	
RX Reply Efficiency	Vol 1 para 3.5.4.2.3	Vol 1 para 3.2.12	Ground test per State-approved programme	-103 dBW/m² for 70% repl. Eff.	
RX Bandwidth	Vol 1 para 3.5.4.2.6	Vol 1 para 3.2.14	Ground test per State-approved programme	≤ 3dB for int. freq. drift of ± 100 KHz	
Decoder Rejection	Vol 1 para 3.5.4.3.3	Vol 1 para 3.2.15	Ground test per State-approved programme		
Time Delay	Vol 1 para 3.5.4.4; 3.5.4.5	Vol 1 para 3.2.16	Ground test per State-approved programme		
Identification	Vol 1 para 3.5.3.6	Vol 1 para 3.2.17	Commissioning / periodic per State-approved programme		
Integrity Monitor	Vol 1 para 3.5.4.7.2	Vol 1 para 3.2.18	Commissioning / periodic per State-approved programme		

ILS

Parameter	Annex 10 reference	Doc 8071 reference	Inspection type / periodicity	Tolerance / criterion	Comments
Localizer signal-in-space / course / coverage	Annex 10 Vol. I 3.1	Doc 8071 Vol. I 4.3	Site; commissioning/categorization; periodic - nominal 180 days	Applicable facility performance category tolerances	Flight inspection; ground checks may be used where correlation is established.
Glide path signal-in-space / angle / coverage	Annex 10 Vol. I 3.1	Doc 8071 Vol. I 4.3	Site; commissioning/categorization; periodic - nominal 180 days	Applicable facility performance category tolerances	Flight inspection; selected parameters may be checked on ground after commissioning correlation.
Monitor system	Annex 10 Vol. I 3.1	Doc 8071 Vol. I 4.2 / 4.3	Ground periodicity per parameter; flight checks as applicable	Alarm/transfer/shutdown at applicable limits	Monitor-test periodicity may be increased only when supported by integrity/stability history.
Marker beacons, where retained	Annex 10 Vol. I 3.1.7	Doc 8071 Vol. I 4.2 / 4.3	Flight periodic - nominal 180 days; ground checks by parameter	Coverage, keying, field strength and monitor requirements	DME may be used in lieu of markers where approved.
Standby equipment and power	-	Doc 8071 Vol. I 4.3	Commissioning / periodic	Performance comparable to main equipment; no unacceptable degradation	Verify changeover and operational performance.
Special inspection / return to service	-	Doc 8071 Vol. I Ch. 1 and Ch. 4	As required	Required parameters within tolerance	After major maintenance, site/environment change, suspected interference or other event affecting performance.

PBN use of conventional NAVAIDs: where VOR/DME or DME/DME is credited to support a PBN operation, the infrastructure assessment shall identify the minimum facility set and the inspection programme shall verify the signal coverage relied upon by the operation. Doc 8071 Volume I identifies VOR/DME use for PBN as limited to RNAV 5 and DME/DME as the principal conventional terrestrial support for RNAV operations alongside GNSS.

GBAS flight testing shall be performed before commissioning on each runway served and for each approach; after relevant procedure or system-configuration changes; after site changes such as new obstructions or major construction that could affect GNSS reception or VDB transmission; following specified maintenance; and when interference is reported or suspected and ground testing cannot confirm elimination. If periodic GBAS flight tests are adopted, the State shall determine the parameters and intervals.

GBAS ground testing shall be conducted for initial commissioning, following system reconfiguration and corrective maintenance, and periodically when required by the manufacturer or State authority. Before testing that may radiate a non-compliant signal-in-space, the facility shall be administratively removed from service and its status properly published.

ABAS and SBAS procedure checks shall be performed at commissioning and as special inspections when published procedure design changes occur or when interference is suspected. Checks should confirm procedure/design correlation, continuous guidance and the absence of relevant alerts. If a State elects to conduct periodic interference checks, the parameters and intervals shall be defined in its approved programme.

7.2 Availability

Facility availability is defined as the ratio of the actual operating time to the specified operating time of a navigation aid; as a percentage, it may be expressed in terms of the ratio of the actual operating time divided by the specified operating time taken over a long period (annex 10 Vol I attachment F).

Facility availability is important as it refers to the capacity of a navigation aid to remain accessible to users.

Several important factors are involved in providing a high degree of availability, the main ones are:

a. Facility reliability
b. Quick response of maintenance personnel to failures
c. Adequate training of maintenance personnel
d. Equipment designs providing good component accessibility and maintainability
e. Efficient logistic support
f. Provision of adequate test equipment
g. Standby equipment and /or utilities

A high degree of navaid facility availability is desirable as it ensures safety and continuity of aircraft operations. For PBN applications, facility availability and navigation-service availability shall not be treated as identical. In a multi-sensor or DME/DME environment, an individual NAVAID may be unavailable while the required navigation service remains available through other authorized ranging sources and acceptable geometry. Conversely, the outage of a single critical DME may remove the navigation service where no redundant pair is available.

States and ANSPs shall therefore monitor both equipment status and operational service impact. Critical NAVAIDs supporting RNAV applications shall be identified in advance so that outages can trigger the appropriate maintenance priority, operational restrictions, contingency measures and aeronautical information actions.

Navigation Aids, which support en-route and terminal procedures, should have availability values of greater than 99.7%.
Category I ILS systems should have availability values of greater than 99.9%.

7.3 Accuracy

Accuracy describes how well a measured position (fix or line of position) agrees with the true position, the difference between the true and measured position is termed bias or error. Hence the accuracy of a system can be expressed in terms of the error between the true and measured position.

The accuracy of Ground Based navigation aids varies depending on type of system, specific equipment configuration, and the siting of equipment to name a few factors.

<u>VHF Omni Range (VOR):</u>
VOR systems are capable of bearing accuracies of ±1°; annex 10 volume 1 stipulates a maximum bearing error of ±2° for elevation angles between 0° and 40°.

<u>Distance Measuring Equipment (DME):</u>
DME systems are capable of range accuracies of ±0.2 NM; annex 10 volume 1 stipulates a maximum range accuracy of ±0.25 NM at distances of up to 200 NM from the DME ground station(transponder). It should be noted that DME systems are inherently more accurate than VOR and NDB systems.

Non-Directional Beacon (NDB):
NDB systems are the least accurate of all ICAO specified ground-based navigation aids. Bearing errors for NDB systems are greater than those for VOR systems and these errors are further affected by factors such as atmospheric static discharges, man-made noises and phenomena such coastline effects.

7.4 Integrity

Integrity can be described as the trustworthiness that can be placed in the correctness of navigation signals transmitted by a navigation aid.

Navigation systems employ integrity monitoring to ensure the correctness of the radiated signal components and to issue timely warnings within a specified time (Time to Alert) once any signal component is noted to be out of tolerance.

Ground based aids are required to have executive integrity monitoring systems, these systems continuously monitor parameters of the radiated navigation signals, once an out of tolerance condition is noted for any parameter, then the monitoring system is required to either cause the radiation to cease or transfer to a standby transmitter or transponder within a specified time to alert.

For Category I ILS Localizer equipment this time period between when monitoring system first detects a fault to when radiation ceases should not exceed 10 seconds, while for Category I ILS Glide path equipment the time period between when the monitor system first detects a fault to when radiation ceases should not exceed 6 seconds.

7.5 Coverage

Geographical coverage of ground-based aids is determined by the greatest distance from the facility (both horizontally and vertically) in which the power of the radiated signal is sufficient to allow the airborne equipment to compute its correct position.

These coverage areas, also known as Service Volumes, can be considered as the three-dimensional airspace surrounding the navaid in which a minimum field strength or power density of the transmitted signal is required to provide satisfactory operations of the airborne equipment.

ICAO annex 10 volume 1 specifies the following minimum field intensity for the following aids:

NDB –*The minimum value of field strength in the rated coverage of an NDB should be 70 microvolts per meter.*(annex 10 vol 1 para 3.4.2.1)

VOR - *The field strength or power density in space of VOR signals required to permit satisfactory operation of a typical aircraft installation at the minimum service level at the maximum specified service radius should be 90 microvolts per meter or minus 107 dBW/m²* (Annex 10 vol 1 para. 3.3.4.2)

DME -*When associated with a VOR, DME/N coverage shall be at least that of the VOR to the extent practicable.* (Annex 10 vol 1 para. 3.5.3.1.2.1).

Chapter 8 - Transition and Implementation Plan

Define how and when the concept will be implemented:

Phase	Period	Key Activities	Responsible
1. Assessment	2025–2026	Inventory and condition analysis	CNS/ANSP
2. Rationalization	2026–2027	Decommission redundant NDBs, optimize VOR/DME	ANSP/ICAO
3. Integration	2027–2028	Integrate with PBN and GNSS monitoring	ANSP/Industry
4. Monitoring	2028+	Continuous performance verification	ANSP/ICAO

8.1 Purpose

The purpose of this Transition and Implementation Plan is to define the manner in which the CAR regional navigation concept will be progressively implemented. The plan provides a practical roadmap for moving from the current mixed environment of conventional ground-based navigation aids and GNSS-based operations toward a more integrated, resilient and performance-based navigation system.

The transition shall not be understood as a simple replacement of conventional navigation aids by GNSS. Instead, it shall be implemented as a structured modernization process in which GNSS and PBN become the primary enablers of efficient operations, while selected conventional navigation aids are retained, modernized or optimized to provide operational resilience. In this context, the Minimum Operational Network (MON) becomes a key element of the transition, ensuring that the region maintains a safe and operationally acceptable means of navigation in the event of GNSS degradation, interference or outage.

The transition shall be conducted gradually, with each State adapting the proposed timeline to its own operational needs, budgetary capacity, procurement processes, regulatory framework and level of readiness. However, regional harmonization shall remain essential, particularly because the CAR region includes multiple FIRs, international traffic flows, island environments, cross-border operations and airports that serve as alternates for regional and international operations.

8.2 Implementation Approach

The implementation of this CONOPS shall be based on a phased and risk-based approach. The main objective is to ensure that modernization improves safety, efficiency and resilience without creating gaps in navigation service availability or reducing access to airports and airspace.

During the transition, GNSS shall be considered the primary navigation source for PBN operations in en-route, terminal and approach environments. At the same time, the region shall maintain a right-sized conventional infrastructure to support contingency operations. This conventional infrastructure shall not necessarily preserve all existing NAVAIDs, but rather those that provide a clear operational, safety or contingency value.

The implementation process shall therefore balance three main objectives.

- The first is modernization, through expanded use of RNAV, RNP, RNP APCH, SBAS and, where justified, GBAS.
- The second is rationalization, through the progressive withdrawal of obsolete or redundant systems, especially NDBs that no longer provide sufficient operational value.
- The third is resilience, through the definition and maintenance of a MON composed of selected VOR/DME, DME/DME, ILS/LOC facilities and designated MON airports.

The transition shall also ensure that changes to infrastructure, procedures and operational practices are supported by safety assessments, stakeholder consultation, adequate training, AIM publication, ATC readiness and post-implementation monitoring. No critical navigation aid should be withdrawn unless the operational impact has been assessed and an acceptable alternative has been validated, published and communicated to users.

8.3 Phase 1: Assessment (Completed)

Period: 2025–2026

The first phase of implementation shall focus on establishing a complete and reliable baseline of the current situation in the CAR region. Before any decision is made regarding rationalization, modernization or decommissioning, States and ANSPs must have a clear understanding of the infrastructure currently in service, its operational condition, its contribution to airspace operations and its relevance to contingency planning.

During this phase, each State should conduct a detailed inventory and condition analysis of all existing navigation facilities. This should include NDBs, VORs, DVORs, DMEs, VOR/DMEs, ILS/LOC systems and any GBAS installations or related GNSS monitoring capabilities. The inventory should not be limited to the identification of equipment. It should also describe the operational status of each facility, its age, manufacturer, redundancy configuration, maintenance condition, flight inspection status, service volume, availability record, spare parts situation and vulnerability to environmental hazards such as hurricanes, flooding, terrain limitations or site access constraints.

The assessment should also include the current level of PBN and GNSS implementation. States should identify the RNAV routes, RNAV/RNP SIDs and STARs, RNP APCH procedures, LNAV/VNAV minima, LPV minima where SBAS coverage exists, and any GLS procedures where GBAS has been implemented. This information is essential to determine how dependent the current operational environment is on GNSS and whether sufficient conventional fallback exists.

A specific element of this phase shall be the assessment of DME/DME capability. DME/DME can provide an important GNSS-independent positioning source for selected RNAV operations, particularly in terminal airspace. However, its usefulness depends on station geometry, altitude, terrain, signal coverage, aircraft equipage and the availability of suitable DME pairs. For this reason, States should model existing DME/DME coverage, identify coverage gaps and determine whether additional DME facilities or modernization of existing sites would be necessary to support the future MON.

The assessment phase should also identify airports that may serve as MON airports. These are airports that, during a GNSS degradation or outage, could support safe recovery, diversion or continuation of IFR operations using conventional navigation means. The identification of such airports should consider runway characteristics, traffic relevance, conventional approach availability, airport services, geographic distribution, resilience of infrastructure and the airport's role as an alternate.

Another important component of Phase 1 is the collection of information related to GNSS interference and degradation. States should compile available reports of GNSS anomalies, including pilot reports, ATC observations, ADS-B anomalies, suspected jamming or spoofing events, SBAS or GBAS outages and any NOTAMs issued due to navigation degradation. This baseline will help identify recurrent hotspots and support the development of a regional GNSS RFI reporting process.

By the end of Phase 1, the region should have a consolidated view of its current navigation infrastructure, the condition of its NAVAIDs, the status of PBN implementation, the level of GNSS dependency, the potential MON candidates and the main operational risks associated with the transition.

Phase 1 shall also establish, for each facility, its operational role, supported procedures, fleet equipage dependency, coverage contribution, lifecycle condition, inspection status, power resilience, cross-border dependency and value in each GNSS reversion scenario. Flight-plan data may be used as an initial indicator of aircraft equipage, with operator confirmation where necessary.

8.4 Phase 2: Rationalization and Reversion Design

Period: 2026–2027

The second phase shall focus on the rationalization of the conventional navigation infrastructure. Rationalization does not mean the indiscriminate removal of ground-based navigation aids. Rather, it means identifying which facilities should be retained, modernized, relocated, added, replaced or decommissioned based on their operational value, safety contribution, maintenance sustainability and relevance to the MON.

The rationalization process should begin with NDBs, as these systems don't provide support to the future PBN environment and are increasingly difficult to justify where RNAV, RNP, VOR/DME, DME/DME, ILS or SBAS-based procedures are available. NDBs should be considered candidates for decommissioning when they no longer support essential operations, when equivalent alternatives exist, when maintenance is no longer sustainable or when their continued use does not contribute to contingency operations.

However, the withdrawal of an NDB should not be automatic. In certain locations, especially where terrain, island geography, limited infrastructure or specific user needs exist, an NDB may temporarily remain necessary. In those cases, the State should document the operational reason for retention and define a clear transition strategy. The objective should be to avoid maintaining obsolete infrastructure indefinitely without a safety or operational justification.

VOR/DME facilities should be reviewed differently. Although GNSS will be the primary navigation source for PBN operations, VOR/DME remains valuable for conventional navigation, non-GNSS equipped aircraft, contingency operations and MON support. VOR/DME facilities that support major traffic flows, international routes, terminal operations, alternate airports or cross-border continuity should be considered for retention or modernization. Facilities with overlapping coverage, low usage, poor maintainability or limited contingency value may be candidates for rationalization, provided that the safety assessment confirms that operational continuity will not be affected.

DME and DME/DME capability should be treated as a strategic component of the future architecture. Where DME/DME geometry is adequate, DME can support RNAV operations without GNSS and provide an important layer of resilience. In some locations, the rationalization process may therefore result not in fewer facilities, but in the targeted modernization or installation of additional DME stations to improve coverage, geometry and redundancy.

ILS/LOC facilities should be retained selectively where they continue to provide significant operational value. This will normally include major international airports, airports with low-visibility requirements, airports with high traffic demand, designated MON airports and airports serving as important alternates. ILS should not be viewed as obsolete simply because GNSS-based approaches exist. In the CAR region, ILS may remain essential as a conventional precision approach capability and as a key fallback during GNSS degradation.

The main outcome of Phase 2 shall be the initial definition of the CAR MON. This MON should identify the conventional facilities and airports that will support minimum IFR continuity during GNSS degradation or outage. The MON should include selected VOR/DME, DME/DME and ILS/LOC capabilities, together with associated conventional procedures, ATC contingency arrangements and maintenance priority criteria.

By the end of this phase, each State should have a rationalization plan that identifies which NAVAIDs will be retained, which will be modernized, which will be decommissioned and which new investments may be required. These decisions should be coordinated regionally where they affect international routes, adjacent FIRs, alternate airport planning or MON continuity.

8.5 Phase 3: Integration

Period: 2027–2028

The third phase shall transform the rationalized infrastructure into an integrated operational system. This phase is essential because infrastructure alone does not create operational capability. Navigation aids, GNSS, PBN procedures, ATC systems, AIM processes, surveillance systems, ATFM/CDM mechanisms and contingency procedures must function together as one coordinated environment.

PBN integration shall be one of the main objectives of this phase. States should review and update their procedures to ensure that RNAV and RNP procedures are aligned with available GNSS capability, DME/DME coverage and conventional fallback options. In en-route operations, RNAV routes should be supported by GNSS and, where possible, by suitable DME/DME or VOR/DME infrastructure. In terminal airspace, RNAV 1 or RNP 1 procedures should be implemented where aircraft equipage, airspace design and infrastructure permit. For approach operations, RNP APCH procedures should be expanded, including LNAV, LNAV/VNAV and LPV minima where SBAS coverage and aircraft equipage support their use.

The integration phase should also ensure that each GNSS-dependent procedure has a clearly understood operational fallback when necessary. This does not mean that every GNSS procedure must have a direct conventional equivalent, but it does mean that ATC and operators must understand what alternatives are available during GNSS degradation. These alternatives may include DME/DME-based RNAV operations, conventional VOR/DME procedures, ILS approaches, radar vectors, procedural control or diversion to a MON airport.

GNSS monitoring and RFI reporting should become operational during this phase. States and ANSPs should establish procedures to receive pilot reports of GNSS anomalies, correlate them with ATC observations, review technical monitoring data and coordinate with spectrum authorities when interference is suspected. Where available, GNSS reference receivers, SBAS status information, GBAS monitoring, ADS-B quality indicators and CNS logs should be used to support technical assessment.

ATC integration is equally important. Controllers must be prepared to operate in both GNSS-primary and MON-reversion environments. This requires procedures for recognizing GNSS degradation, responding to pilot reports, suspending affected procedures when necessary, applying increased separation, providing vectors, coordinating with adjacent FIRs and activating MON-related contingency measures. Training should include jamming and spoofing scenarios, ADS-B degradation related to GNSS loss and the operational use of conventional fallback procedures.

AIM, NOTAM and ATIS processes must also be integrated into the implementation. Any change to a NAVAID, PBN procedure, MON designation, GBAS service, SBAS-based procedure or contingency arrangement must be published accurately and in a timely manner. AIRAC discipline shall be essential for planned changes, while NOTAM and ATIS/D-ATIS shall be used for tactical or temporary operational information. The wording used for GNSS degradation, procedure suspension, GBAS outage or DME unavailability should be standardized to avoid ambiguity.

The integration phase should also address surveillance and ATC automation. Because ADS-B position data is normally derived from GNSS, GNSS degradation may affect surveillance quality. States should therefore ensure that fallback surveillance options, such as SSR or MLAT where available, are understood and incorporated into ATC contingency procedures. ATC automation systems should support the display of relevant navigation status, procedure availability, NOTAM information and MON-related restrictions.

ATFM/CDM mechanisms should support the integration phase by helping manage demand when navigation capacity is reduced. If GNSS degradation or NAVAID outages reduce available procedures or require reversion to MON operations, traffic flow measures may be necessary. Regional coordination mechanisms such as CADENA or equivalent platforms can support the sharing of operational information, alternate routing, airport acceptance rates and inter-FIR coordination.

By the end of Phase 3, the region should have an operationally integrated navigation environment in which GNSS-based PBN is used during normal operations, while conventional reversion procedures, MON airports, ATC contingency processes, AIM publications and GNSS RFI reporting mechanisms are available when needed.

8.6 Phase 4: Monitoring and Continuous Improvement

Period: 2028 and beyond

The fourth phase shall establish continuous monitoring and improvement as a permanent function of the regional navigation system. Once the CONOPS has been implemented, the system must be continuously evaluated to ensure that it remains safe, effective, resilient and aligned with operational needs.

Monitoring should include both technical and operational performance. From a technical perspective, States and ANSPs should monitor NAVAID availability, DME/DME performance, ILS serviceability, VOR/DME reliability, GNSS degradation reports, SBAS or GBAS status where applicable, maintenance response times and flight inspection results. From an operational perspective, they should monitor the use of PBN procedures, the frequency of GNSS anomalies, the number of NOTAMs related to navigation services, the activation of contingency procedures and the operational impact of any degraded navigation events.

The MON should be reviewed periodically. A MON that is appropriate at the time of initial implementation may need to change as traffic patterns evolve, aircraft equipage improves, new SBAS or GBAS procedures are introduced, conventional systems age or new GNSS interference risks appear. A formal MON review should be conducted at least every five years, and earlier when significant changes occur, such as the decommissioning of a critical facility, hurricane damage, major changes to airspace structure, airport closures, new runway operations or recurrent GNSS RFI events.

GNSS RFI reporting should become an established regional safety and operational process. Reports from pilots, ATC, CNS units and operators should be recorded, analyzed and shared through appropriate national and regional mechanisms. The purpose is not only to react to individual events, but also to identify trends, recurrent locations, operational impacts and mitigation needs. Coordination with telecommunications regulators, military authorities and security agencies will be necessary when interference sources must be investigated or removed.

Continuous improvement should be based on evidence. When a navigation event occurs, the region should be able to detect it, record it, classify it, analyze its cause, apply mitigations, update procedures or training if necessary and share lessons learned. This cycle should support future investment decisions, MON updates, PBN procedure improvements, changes to ATC contingency procedures and enhancements to GNSS monitoring.

By maintaining this monitoring process after 2028, the CAR region will avoid treating the CONOPS as a one-time project. Instead, the navigation concept will become a living operational framework that evolves with technology, traffic demand, safety experience and regional priorities.

8.7 Training and Competency Development

Training shall be an essential part of the transition. The implementation of GNSS-primary operations and MON reversion procedures will introduce new operational concepts that must be understood by controllers, CNS personnel, AIM specialists, procedure designers, operators and flight crews.

Controllers shall be trained to manage GNSS degradation events, recognize the operational implications of jamming or spoofing, apply MON reversion procedures, use conventional fallback clearances and coordinate with adjacent FIRs. CNS personnel shall be trained on the role of MON-critical facilities, DME/DME network performance, GNSS monitoring, RFI investigation support and return-to-service procedures.

AIM personnel shall be trained on the publication of navigation changes, standardized NOTAM wording for GNSS degradation, AIRAC planning and the traceability of aeronautical data. Procedure designers shall be trained to integrate PBN procedures with conventional fallback options, assess DME/DME availability and clearly chart sensor requirements and limitations. Operators and flight crews shall be trained to understand GNSS degradation, report anomalies, use conventional reversion procedures and operate safely in mixed GNSS/conventional environments.

8.8 Risk Management

The transition shall be supported by a regional risk management process. The most significant risks include incomplete infrastructure data, premature decommissioning of NAVAIDs, insufficient DME/DME coverage, lack of aircraft equipage, inadequate training, poor AIM coordination, increased GNSS interference, funding limitations and cross-border misalignment.

These risks shall be managed through safety assessments, phased implementation, stakeholder consultation, operational trials, regional coordination and post-implementation monitoring. In particular, decommissioning decisions should be carefully controlled. Removing a navigation aid may appear technically or economically justified, but could create operational risk if it supports an alternate airport, a contingency route, a non-GNSS user group or an element of the MON.

Risk management should therefore remain active throughout all phases of implementation. The risk register should be updated as new data becomes available, as procedures are introduced, as facilities are withdrawn and as GNSS interference trends evolve.

Chapter 9 - Human and Technical Resources

Identify the personnel, training, and equipment required:

- CNS engineers, calibration teams, maintenance staff.
- Remote monitoring systems, calibration aircraft, data links.
- Training in Annex 10, Doc 8071, Doc 10066.
- Logistics, spare parts, maintenance agreements.

9.1 Purpose

The successful implementation of the CAR navigation CONOPS depends not only on the availability of navigation infrastructure, but also on the availability of qualified personnel, adequate technical equipment, effective maintenance processes, reliable monitoring capabilities, and sustainable logistical support. The transition toward a GNSS-primary and MON-resilient navigation environment requires States and ANSPs to ensure that human and technical resources are planned, developed and maintained as part of the overall navigation service provision strategy.

This chapter identifies the main personnel, training, equipment, maintenance and logistical resources required to support the planning, operation, inspection, monitoring and continuous improvement of conventional NAVAIDs, GNSS-based services, PBN procedures and the Minimum Operational Network (MON) in the CAR region.

The objective is to ensure that each State has the capability to maintain safe, continuous and reliable navigation services during normal operations, degraded operations, maintenance activities and contingency situations, including GNSS interference or outage events.

9.2 Human Resource Requirements

The implementation and operation of this CONOPS will require multidisciplinary teams. Navigation services can no longer be managed only as isolated ground equipment systems; they must be managed as part of an integrated CNS/ATM environment involving navigation infrastructure, GNSS, PBN procedures, ATC operations, AIM, surveillance, safety management and spectrum coordination.

Each State or ANSP should ensure the availability of qualified personnel in the areas of CNS engineering, NAVAID maintenance, flight inspection coordination, procedure design, AIM data management, ATC operations, safety assessment, spectrum coordination and project management.

CNS Personnel

CNS engineers will be required to plan, operate and maintain VOR/DME, DME, ILS/LOC, remote monitoring systems, GNSS monitoring equipment and any GBAS-related infrastructure where applicable. These engineers should have sufficient knowledge of radiofrequency systems, signal-in-space performance, alarm limits, equipment redundancy, power systems, antenna systems, data communications and system interfaces with ATC and AIM.

Maintenance personnel will be required to perform preventive and corrective maintenance on conventional NAVAIDs and associated support systems. Their role will be especially important for MON-designated facilities, where service availability has a direct impact on contingency capability. Maintenance staff should therefore be trained not only to repair equipment, but also to understand the operational consequences of outages, degraded redundancy, delayed restoration and incorrect return-to-service decisions.

Calibration and flight inspection teams will be required to verify that navigation facilities meet the required performance standards before commissioning, after major maintenance, after relocation or modification, and during periodic inspection cycles. Where States do not operate their own flight inspection aircraft, arrangements should be established with regional or external providers to ensure timely access to inspection services.

AIM Personnel

AIM personnel will be required to manage the publication of NAVAID status, procedure changes, NOTAM, AIP amendments, AIP supplements and AIRAC updates. Their role is critical because technical changes to navigation infrastructure must be accurately reflected in operational publications and aircraft navigation databases.

ATC Personnel

ATC personnel will need to understand how the navigation architecture works in both GNSS-primary and MON-reversion environments. Controllers should be familiar with GNSS degradation procedures, use of conventional fallback, implications of DME/DME or VOR/DME outages, ATIS/NOTAM coordination, and the operational activation of contingency procedures.

Safety and Regulatory Personnel

Safety and regulatory personnel will be required to support safety assessments associated with new procedures, decommissioning of legacy NAVAIDs, implementation of SBAS or GBAS services, MON definition and major changes to ATC procedures. This role is essential to ensure that modernization decisions are properly justified and that residual risks are acceptable.

Finally, each State should designate focal points for GNSS interference reporting and coordination with national spectrum, telecommunications, military and security authorities. These focal points should be capable of managing reports of jamming, spoofing or other GNSS anomalies and ensuring that technical and operational information is escalated through the appropriate channels.

9.3 Competency and Training Requirements

Training is one of the most important enablers of the CONOPS. The transition toward GNSS-primary operations supported by a conventional MON requires personnel to understand both modern PBN/GNSS concepts and the continued operational value of selected conventional systems.

Training programmes should be aligned with relevant ICAO provisions and guidance material, including Annex 10, Doc 8071, Doc 9849, Doc 9613, Doc 8168, Doc 4444 and Doc 10066, as applicable to each functional area. The purpose of this training is not only regulatory compliance, but also the creation of common technical and operational understanding across CNS, ATM, AIM, procedure design and safety teams.

CNS personnel should receive training on VOR, DME, ILS, remote monitoring systems, power systems, antenna systems, fault diagnosis, alarm interpretation, return-to-service procedures and maintenance documentation. They should also receive training on GNSS fundamentals, SBAS, GBAS, GNSS vulnerability, jamming, spoofing and the role of GNSS monitoring in operational decision-making.

Maintenance personnel should be trained to apply the testing and inspection principles of ICAO Doc 8071. This includes understanding the relationship between ground checks, flight inspection, facility tolerances, alarm limits, equipment configuration and operational availability. For MON-critical facilities, training should emphasize restoration priorities, redundancy management and coordination with ATC and AIM.

ATC personnel should receive training on how navigation service degradation affects the operational environment. This includes the impact of GNSS interference on PBN procedures, ADS-B surveillance, RNAV/RNP operations, approach availability, contingency routes and separation methods. Controllers should also be trained on the use of standardized phraseology and coordination procedures when pilots report GNSS anomalies.

AIM personnel should be trained in accordance with the principles of aeronautical data quality and information management. This includes AIRAC discipline, NOTAM origination, AIP amendment procedures, data traceability and the coordination required when navigation facilities are commissioned, withdrawn, degraded or returned to service.

Procedure designers should receive specific training on how to integrate GNSS-based procedures with conventional fallback options and MON planning. They should be able to assess whether DME/DME coverage can support a procedure, whether conventional procedures remain necessary, and how charting should communicate sensor requirements, limitations and reversion options.

Operators and flight crews should also be considered within the training strategy. Although they are not under the direct technical control of the ANSP, their understanding of GNSS degradation, MON operations, conventional reversion, reporting procedures and SBAS/GBAS limitations is essential for successful implementation.

Training should be delivered through a combination of classroom instruction, technical courses, operational workshops, simulator exercises, tabletop exercises and regional seminars. The region should also consider shared training initiatives to reduce cost and promote harmonized implementation among CAR States.

9.4 Flight Inspection and Calibration Resources

Flight inspection and calibration are essential to maintain confidence in conventional NAVAIDs and, where applicable, GNSS-based procedure validation. The region should ensure that all VOR, DME, ILS and other operationally significant facilities are inspected in accordance with State-approved programmes and applicable ICAO guidance.

States may meet this requirement through national flight inspection aircraft, regional shared services, contracted international providers or cooperative agreements. Regardless of the model selected, the service must be available with sufficient reliability to support commissioning, periodic inspection, post-maintenance verification, special inspections and return-to-service requirements.

The CAR region should consider the benefits of regional coordination for flight inspection services. Many States have relatively small networks of NAVAIDs, and individual ownership of flight inspection aircraft may not be economically efficient. A shared or coordinated approach may improve availability, reduce costs, support standardization and ensure that MON-critical facilities receive timely inspection.

Ground calibration teams should also be properly equipped and trained. Their work supports flight inspection by ensuring that facilities are stable, correctly configured and ready for inspection. Poor ground preparation can result in repeated flight inspection missions, increased cost and prolonged facility outages.

For MON-designated facilities, inspection planning should consider operational criticality. These facilities should receive priority scheduling, and their inspection status should be closely tracked. If a MON facility loses inspection validity, the operational impact should be immediately assessed and communicated to ATC and AIM.

9.5 Maintenance Organization and Support

The maintenance organization shall be capable of supporting both routine service provision and contingency recovery. This requires clear procedures, qualified personnel, adequate documentation, spare parts availability, maintenance tools, transportation arrangements, site access procedures and escalation mechanisms.

Preventive maintenance should be planned and documented. Its purpose is to reduce the probability of failures, extend equipment life and maintain performance within approved limits. Corrective maintenance should be supported by rapid fault diagnosis, access to spare parts, technical documentation and escalation to manufacturers or specialized contractors when required.

Maintenance agreements may be necessary for systems that require manufacturer support, specialized tools or proprietary software. These agreements should define response times, spare parts availability, software support, technical assistance, repair processes, warranty conditions and obsolescence management.

Special attention should be given to equipment lifecycle management. Some conventional NAVAIDs in the region may be approaching end-of-life, with limited spare parts availability or reduced manufacturer support. States should not wait until equipment failure occurs before planning replacement or rationalization. Lifecycle information should be integrated into the national and regional infrastructure planning process.

Maintenance procedures should also address environmental hazards. In the CAR region, tropical storms, hurricanes, flooding, lightning, salt corrosion, power instability and access limitations may affect navigation facilities. Maintenance planning should therefore include seasonal readiness, site hardening, backup power, spare antenna components, emergency repair kits and post-disaster inspection procedures.

9.6 Logistics, Spare Parts and Supply Chain Management

Logistics and spare parts management are critical to the sustainability of navigation services. One of the recurring challenges in the CAR region is the long procurement cycle for spare parts and the limited availability of manufacturer support for older systems. This can lead to extended outages, loss of redundancy and increased operational risk.

Each State or ANSP should establish a spare parts strategy based on the criticality of each facility. MON facilities, high-traffic airport systems, ILS installations, critical DMEs and VOR/DME facilities supporting contingency routes should receive higher priority in spare parts planning. For these facilities, the minimum spare parts holding should be defined not only by manufacturer recommendations, but also by operational criticality and historical failure data.

Where possible, States should explore regional pooling of spare parts for common equipment types. A regional spare parts pool could reduce cost, improve availability and shorten restoration times, especially for States with small inventories. This approach would require agreements on ownership, storage, transport, customs procedures, cost sharing and replenishment.

Logistics planning should also include transportation to remote sites, access during severe weather, customs clearance for imported parts, repair and return processes for Line Replaceable Units, and emergency procurement mechanisms. Delays in any of these areas can directly affect navigation service availability.

For older systems, States should determine whether continued operation is sustainable. If spare parts are no longer available or repairs require excessive lead times, the facility should be considered for modernization, replacement or decommissioning, depending on its operational role and MON value.

9.7 Staffing Model and Regional Cooperation

Because CAR States vary in size, traffic volume, technical capacity and financial resources, a single staffing model will not be appropriate for all. However, each State must ensure that essential functions are covered either internally or through formal agreements.

Larger States or ANSPs may maintain full CNS engineering, maintenance, flight inspection coordination, GNSS monitoring and procedure support teams. Smaller States may rely on a combination of internal focal points, regional service providers, contracted maintenance support and shared technical resources.

Regional cooperation should be encouraged where it improves efficiency and harmonization. This may include shared training programmes, regional maintenance agreements, common procurement frameworks, shared flight inspection services, common GNSS RFI reporting tools, shared spare parts pools and technical assistance through ICAO regional mechanisms.

The region should also consider developing communities of practice for CNS engineers, AIM personnel, procedure designers and GNSS RFI focal points. These communities can support knowledge sharing, lessons learned, standardization and rapid dissemination of operational experience.

9.8 Resource Planning for MON Facilities

MON facilities require special attention because they provide the conventional safety net during GNSS degradation or outage. A facility designated as part of the MON should not be managed only as a standard navigation aid; it should receive higher priority in maintenance, monitoring, inspection, spare parts and restoration planning.

For each MON facility, the responsible ANSP should identify the personnel, equipment, spare parts, data links, backup power and inspection arrangements required to maintain operational readiness. The facility should also have documented restoration priorities and clear coordination procedures with ATC and AIM.

If a MON facility is unavailable, operating without redundancy or affected by a prolonged maintenance issue, the operational impact should be assessed immediately. Depending on the severity, this may require NOTAM action, temporary modification of contingency procedures, coordination with adjacent FIRs or temporary adjustment of the MON concept.

MON airports should also be reviewed from a resource perspective. It is not sufficient for an airport to have a conventional approach procedure on paper. The airport should have the necessary navigation facilities, runway capability, rescue and firefighting services, communications, power resilience and operational coordination to support its role during contingency conditions.

Chapter 10 - Risk Management

The rationalization or withdrawal of a navigation aid shall be supported by a documented safety and operational assessment. The assessment shall consider the loss of the facility in normal and GNSS-degraded conditions, affected procedures and routes, aircraft equipage, alternate aerodromes, terrain and low-altitude coverage, communications/surveillance dependencies, ATC workload, common-mode failures, maintenance and power resilience, and cross-border effects.

Particular attention shall be given to GNSS radio-frequency interference, ionospheric effects, mixed aircraft equipage, DME/DME geometry limitations, and the possibility that a reversion service may be available to some users but not others. Where the MON cannot provide the same service level as normal GNSS-based operations, predefined operational restrictions and ATFM/CDM measures shall form part of the contingency concept.

No NAVAID should be withdrawn solely because a PBN procedure exists. Withdrawal decisions shall confirm that adequate redundancy/reversion is available, that associated procedures and aeronautical information have been updated, that affected users have been consulted, and that the resulting configuration remains safe, interoperable and cost-effective.

Identify and evaluate potential risks (aligned with ISO 31000 / Doc 9859):

Risk	Probability	Impact	Mitigation
Obsolescence of equipment	High	Medium	Plan phased replacement and spare parts strategy.
GNSS interference	Medium	High	Maintain MON coverage and RFI monitoring.
Power failure at remote site	Medium	Medium	Install UPS and automatic transfer system.

Chapter 11 - Monitoring, Evaluation and Reporting

Navigation-service monitoring for PBN shall include a NAVAID infrastructure view consistent with Doc 9613: conventional beacon status, critical-DME status, availability of redundant DME pairs, the effect of outages on supported RNAV/RNP applications, and the timely publication of operational restrictions. Monitoring shall distinguish an individual equipment outage from actual loss of the navigation service.

Define KPIs and reporting mechanisms:

- Availability per site (%).
- MTBF / MTTR indicators.
- Scheduled vs unscheduled maintenance ratio.
- Reports to ICAO NACC (annual CNS performance dashboard).

Additional Annex 10-aligned indicators should include: inspection validity of retained NAVAIDs; operational availability and outage duration; backup-power test results; time from detected status change to ATS/AIM notification; number and duration of GNSS interference events; percentage of NAVAIDs with an approved retain/rationalize/replace decision; and percentage of designated reversion scenarios validated by simulation, tabletop exercise or operational trial.

Chapter 12 - References

List applicable documents:

- ICAO Annex 10 — Aeronautical Telecommunications, Volume I — Radio Navigation Aids, Eighth Edition (2023), including Amendment 94 (applicable 27 November 2025); in particular Chapter 2 and Attachments B, C, D, F and H.
- ICAO Doc 8071 - Manual on Testing of Radio Navigation Aids: Volume I - Testing of Ground-based Radio Navigation Systems, Sixth Edition (Advance unedited, 2026); Volume II - Testing of Satellite-based Radio Navigation Systems, Fifth Edition (2007).
- ICAO Doc 9854 – Global ATM Operational Concept
- ICAO Doc 9750 — Global Air Navigation Plan (GANP), current applicable edition.
- ICAO Doc 9849 — Global Navigation Satellite System (GNSS) Manual, Fifth Edition (2025), including Corrigendum No. 1 dated 20 November 2025.
- ICAO Doc 9613 — Performance-based Navigation (PBN) Manual, Fifth Edition (2023), including Corrigendum No. 1 dated 14 April 2024.
- ICAO Doc 10066 - Procedures for Air Navigation Services - Aeronautical Information Management (PANS-AIM), First Edition (2018), consolidated through Amendment No. 4 (applicable 27 November 2025), with Amendment No. 5 (approved 22 April 2026; applicable 26 November 2026) considered for forward alignment of NAVAID-related definitions.
- GREPECAS MON Strategy, NACC/WG/10 Conclusions

13. Charter 13 - Appendices

APPENDIX A — NETWORK MAP OF NAVAIDS

A.1 Purpose. This appendix presents the consolidated planning inventory and geographic distribution of conventional navigation aids reported for the CAR Region. It supports development of the CAR Regional Minimum Operational Network (MON).

Validation requirement. All CAR States and Territories shall validate each facility, identifier, frequency/channel, coordinates, operational status, technical configuration and lifecycle information against the applicable AIP and authoritative State records. The map is a planning visualization—not a certified coverage, signal-performance or flight-planning chart.

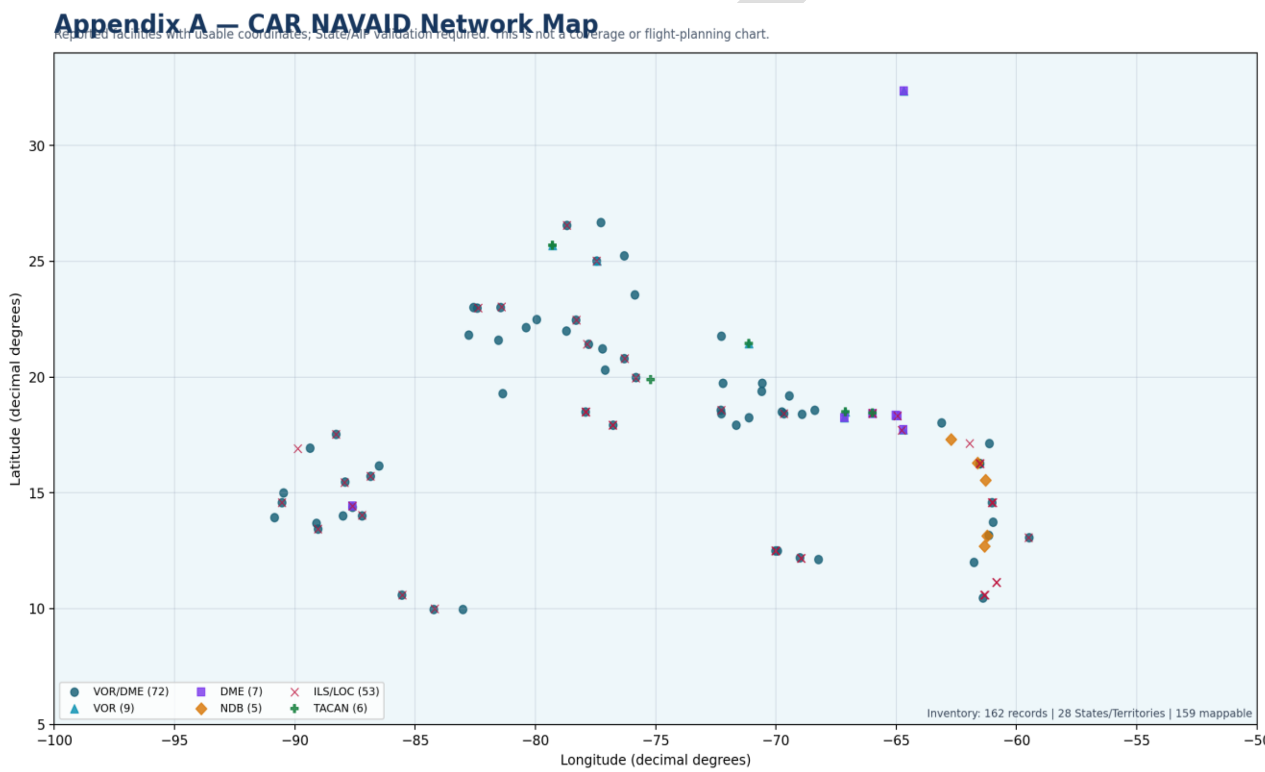

Figure A-1. CAR NAVAID network based on reported coordinates.

A.2 Inventory by State/Territory and service family

State/Territory	Total	VOR/DME	VOR	DME	NDB	ILS/LOC	TACAN	Mappable	Needs validation
Antigua and Barbuda	2	1	0	0	0	1	0	2	2
Aruba	5	2	0	0	0	3	0	5	4
Bahamas	1	7	2	0	0	2	2	1	1
Barbados	3	1	0	0	0	1	0	3	3
Belize	2	1	0	0	0	1	0	2	2
Bermuda	2	0	1	1	0	0	0	2	2
Bonaire	1	1	0	0	0	0	0	1	1
Cayman Islands	2	1	0	0	0	1	0	1	2
Costa Rica	5	3	0	0	0	2	0	5	5
Cuba	21	14	0	0	0	6	1	21	21
Curacao	4	1	0	0	0	3	0	3	4
Dominica	1	0	0	0	1	0	0	1	1
Dominican Republic	13	10	0	0	0	3	0	13	13
El Salvador	4	2	0	0	0	2	0	4	4
French Antilles	11	4	0	0	1	6	0	11	11
Grenada	1	1	0	0	0	0	0	1	1
Guatemala	10	6	0	0	0	4	0	10	10
Haiti	4	3	0	0	0	1	0	4	4
Honduras	12	7	0	1	0	4	0	12	12
Jamaica	8	2	0	0	0	6	0	7	8
Puerto Rico	12	0	3	2	0	2	2	12	12
Saint Kitts	1	0	0	0	1	0	0	1	1
Saint Lucia	1	1	0	0	0	0	0	1	1
Saint Vincent and the Grenadines	3	1	0	0	2	0	0	3	3
St. Maarten	1	1	0	0	0	0	0	1	1
Trinidad and Tobago	7	1	0	0	0	6	0	7	0
Turks And Caicos Islands	3	1	1	0	0	0	1	3	2
Virgin Islands	10	0	2	3	0	2	0	10	10

Source reconciliation: the latest/best-available State-specific entries were selected from the supplied workbooks. Test records and territories outside the CAR scope were excluded. Conflicts and omissions are retained as validation issues in the accompanying workbook.

APPENDIX B — SYSTEM CONFIGURATION AND TECHNICAL DATA

B.1 System configuration. The CAR navigation infrastructure is represented as facility records linked, where possible, to an aerodrome reference and described by service type, identifier, assigned frequency/channel, coordinates, equipment make/model and lifecycle dates. Aerodrome links in this draft were generated by automated name matching and shall be confirmed by the responsible State/Territory.

B.2 Data quality. Blank cells mean that the information was not present in the supplied source, not that the parameter is inapplicable. The complete source lineage, original coordinate strings, aerodrome enrichment, remarks and record-level validation issues are preserved in the accompanying Excel workbook.

Table B-1. Consolidated technical inventory

ID	State/Territory	Location	ICAO	Service	Ident.	Freq.	DME Ch.	Lat.	Lon.	Manufacturer / model	Installed / replace	Validation
CAR-0001	Antigua and Barbuda	SAINT JOHNS V.C. Bird Intl.		ILS		108.700		17.15	-61.95			Needs State validation
CAR-0002	Antigua and Barbuda	SAINT JOHNS V.C. Bird Intl.		VOR/DME		114.500	92X	17.125833	-61.133611	Selex / 1150A	2019-06-01 00:00:00	Needs State validation
CAR-0003	Bahamas	ALICE TOWN South Bimini Intl.		VOR/TAC		116.700	114X	25.7	-79.3			Needs State validation
CAR-0004	Bahamas	FREEPORT Freport Intl.		ILS		109.700		26.55	-78.7			Needs State validation
CAR-0005	Bahamas	FREEPORT Freport Intl.		VOR/DME		113.200	79X	26.55	-78.7			Needs State validation
CAR-0006	Bahamas	G. HARBOUR Governor's Harbour		VOR/DME		112.500	72X	25.25	-76.316667			Needs State validation
CAR-0007	Bahamas	GEORGETOWN Exuma Intl.		VOR/DME		112.200	59X	23.55	-75.866667			Needs State validation
CAR-0008	Bahamas	NASSAU Nassau Intl.		ILS/DME		110.100	38X	25.033333	-77.45			Needs State validation
CAR-0009	Bahamas	NASSAU Nassau Intl.		VOR/DME		112.700	74X	25.033333	-77.45			Needs State validation
CAR-0010	Bahamas	ROCK SOUND		VOR/DME		117.500	122X	-0.0	-0.0			Needs State validation
CAR-0011	Bahamas	TREASURE CAY Treasure Cay Intl.		VOR/DME		112.900	76X	26.683333	-77.283333			Needs State validation
CAR-0012	Bahamas	WEST END West End, G. Bahama I.		VOR/DME		0	0	-0.0	-0.0			Needs State validation
CAR-0013	Bahamas	BIMINI		VOR		116.7		25.70389	-79.29361			Needs State validation
CAR-0014	Bahamas	BIMINI		TACAN		1201		25.70389	-79.29361			Needs State validation
CAR-0015	Bahamas	NASSAU		VOR		112.7		25.02556	-77.44639			Needs State validation
CAR-0016	Barbados	BRIDGETOWN Grantley Adams Intl.		ILS		110.100		13.078853	-59.491603			Needs State validation
CAR-0017	Barbados	BRIDGETOWN Grantley Adams Intl.		VOR/DME		112.700	74X	13.075	-59.483828	SELEX / 1150A		Needs State validation
CAR-0018	Barbados	BRIDGETOWN Grantley Adams Intl.		MM		75		13.069006	-59.51505			Needs State validation

ID	State/Territory	Location	ICAO	Service	Ident.	Freq.	DME Ch.	Lat.	Lon.	Manufacturer / model	Installed / replace	Validation
CAR-0019	Belize	BELIZE Philip S.W. Goldson Intl.		ILS/DME		108.900	26X	17.533333	-88.3			Needs State validation
CAR-0020	Belize	BELIZE Philip S.W. Goldson Intl.		VOR/DME		114.300	90X	17.533333	-88.3			Needs State validation
CAR-0021	Costa Rica	ALAJUELA Juan Santamaría Intl.		VOR/DME		115.700	104X	9.983333	-84.233333			Needs State validation
CAR-0022	Costa Rica	LIBERIA Daniel Oduber Intl.		ILS/DME		111.300	50X	10.6	-85.533333			Needs State validation
CAR-0023	Costa Rica	LIBERIA Daniel Oduber Intl.		VOR/DME		112.800	75X	10.6	-85.55			Needs State validation
CAR-0024	Costa Rica	LIMON Limón Intl.		VOR/DME		116.300	110X	9.966667	-83.016667			Needs State validation
CAR-0025	Costa Rica	ALAJUELA Juan Santamaría Intl.		ILS/DME		109.500	32X	10.0	-84.2	THALES / 420/435	2022 / 2042	Needs State validation
CAR-0026	Dominica	Douglas Charles Airport		NDB/DME	DOM		111X	15.550556	-61.295556	Selex / 1119A	2023-05-01 00:00:00	Needs State validation
CAR-0027	Dominican Republic	ARROYO BARRIL		VOR/DME		114.500	92X	19.2	-69.45			Needs State validation
CAR-0028	Dominican Republic	BARAHONA María Montes Intl.		VOR/DME		112.000	57X	18.25	-71.133333			Needs State validation
CAR-0029	Dominican Republic	CABO ROJO		VOR/DME		114.300	90X	17.933333	-71.65			Needs State validation
CAR-0030	Dominican Republic	LA ISABELA		VOR/DME		115.800	105X	-0.0	-0.0			Needs State validation
CAR-0031	Dominican Republic	LA ROMANA La Romana Intl.		VOR/DME		116.200	109X	18.4	-68.916667			Needs State validation
CAR-0032	Dominican Republic	PUERTO PLATA G. Luperón Intl.		VOR/DME		115.100	98X	19.75	-70.566667			Needs State validation
CAR-0033	Dominican Republic	PUNTA CANA Punta Cana Intl.		VOR/DME		112.700	74X	18.566667	-68.383333			Needs State validation
CAR-0034	Dominican Republic	SAN ISIDRO		ILS/DME		109.100	28X	0.0	-0.0			Needs State validation
CAR-0035	Dominican Republic	SAN ISIDRO		VOR/DME		112.400	71X	18.5	-69.766667			Needs State validation
CAR-0036	Dominican Republic	SANTIAGO Cibao Santiago Intl.		ILS/DME		109.300	30X	-0.0	-0.0			Needs State validation
CAR-0037	Dominican Republic	SANTIAGO Cibao Santiago Intl.		VOR/DME		114.900	96X	19.4	-70.6			Needs State validation
CAR-0038	Dominican Republic	SANTO DOMINGO D.L. Américas Intl.		ILS/DME		108.900	26X	18.433333	-69.666667			Needs State validation
CAR-0039	Dominican Republic	SANTO DOMINGO D.L. Américas Intl.		VOR/DME		114.700	94X	18.433333	-69.666667			Needs State validation
CAR-0040	El Salvador	SALVADOR SLV SAN SALVADOR El Salvador Intl.		ILS/DME		109.300	30X	-0.0	-0.0			Needs State validation
CAR-0041	El Salvador	SALVADOR SLV SAN SALVADOR El Salvador Intl.		ILS		110.300		13.433333	-89.033333			Needs State validation
CAR-0042	El Salvador	SALVADOR SLV SAN SALVADOR El Salvador Intl.		VOR/DME		117.500	122X	13.433333	-89.033333			Needs State validation
CAR-0043	El Salvador	SALVADOR SLV SAN SALVADOR Ilopango Intl.		VOR/DME		116.500	112X	13.683333	-89.116667			Needs State validation

ID	State/Territory	Location	ICAO	Service	Ident.	Freq.	DME Ch.	Lat.	Lon.	Manufacturer / model	Installed / replace	Validation
CAR-0044	Grenada	SAINT. GEORGES Point Salines Intl.		VOR/DME		117.100	118X	12.001667	-61.785278	Selex / 1150A/1119A	2013-09-01 00:00:00	Needs State validation
CAR-0045	Guatemala	CHINAUTLA		VOR/DME		114.100	88X	-0.0	-0.0			Needs State validation
CAR-0046	Guatemala	FLORES Flores Intl.		ILS/DME		111.100	48X	16.916667	-89.883333			Needs State validation
CAR-0047	Guatemala	FLORES Flores Intl.		VOR/DME		113.300	80X	16.933333	-89.366667			Needs State validation
CAR-0048	Guatemala	GUATEMALA La Aurora Intl.		ILS/DME		110.100	38X	14.583333	-90.533333			Needs State validation
CAR-0049	Guatemala	GUATEMALA La Aurora Intl.		ILS/DME		110.900	46X	0.0	-0.0			Needs State validation
CAR-0050	Guatemala	GUATEMALA La Aurora Intl.		VOR/DME		114.500	92X	14.583333	-90.533333			Needs State validation
CAR-0051	Guatemala	P. BARRIOS Puerto Barrios Intl.		ILS		111.500		-0.0	-0.0			Needs State validation
CAR-0052	Guatemala	P. BARRIOS Puerto Barrios Intl.		VOR/DME		115.100	98X	-0.0	-0.0			Needs State validation
CAR-0053	Guatemala	RABINAL		VOR/DME		116.100	108X	15.016667	-90.466667			Needs State validation
CAR-0054	Guatemala	SAN JOSÉ San José Intl.		VOR/DME		114.100	88X	13.933333	-90.85			Needs State validation
CAR-0055	Haiti	CAP HAITIEN Cap Haitien Intl.		VOR/DME		113.900	86X	19.733333	-72.2			Needs State validation
CAR-0056	Haiti	OBLEON		VOR/DME		113.200	79X	18.433333	-72.266667			Needs State validation
CAR-0057	Haiti	PORT-AU-PRINCE Port-au-Prince Intl.		ILS		111.500		18.583333	-72.266667			Needs State validation
CAR-0058	Haiti	PORT-AU-PRINCE Port-au-Prince Intl.		VOR/DME		115.300	100X	18.583333	-72.3			Needs State validation
CAR-0059	Honduras	COXEN HOLE Juan M. Galvez Intl.		VOR/DME		113.800	85X	16.183333	-86.516667			Needs State validation
CAR-0060	Honduras	LA CEIBA Goloson Intl.		ILS/DME		111.700	54X	15.733333	-86.85			Needs State validation
CAR-0061	Honduras	LA CEIBA Goloson Intl.		VOR/DME		113.500	82X	15.733333	-86.866667			Needs State validation
CAR-0062	Honduras	Palmerola (MHPR)		ILS		108.300		14.4325	-87.616944			Needs State validation
CAR-0063	Honduras	Palmerola (MHPR)		VOR/DME		115.900	106X	14.3825	-87.616944			Needs State validation
CAR-0064	Honduras	Palmerola (MHPR)		DME			25/100	14.4325	-87.616944			Needs State validation
CAR-0065	Honduras	SAN PEDRO SULA La Mesa Intl.		ILS/DME		110.700	44X	15.45	-87.933333			Needs State validation
CAR-0066	Honduras	SAN PEDRO SULA La Mesa Intl..		VOR/DME		113.100	78X	15.466667	-87.916667			Needs State validation
CAR-0067	Honduras	TEGUCIGALPA Toncontin Intl.		ILS		109.900		14.05	-87.216667			Needs State validation
CAR-0068	Honduras	TEGUCIGALPA Toncontin Intl.		VOR/DME		112.300	70X	14.016667	-87.216667			Needs State validation
CAR-0069	Honduras	TEGUCIGALPA Toncontin Intl.		VOR/DME		112.500	72X	14.016667	-88.0			Needs State validation

ID	State/Territory	Location	ICAO	Service	Ident.	Freq.	DME Ch.	Lat.	Lon.	Manufacturer / model	Installed / replace	Validation
CAR-0070	Honduras	TEGUCIGALPA Toncontin Intl.		VOR/DME		115.400	101X	-0.0	-0.0			Needs State validation
CAR-0071	Jamaica	KINGSTON Norman Manley Intl.		ILS LOC	IMLY	109.100		17.931064	-76.779392			Needs State validation
CAR-0072	Jamaica	KINGSTON Norman Manley Intl.		ILS GS				17.938417	-76.797033			Needs State validation
CAR-0073	Jamaica	KINGSTON Norman Manley Intl.		ILS/DME			28X					Needs State validation
CAR-0074	Jamaica	KINGSTON Norman Manley Intl.		VOR/DME	MLY	115.500	102X	17.930247	-76.777628			Needs State validation
CAR-0075	Jamaica	MONTEGO BAY Sangster Intl.		ILS LOC	ISIA	109.500		18.510803	-77.896981			Needs State validation
CAR-0076	Jamaica	MONTEGO BAY Sangster Intl.		ILS GS				18.501647	-77.920847			Needs State validation
CAR-0077	Jamaica	MONTEGO BAY Sangster Intl.		ILS/DME			32X	18.510167	-77.896694			Needs State validation
CAR-0078	Jamaica	MONTEGO BAY Sangster Intl.		VOR/DME		115.700	104X	18.501022	-77.924119			Needs State validation
CAR-0079	Saint Kitts	BASSETERRE BRADSHAW AIRPORT		NDB/DME	SKB		57X	17.306389	-62.727778	Selex / 1118A	2010-02-01 00:00:00	Needs State validation
CAR-0080	Saint Lucia	HEWANORRA AIRPORT		VOR/DME	BNE	112.4	71x	13.733333	-60.976944	Selex / 1150A/1119A	2015-11-01 00:00:00	Needs State validation
CAR-0081	Saint Vincent and the Grenadines	Argyle AIRPORT		VOR/DME	ARG	115.4	101X	13.166389	-61.149444	Selex / 1150A/1119A	2017-02-01 00:00:00	Needs State validation
CAR-0082	Saint Vincent and the Grenadines	CANE GARDEN		NDB/DME	SV		21X	13.140556	-61.226111	Selex / 1118	2001-08-03 00:00:00	Needs State validation
CAR-0083	Saint Vincent and the Grenadines	CANOUAN Is CANOUAN AIRPORT		NDB/DME	CAI		51X	12.696111	-61.339167	Selex / 1118A	2008-11-01 00:00:00	Needs State validation
CAR-0084	St. Maarten			VOR/DME	PJM	113	77X	18.038111	-63.118278	Selex / 1150A/1119A	2019	Needs State validation
CAR-0085	Aruba	ORANJESTAD Reina Beatrix, Aruba I.		ILS LOC	IBE	108.700		12.498194	-70.001833	AMS / 2100	2004 / 2028	Reported — verify against State AIP/data
CAR-0086	Aruba	ORANJESTAD Reina Beatrix, Aruba I.		ILS GS		330.5		12.502639	-70.025083	AMS / 2110	2004 / 2028	Needs State validation
CAR-0087	Aruba	ORANJESTAD Reina Beatrix, Aruba I.		ILS/DME			24X	12.502639	-70.025083	SELEX / 1118A	2023	Needs State validation
CAR-0088	Aruba	ORANJESTAD Reina Beatrix, Aruba I.		VOR/DME	ABA	112.500	72X	12.505667	-69.942361	SELEX / 1150/1119A	2010	Needs State validation
CAR-0089	Aruba	ORANJESTAD Reina Beatrix, Aruba I.		VOR/DME	BEA	113.800	85X	12.501611	-70.020778	THALES / 431/435	2005	Needs State validation
CAR-0090	Curacao	Hato Curacao International airport		ILS LOC	IATO	111.9		12.185306	-68.942528			Needs State validation
CAR-0091	Curacao	Hato Curacao International airport		ILS/GS								Needs State validation
CAR-0092	Curacao	Hato Curacao International airport		ILS/DME			56X	12.191083	-68.964667			Needs State validation
CAR-0093	Curacao	Hato Curacao International airport		VOR/DME	PJG	116.7	114X	12.197056	-69.011889			Needs State validation
CAR-0094	Bonaire	Flamingo International airport		VOR/DME	PJB	115	97X	12.131667	-68.249444			Needs State validation
CAR-0095	Bermuda	HAMILTON		VOR		113.9		32.36444	-64.68944			Needs State validation

ID	State/Territory	Location	ICAO	Service	Ident.	Freq.	DME Ch.	Lat.	Lon.	Manufacturer / model	Installed / replace	Validation
CAR-0096	Bermuda	HAMILTON		DME		1173		32.36444	-64.68944			Needs State validation
CAR-0097	Cayman Islands	GEORGETOWN Owen Roberts Intl.		ILS								Needs State validation
CAR-0098	Cayman Islands	GEORGETOWN Owen Roberts Intl.		VOR/DME		115.600	103X	19.283333	-81.366667	Indra / 1150A/1119A	2025	Needs State validation
CAR-0099	Turks And Caicos Islands	GRAND TURK		TACAN		1176		21.44056	-71.13444			Needs State validation
CAR-0100	Turks And Caicos Islands	GRAND TURK		VOR		114.2		21.44056	-71.13444			Needs State validation
CAR-0101	Turks And Caicos Islands	Providenciales		VOR/DME	PVN	115.6	103X	21.772167	-72.266028	SELEX / 1150A/1119A	2016-04-01 00:00:00 / ?	Reported — verify against State AIP/data
CAR-0102	Puerto Rico	AGUADILLA		VOR		113.5		18.49806	-67.10833			Needs State validation
CAR-0103	Puerto Rico	AGUADILLA		TACAN		1169		18.49833	-67.10833			Needs State validation
CAR-0104	Puerto Rico	MAYAGUEZ		VOR		110.6		18.25639	-67.15111			Needs State validation
CAR-0105	Puerto Rico	MAYAGUEZ		DME		1004		18.25639	-67.15111			Needs State validation
CAR-0106	Puerto Rico	SAN JUAN		Outer Marker		75		18.40889	-66.08944			Needs State validation
CAR-0107	Puerto Rico	SAN JUAN		Localizer		109.7		18.43361	-65.98778			Needs State validation
CAR-0108	Puerto Rico	SAN JUAN		Localizer		110.3		18.45	-65.98722			Needs State validation
CAR-0109	Puerto Rico	SAN JUAN		VOR		114		18.44639	-65.98944			Needs State validation
CAR-0110	Puerto Rico	SAN JUAN		Glide Slope		333.2		18.43278	-66.01083			Needs State validation
CAR-0111	Puerto Rico	SAN JUAN		Glide Slope		335		18.44083	-66.01278			Needs State validation
CAR-0112	Puerto Rico	SAN JUAN		DME		995		18.43417	-65.98778			Needs State validation
CAR-0113	Puerto Rico	SAN JUAN		TACAN		1174		18.44639	-65.98944			Needs State validation
CAR-0114	Virgin Islands	CHARLOTTE AMALIE		VOR		108.6		18.35583	-65.02444			Needs State validation
CAR-0115	Virgin Islands	CHARLOTTE AMALIE		DME		984		18.35583	-65.02444			Needs State validation
CAR-0116	Virgin Islands	SAINT CROIX		Outer Marker		75		17.69194	-64.88472			Needs State validation
CAR-0117	Virgin Islands	SAINT CROIX		VOR		108.2		17.73444	-64.70083			Needs State validation
CAR-0118	Virgin Islands	SAINT CROIX		Localizer		109.5		17.70306	-64.78556			Needs State validation
CAR-0119	Virgin Islands	SAINT CROIX		Glide Slope		332.6		17.69972	-64.81278			Needs State validation
CAR-0120	Virgin Islands	SAINT CROIX		DME		980		17.73417	-64.70028			Needs State validation
CAR-0121	Virgin Islands	SAINT THOMAS		Localizer		110.1		18.33778	-64.96028			Needs State validation

ID	State/Territory	Location	ICAO	Service	Ident.	Freq.	DME Ch.	Lat.	Lon.	Manufacturer / model	Installed / replace	Validation
CAR-0122	Virgin Islands	SAINT THOMAS		Glide Slope		334.4		18.33639	-64.98			Needs State validation
CAR-0123	Virgin Islands	SAINT THOMAS		DME		999		18.33861	-64.96111			Needs State validation
CAR-0124	Cuba	CAMAGUEY I. Agramonte Intl.		ILS		110.300		21.416667	-77.866667			Needs State validation
CAR-0125	Cuba	CAMAGUEY I. Agramonte Intl.		VOR/DME		114.100	88X	21.437222	-77.800278			Needs State validation
CAR-0126	Cuba	CAYO COCO Jardines del Rey		ILS/DME		108900	26X	22.466944	-78.309167			Needs State validation
CAR-0127	Cuba	CAYO COCO Jardines del Rey		VOR/DME		117.800	125X	22.467222	-78.311944			Needs State validation
CAR-0128	Cuba	CAYO LARGO DEL SUR V. Acuña Intl.		VOR/DME		112.100	58X	21.605	-81.5325			Needs State validation
CAR-0129	Cuba	CIEGO DE AVILA Máximo Gómez		VOR/DME		117.400	121X	22.0	-78.716667			Needs State validation
CAR-0130	Cuba	CIENFUEGOS		VOR/DME		112.300	70X	22.15	-80.4			Needs State validation
CAR-0131	Cuba	GUANTÁNAMO		VOR/TAC		114.600	93X	19.9	-75.2			Needs State validation
CAR-0132	Cuba	HABANA José Martí Intl.		VOR/DME		109.200	29X	23.023333	-82.581667			Needs State validation
CAR-0133	Cuba	HABANA José Martí Intl.		ILS/DME		110.500	42X	23.000833	-82.390833			Needs State validation
CAR-0134	Cuba	HABANA José Martí Intl.		VOR/DME		116.100	108X	22.978611	-82.426389			Needs State validation
CAR-0135	Cuba	HOLGUIN Frank País Intl.		ILS/DME		111.300	50X	20.798333	-76.300556			Needs State validation
CAR-0136	Cuba	HOLGUIN Frank País Intl.		VOR/DME		116.800	115X	20.798056	-76.302778			Needs State validation
CAR-0137	Cuba	MANZANILLO		VOR/DME		116.000	107X	20.3	-77.1			Needs State validation
CAR-0138	Cuba	NUEVA GERONA		VOR/DME		115300	100X	21.834722	-82.780833			Needs State validation
CAR-0139	Cuba	NUEVAS		VOR/DME		116.300	110X	21.233333	-77.216667			Needs State validation
CAR-0140	Cuba	SANTA CLARA		VOR/DME		117.200	119X	22.487222	-79.960278			Needs State validation
CAR-0141	Cuba	SANTIAGO DE CUBA A. Maceo Intl.		ILS/DME		110700	44X	19.971944	-75.820833			Needs State validation
CAR-0142	Cuba	SANTIAGO DE CUBA A. Maceo Intl.		VOR/DME		113.300	80X	19.977778	-75.8225			Needs State validation
CAR-0143	Cuba	VARADERO Juan G. Gómez Intl.		ILS/DME		111.300	50X	23.045556	-81.417222			Needs State validation
CAR-0144	Cuba	VARADERO Juan G. Gómez Intl.		VOR/DME		114.800	95X	23.024444	-81.453333			Needs State validation
CAR-0145	Trinidad and Tobago	Piarco Intl		ILS LOC	IPOS	109.7		10.595419	-61.319783	Selex / 2100	2007 / 2026	Reported — verify against State AIP/data
CAR-0146	Trinidad and Tobago	Piarco Intl		ILS GS	IPOS	333.2		10.594158	-61.349478	Selex / 2100	2007 / 2026	Reported — verify against State AIP/data
CAR-0147	Trinidad and Tobago	Piarco Intl		ILS/DME	IPOS		34X	10.595419	-61.319844	Selex / 1118A	2019 / To be determined	Reported — verify against State AIP/data

ID	State/Territory	Location	ICAO	Service	Ident.	Freq.	DME Ch.	Lat.	Lon.	Manufacturer / model	Installed / replace	Validation
CAR-0148	Trinidad and Tobago	Piarco Intl		VOR/DME	POS	116.9	116X	10.466389	-61.392361	Selex / 1150A/1119A	2019 (DME) / 2026 (DVOR)	Reported — verify against State AIP/data
CAR-0149	Trinidad and Tobago	Crown Point		ILS LOC	ITAB	109.3		11.149167	-60.816111	Selex / 2100	2019 / To be determined	Reported — verify against State AIP/data
CAR-0150	Trinidad and Tobago	Crown Point		ILS GS	ITAB	332		11.149461	-60.839483	Selex / 2100	2012 / 2026	Reported — verify against State AIP/data
CAR-0151	Trinidad and Tobago	Crown Point		ILS/DME	ITAB		30X	11.149167	-60.816111	Selex / 1118A	2019 / To be determined	Reported — verify against State AIP/data
CAR-0152	French Antilles	POINTE-A-PITRE Le Raizet Intl. MARYSE CONDE AIRPORT		NDB	PTP	385kHz		16.283611	-61.630944			Needs State validation
CAR-0153	French Antilles	POINTE-A-PITRE Le Raizet Intl. MARYSE CONDE AIRPORT		ILS-DME/LOC	PP	110.3MHz		16.262317	-61.515717			Needs State validation
CAR-0154	French Antilles	POINTE-A-PITRE Le Raizet Intl. MARYSE CONDE AIRPORT		ILS-DME/GP		335MHz		16.266028	-61.541869			Needs State validation
CAR-0155	French Antilles	POINTE-A-PITRE Le Raizet Intl. MARYSE CONDE AIRPORT		ILS-DME/DME	PP		40X	16.266028	-61.541864			Needs State validation
CAR-0156	French Antilles	POINTE-A-PITRE Le Raizet Intl. MARYSE CONDE AIRPORT		VOR-DME/VOR	PPR	112.9 MHz		16.265194	-61.540139			Needs State validation
CAR-0157	French Antilles	POINTE-A-PITRE Le Raizet Intl. MARYSE CONDE AIRPORT		VOR-DME/DME	PPR		76X	16.265194	-61.540139			Needs State validation
CAR-0158	French Antilles	FORT-DE-FRANCE Le Lamentain Intl. AIME CESAIRE AIRPORT		ILS-DME/LOC	FF	109.9MHz		14.593911	-60.986517			Needs State validation
CAR-0159	French Antilles	FORT-DE-FRANCE Le Lamentain Intl. AIME CESAIRE AIRPORT		ILS-DME/GP		333.8MHz		14.590047	-61.015464			Needs State validation
CAR-0160	French Antilles	FORT-DE-FRANCE Le Lamentain Intl. AIME CESAIRE AIRPORT		ILS-DME/DME	FF		36X	14.590047	-61.015458			Needs State validation
CAR-0161	French Antilles	FORT-DE-FRANCE Le Lamentain Intl. AIME CESAIRE AIRPORT		VOR-DME/VOR	FOF	113.3MHz		16.265194	-61.540139			Needs State validation
CAR-0162	French Antilles	FORT-DE-FRANCE Le Lamentain Intl. AIME CESAIRE AIRPORT		VOR-DME/DME	FOF		80X	14.59075	-61.022806			Needs State validation

Note: "Needs State validation" indicates one or more missing core attributes (identifier, make/model, lifecycle date or valid coordinate). All records remain subject to formal State/AIP validation before adoption in the CAR Regional MON.

Appendix C: Contingency Procedures

Purpose. This appendix establishes a common regional framework for maintaining safe and orderly IFR operations when GNSS or terrestrial navigation services are degraded, unavailable or unreliable. Each State and Territory shall convert this framework into approved national and unit-level procedures, using its airspace design, aircraft equipage, surveillance and communications capability, available conventional procedures and validated Minimum Operational Network.

Core decision. A contingency shall be managed according to the navigation service that remains available, not only the status of an individual facility. The responsible ATS authority shall determine whether affected PBN or conventional operations remain available, require restrictions, or must be suspended. Safety takes precedence over capacity and efficiency.

Validation requirement. All CAR States and Territories shall validate their contingency contacts, critical facilities, DME/DME dependencies, designated contingency aerodromes and routes, notification targets, operational restrictions, restoration priorities and publication processes. Cross-border arrangements shall be agreed with adjacent FIRs before operational use.

1. Scope and operating principles

- GNSS events, including jamming, spoofing, constellation or augmentation degradation, ionospheric effects and unexplained loss of integrity or availability;
- failure or degradation of VOR, DME, NDB, ILS, GBAS, SBAS-related service or remote monitoring supporting an operational navigation service;
- simultaneous or cascading failures affecting the regional MON, contingency routes or designated alternate aerodromes;
- planned maintenance or withdrawal that temporarily removes required navigation redundancy; and
- common-mode events in which loss of GNSS also affects ADS-B, aircraft timing, communications, surveillance or automation dependencies.

The procedures apply to normal, degraded, contingency and recovery modes. They do not replace pilot operating procedures, State emergency plans, approved ATC contingency plans, PANS-ATM provisions, AIP instructions or the applicable aircraft operational approval.

2. Event classification and activation

Level	Operational condition	Typical indicators	Required response
Level 0 Normal	Navigation services and required redundancy are available.	No unresolved alarm, adverse report or relevant planned outage.	Routine monitoring, inspection and readiness checks.
Level 1 Advisory	An anomaly or single failure is detected, but the intended navigation service remains available.	Single non-critical NAVAID outage; isolated pilot report; reduced redundancy; planned maintenance.	Verify the event, assess service impact, notify affected units and prepare restrictions if conditions deteriorate.
Level 2 Degraded	A navigation application remains possible only with reduced redundancy, limited coverage, higher workload or restrictions.	Loss of a critical DME pair member; localized GNSS interference; loss of an approach aid with an alternative available.	Activate the approved degraded-mode plan, publish limitations, apply traffic/route/approach measures and coordinate adjacent units.

Level	Operational condition	Typical indicators	Required response
Level 3 Contingency	Required navigation performance or safe capacity cannot be maintained under normal procedures.	Widespread GNSS disruption; multiple MON failures; loss of all suitable approaches at a required aerodrome; suspected spoofing.	Activate the State/ANSP contingency organization, impose capacity and airspace measures, use validated reversion procedures and request regional support.
Level 4 Recovery	Technical service is restored but operational confidence and publications are not yet fully normalized.	Stable monitoring after repair; satisfactory ground/flight test; interference no longer detected.	Verify, authorize return to service, cancel restrictions in a controlled sequence and conduct post-event review.

3. Common response sequence

1. Detect and record. Capture alarms, pilot reports, time, affected area/altitude, aircraft observations, facility status, monitoring data and environmental or interference indicators.
2. Verify. Correlate independent technical and operational sources. Treat suspected spoofing cautiously; do not rely on one affected GNSS-dependent source to validate another.
3. Assess the service. Determine affected routes, procedures, airspace volumes, aerodromes, DME pairs, aircraft groups and cross-border dependencies. Distinguish equipment loss from actual loss of the navigation application.
4. Classify and activate. The designated operational authority assigns the event level and activates the approved local, national or regional contingency arrangements.
5. Notify. Inform ATS units, technical operations, AIM/NOTAM, airspace users, adjacent FIRs and other authorities according to the notification matrix.
6. Apply operational measures. Use validated alternate navigation sources, routes, levels, approaches, surveillance/separation methods, flow restrictions or suspension criteria.
7. Monitor and update. Reassess scope, duration, redundancy, traffic demand and emerging common-mode effects. Keep operational information synchronized.
8. Restore and close. Complete required technical testing, authorize return to service, withdraw publications/restrictions in sequence, preserve evidence and conduct review.

4. GNSS degradation interference or outage

4.1 Immediate actions

- ATC shall solicit and correlate pilot reports using approved phraseology and record the affected position, altitude, time, symptoms and equipment indications.
- Technical and spectrum focal points shall examine GNSS monitoring, interference-detection information and relevant NOTAM or regional reports. Suspected harmful interference shall be escalated to the competent national spectrum, security and enforcement authorities.
- The operational authority shall assess impacts on PBN routes and procedures, ADS-B and other GNSS-dependent surveillance, aircraft timing, GBAS/SBAS service, navigation databases and automation functions.
- AIM shall publish operationally relevant limitations. Technical uncertainty shall not delay a necessary operational warning.

4.2 Operational reversion measures

Available capability	Permitted contingency use	Required confirmation	Possible restrictions
Validated DME/DME	RNAV 1, RNAV 2 or RNAV 5 only where supported by the applicable navigation specification, aircraft capability, State authorization and validated geometry.	Usable DME pairs, service volume, altitude, critical-facility status and fleet equipage.	Route/level limits, capacity reduction, exclusion of non-capable aircraft, increased spacing.
VOR/DME or residual VOR network	RNAV 5 where permitted, conventional routes/procedures, position cross-checking and reversion for suitably equipped users.	Facility status, coverage, associated DME, procedure availability and aircraft equipage.	Conventional route structure, altitude limits, tactical vectors or procedural control.
ILS or LOC approaches	Continued approach capability at designated aerodromes when GNSS approaches or GBAS/SBAS service are unavailable.	Inspection validity, facility status, runway availability, DME/marker association and published procedure.	Use of designated alternates, reduced arrival rate, weather/minima constraints.
Inertial capability	Continuation within the limits of the applicable approval and navigation specification; may bridge limited DME coverage gaps where authorized.	Aircraft capability, elapsed time and approved operating limitations.	Route or duration limits; additional cross-checks; exclusion of non-capable aircraft.
No adequate navigation reversion	Procedural contingency using approved routes, headings, surveillance assistance and diversion as available.	Communications and surveillance availability, terrain, workload, alternate aerodromes and adjacent FIR acceptance.	Suspension of affected PBN procedures, entry restrictions, rerouting, ground delay or diversion.

4. 3 Suspected spoofing

Suspected spoofing shall be treated as an integrity event, not merely an availability event. Controllers and technical personnel shall consider disagreement between independent position sources, implausible tracks or time, multiple aircraft deviations, abnormal avionics reports and ADS-B inconsistencies. Aircraft should be moved to validated non-GNSS navigation and surveillance support in accordance with approved procedures. Evidence shall be preserved for technical, safety and spectrum investigation.

5. Terrestrial NAVAID contingencies

Event	Service-impact assessment	Operational response	Technical and AIM response
Single non-critical NAVAID failure	Determine whether remaining facilities still support the published route/procedure and required redundancy.	Continue only if the navigation service remains valid; otherwise restrict the affected application.	Confirm alarm, issue NOTAM as required, estimate restoration and monitor secondary impacts.
Critical DME failure	Identify every segment/altitude for which the station is part of the only usable pair or reduces two independent pairs to limited redundancy.	Apply route, altitude, equipage or capacity restrictions; activate alternate conventional or GNSS-independent arrangements as applicable.	Prioritize repair and inspection; update the critical-NAVAID register and service-impact status.
Multiple VOR or DME failures	Assess loss of geographic coverage, cross-border pairs, contingency routes and aircraft groups.	Activate regional coordination, reroute traffic, apply flow measures and protect remaining MON capacity.	Coordinate restoration priorities and inspection resources; issue harmonized NOTAM information.
ILS LOC GP or associated DME failure	Determine which minima or complete approach capability are unavailable and whether suitable alternatives exist.	Use another runway/procedure or designated alternate; adjust arrival rate and weather acceptance.	Apply facility-specific maintenance and Doc 8071 testing; publish component and procedure impact accurately.
NDB failure	Confirm whether any retained conventional procedure or user group still depends on the NDB.	Use the published alternative; suspend the dependent procedure if no approved substitute exists.	NOTAM, repair or documented rationalization decision; do not leave the procedure ambiguous.

Event	Service-impact assessment	Operational response	Technical and AIM response
GBAS or SBAS service degradation	Identify affected approach service levels, aircraft and procedures; verify whether core GNSS is also affected.	Suspend affected minima/procedures and use available ILS, conventional or other authorized approaches.	Publish service status, investigate integrity/interference indications and complete required validation before restoration.
Monitoring or remote-control failure	Determine whether safe local monitoring and intervention remain available.	Continue only within approved unmonitored-operation conditions and time limits; otherwise withdraw the service.	Dispatch/local monitoring, record alarms, issue status information and restore monitoring priority.

6. Common mode CNS and ATM considerations

GNSS loss may simultaneously affect navigation, ADS-B position, ADS-C reporting, time synchronization and other automated functions. The contingency assessment shall therefore address the complete CNS and ATM service rather than treating navigation in isolation.

- verify independent surveillance availability and select the approved separation method;
- confirm communications coverage and the capacity of voice or data alternatives;
- assess automation, timing and flight-data dependencies;
- protect sectors and aerodromes from workload beyond the degraded-mode capacity;
- coordinate traffic-management initiatives through applicable regional ATFM/CDM mechanisms; and
- apply predefined entry, route, level, speed, spacing, holding, ground-delay or diversion measures.

7. Roles and coordination responsibilities

Actor	Primary responsibilities during contingency
State regulatory authority	Ensure approved contingency and testing frameworks; coordinate spectrum/enforcement and national emergency authorities; accept safety cases and interval/return-to-service decisions within national authority.
ANSP operational authority	Classify and activate the contingency; decide service availability and restrictions; coordinate ATC units, adjacent FIRs, operators and ATFM/CDM; authorize operational normalization.
ATC units	Receive and correlate reports; apply approved procedures, separation and traffic measures; communicate limitations to aircraft; record operational effects and changes.
CNS technical operations	Verify equipment and monitoring status; isolate faults; assess technical dependencies; repair, test and recommend return to service; preserve technical evidence.
AIM and NOTAM office	Publish accurate, timely and consistent facility, procedure and service-impact information; coordinate AIRAC action for lasting changes; close information only after authorization.
Procedure and airspace design	Identify sensor dependencies, validate reversion routes/procedures and evaluate temporary or permanent changes.
Flight inspection or validation provider	Perform commissioning, special or return-to-service activities required by the approved programme and provide traceable results.
Aerodrome operator	Coordinate runway/approach availability, lighting, power, rescue/firefighting and alternate/contingency aerodrome readiness.
Aircraft operators and pilots	Apply approved procedures; report anomalies promptly; confirm aircraft capability when required; comply with restrictions and provide operational observations.
ICAO NACC and regional mechanisms	Facilitate cross-border coordination, regional situational awareness, technical assistance, lessons learned and updates to the CAR MON framework.

8. Notification and information management

Information item	Minimum content	Recipient or channel	Update and closure
Initial operational alert	Time, affected service/area, confidence level, immediate restriction and contact point.	Affected ATS units, technical operations, AIM and operational authority.	Update whenever scope, confidence or operational measure changes.
Pilot report record	Aircraft, time, position/altitude, observed indications, affected equipment/functions and duration.	ATC supervisor, technical/safety investigation and GNSS interference focal point.	Correlate with other reports; preserve original record.
NOTAM or other aeronautical information	Facility or navigation service affected, procedure/route impact, effective period and usable alternatives.	Airspace users and operational systems.	Revise promptly; cancel only after operational authorization.
Adjacent FIR coordination	Boundary impact, accepted routes/levels, capacity, transfer conditions and duration.	Adjacent ATS units and regional ATFM/CDM.	Reconfirm at agreed intervals and at each phase change.
Spectrum or security report	Location/time/frequency evidence, affected services, safety impact and technical observations.	Competent national authority through protected channels as appropriate.	Maintain investigation status without delaying operational notices.
Restoration notice	Technical verification, inspection status, effective time and remaining limitations.	ATS, AIM, operators and adjacent units previously notified.	Close restrictions in the approved operational sequence.

Each State shall define measurable notification targets. Contact lists, escalation paths and secure reporting channels shall be maintained, tested and available when normal communications systems are degraded.

9. Recovery and return to normal operations

1. Confirm that the fault or interference condition has ceased and that the service is stable under monitoring.
2. Complete the ground tests, calibration, flight inspection or procedure validation required by the approved programme and the nature of the event.
3. Assess residual risk, redundancy and any temporary configuration. Record restrictions that must remain in force.
4. Obtain the designated technical recommendation and operational return-to-service authorization.
5. Coordinate ATS, AIM, adjacent FIRs and operators before cancelling NOTAMs, route/approach restrictions or ATFM measures.
6. Restore capacity progressively where uncertainty, traffic complexity or common-mode effects remain.
7. Preserve logs, recordings, reports and decisions; complete a post-event review and assign corrective actions.

10. Preparedness exercises and assurance

Activity	Minimum objective	Suggested evidence
Contact and notification test	Confirm current contacts, 24-hour escalation and ability to reach adjacent FIRs and national spectrum/security authorities.	Dated test record; deficiencies and closure actions.
Tabletop exercise	Validate roles and decisions for localized GNSS interference, widespread outage, critical DME failure and loss of a contingency approach.	Scenario, attendance, decision log and improvement plan.
Operational simulation	Test sector capacity, routes, separation, phraseology, surveillance fallback and operator handling under degraded navigation.	Simulation report; validated restrictions and capacity assumptions.
Technical restoration drill	Demonstrate fault isolation, spares, site access, backup power, testing, inspection coordination and return-to-service control.	Restoration time, test records and resource gaps.
Regional exercise	Validate cross-border routes, DME dependencies, notifications and ATFM/CDM coordination.	Joint report, unresolved issues and approved amendments.
Annual readiness review	Confirm plans, AIP/NOTAM templates, inspection validity, MON criticality, training and resource readiness before the hurricane season or State-defined risk period.	Signed readiness checklist and management actions.

11. State and Territory contingency plan record

Each State and Territory should complete the following record and maintain it with the approved national plan. ICAO NACC may use the same structure to consolidate the regional contingency baseline.

Required field	State or Territory entry
Responsible authority and 24-hour operational contact	
Technical GNSS interference focal point and escalation authority	
Adjacent FIR and regional coordination contacts	
Designated MON facilities and restoration priority	
Critical DME pairs by route segment and altitude	
Validated conventional contingency routes and procedures	
Designated contingency aerodromes and available approaches	
Aircraft equipage assumptions and affected user groups	
Surveillance and communications fallback	
ATFM/CDM restrictions and capacity values	
Activation authority and event-level criteria	
NOTAM templates and publication responsibility	
Return-to-service approval and required evidence	
Last exercise date and open corrective actions	
Document approval version and next review date	

12. Regional indicators

- percentage of CAR States and Territories with validated navigation contingency procedures and current 24-hour contacts;
- percentage of designated MON facilities within inspection validity and with tested backup power;
- percentage of designated reversion routes and approaches supported by validated infrastructure and current publications;
- time from initial confirmed event to operational notification, restriction decision and adjacent-FIR coordination;
- percentage of critical DME dependencies with documented redundancy classification and outage measures;

- number of State and regional exercises completed and percentage of corrective actions closed by the agreed date; and
- restoration time and recurrence rate for operationally significant navigation-service interruptions.

E.2 Key operational terms

Term	Meaning and application in the CONOPS
Contingency procedure	A predefined operational procedure activated when a navigation service or supporting system is unavailable or degraded, including coordination, notification, traffic-management and recovery actions.
Coverage	The volume of airspace within which a navigation signal meets the applicable performance requirements for its intended operational use.
Decommissioning	The formally approved permanent withdrawal of a navigation facility from operational service, following assessment, stakeholder coordination and aeronautical information action.
GNSS degradation	A reduction in GNSS performance or reliability that may affect accuracy, integrity, continuity or availability without necessarily causing a complete loss of service.
GNSS outage	A period during which GNSS does not provide the service or performance required for an intended operation.
Jamming	Intentional or unintentional radio-frequency transmission that overwhelms or blocks reception of legitimate navigation signals.
MON airport	An airport designated to support safe recovery, diversion or continuation of IFR operations during GNSS degradation or outage using suitable conventional navigation and supporting services.
Navigation specification	A set of aircraft and flight-crew requirements needed to support PBN operations within a defined airspace concept; expressed as an RNAV or RNP specification.
Operational continuity	The ability to sustain an acceptable level of air navigation service during equipment failure, GNSS interference, severe weather, natural disaster or other disruptive event.
Rationalization	A risk-based process for retaining, modernizing, relocating, adding or decommissioning navigation facilities according to operational need, safety contribution, resilience, lifecycle condition and cost-effectiveness.
Resilience	The ability of the navigation system to anticipate, withstand, adapt to and recover from disruptions while maintaining or restoring an acceptable level of service.
Reversion	The planned transition from the primary navigation capability to an alternate or backup capability following degradation or loss of the primary service.
Service volume	A defined portion of airspace within which a navigation facility is intended to provide a usable signal meeting specified performance characteristics.
Spoofing	Transmission or generation of false GNSS-like signals intended to mislead a receiver into calculating an incorrect position, velocity or time.
Validation	The process of confirming, through coordinated technical and operational review, that the CONOPS and its supporting data are complete, correct, applicable and acceptable to the participating CAR States and Territories.

Appendix D: ICAO Annex 10, Volume I Alignment Matrix

Annex 10 provision/guidance	CONOPS application	Required regional/State action	Evidence / KPI
Chapter 2.2 - Ground and flight testing	Retained NAVAIDs remain within an approved inspection programme.	Maintain periodic ground/flight tests using Doc 8071 and State procedures.	Inspection validity; overdue inspections; return-to-service records.
Chapter 2.3 - Operational status	ATS units receive timely status of navigation services essential to approach, landing and take-off.	Integrate technical monitoring, ATS notification, AIM/NOTAM and contingency activation.	Notification time; NOTAM timeliness; status-feed availability.
Chapter 2.4 - Power supply	Continuity of service is commensurate with operational use.	Define and test primary/backup power for MON and critical facilities.	Backup-power availability; switchover test results; outage minutes.
Attachment H - NDB	NDB functions are progressively replaced except where justified constraints remain.	Assess each NDB and associated procedure; replace with RNAV/PBN or other suitable capability before withdrawal.	% NDBs assessed; % with approved transition/retention decision.
Attachment H - VOR/VOR-DME	VOR is rationalized; residual VOR/VOR-DME retained where required for reversion/user equipage.	Define residual coverage based on operational scenarios rather than legacy network size.	Coverage of designated reversion areas; user-equipage compatibility.
Attachment H - DME/DME	Preferred terrestrial PBN reversion capability where feasible.	Optimize DME geometry, use cross-border/TACAN assets where agreed, and address operationally significant gaps.	Validated DME/DME coverage by designated route/airspace and altitude.
Attachment H - Reversion scenarios	Infrastructure evolution is accompanied by operational reversion procedures.	Validate GNSS-outage scenarios considering CNS dependencies and common-mode failures.	Exercises/trials completed; restrictions and ATFM measures documented.
Attachment B - Approach/landing	ILS continues where operationally/economically justified; GNSS augmentation is introduced as appropriate.	Use airport-specific safety, service, equipage and cost analysis before ILS rationalization.	Availability of designated contingency approaches; redundancy assessment.

Appendix E: ICAO Doc 8071 NAVAID Testing and Inspection Alignment Matrix

CAR Regional Navigation Concept of Operations

ICAO Doc 8071 testing alignment and ICAO Doc 9613 infrastructure and PBN alignment

Purpose. These appendices provide a traceable regional framework for demonstrating that retained, modernized or newly commissioned NAVAIDs are tested, inspected and used consistently with their operational role in the CAR Regional Minimum Operational Network. They also identify the evidence that States and Territories should submit during regional validation.

Proposed action. All CAR States and Territories should validate the matrices against their approved national programmes, AIP/eAIP, PBN implementation plans and actual NAVAID configurations. ICAO NACC should establish an ad-hoc group to reconcile cross-border dependencies, complete missing evidence and recommend the validated regional baseline.

Document basis. ICAO Doc 8071, Volume I, Sixth Edition advance unedited 2026, and Volume II, Fifth Edition 2007; and ICAO Doc 9613, Fifth Edition 2023, including Corrigendum No. 1 dated 14 April 2024. Applicable Annex 10 provisions and State regulations remain controlling. The matrices summarize alignment actions and do not replace the source documents.

E.1 Scope. This matrix aligns the CONOPS with the testing and inspection framework for conventional ground-based NAVAIDs and, where applicable, satellite-based navigation services. The programme must distinguish commissioning, periodic and special inspections; combine ground and flight evidence according to the parameter being verified; maintain calibration traceability; and control return to service.

E.2 Application rule. The intervals shown are planning baselines. A State may apply an approved alternative only when supported by equipment stability, monitoring capability, reliability history, operational criticality and a documented safety basis. MON-critical facilities should receive priority and must not remain operational beyond inspection validity without an explicit operational decision and mitigation.

NAVAID or programme element	Doc 8071 basis	CONOPS application	Planning baseline or trigger	Required evidence	Responsible function
State testing programme	Vol. I, general programme provisions	Maintain a State-approved programme covering site proving, commissioning/categorization, periodic and special inspections. Define authority, facility criticality, ground/flight division, tolerances, interval control and return-to-service approval.	Initial approval; annual programme review; change in regulation, equipment, service use or inspection provider.	Approved programme; facility register; inspection schedule; competency records; overdue-action log.	State regulator / ANSP
VOR / DVOR	Vol. I, Chapter 2	Verify identification, frequency, modulation, bearing/course structure, coverage, monitor limits, standby equipment and operational service volume. Correlate ground and airborne results where approved.	Commissioning and nominal 12-month flight-inspection baseline; special inspection after major maintenance, antenna/site/environmental change, abnormal monitor event or interference. Any interval variation requires documented State approval.	Ground and flight-inspection reports; calibration traceability; coverage plot; monitor/standby tests; operational-status record.	ANSP CNS / flight inspection
DME	Vol. I, Chapter 3	Verify identification, channel/frequency pairing, system delay, pulse characteristics, reply efficiency, accuracy, coverage, monitor performance, standby configuration and interaction with nearby facilities.	Commissioning and State-approved periodic programme; special checks after delay adjustment, transmitter/antenna work, relocation, interference, site change or abnormal performance.	Ground/flight report; delay calibration; reply-efficiency and coverage results; monitor/standby tests; interference record.	ANSP CNS / flight inspection
ILS localizer and glide path	Vol. I, Chapter 4	Apply site, commissioning/categorization, periodic and special inspection. Verify course/path structure and alignment, displacement sensitivity, clearance, coverage, modulation, identification, monitors, standby and runway-environment effects.	Commissioning/categorization and nominal 180-day flight-inspection baseline; parameter-specific ground checks; special inspection after relevant maintenance, antenna/runway/site changes, monitor-limit changes or suspected interference. Risk-based interval change only through an approved programme.	Categorization and inspection report; monitor tests; ground-air correlation; runway/site-change assessment; return-to-service authorization.	ANSP CNS / aerodrome / flight inspection
ILS-associated DME or marker function	Vol. I, Chapters 3 and 4	Confirm distance/position information used by the approach, identification association, coverage and compatibility with the published procedure.	Commissioning; procedure or threshold-reference change; DME delay/antenna change; periodic and special ILS/DME inspection.	Procedure correlation; DME reference/delay record; flight-inspection result; AIP consistency check.	ANSP CNS / procedure design / AIM
NDB retained in service	Vol. I, Chapter 5	Verify frequency, identification, modulation, antenna current, monitor function and usable operational coverage. Retention must be justified because NDB has no substantive PBN role.	Ground checks at the State-approved parameter intervals; flight inspection at commissioning and thereafter according to operational use and State programme; special checks after antenna/site/environmental change or interference.	Ground/flight reports; coverage record; monitor test; inspection validity; approved retention and procedure dependency.	ANSP CNS / regulator
Conventional NAVAIDs supporting PBN	Vol. I, Chapter 8	Link the PBN infrastructure assessment to testing of the VOR/DME or DME/DME facilities and service volume actually credited by the operation. Prioritize critical facilities and cross-border dependencies.	PBN commissioning or redesign; change to credited facility/pair; outage pattern or coverage-model change; rationalization; periodic programme.	Infrastructure assessment; usable-pair/coverage model; inspection evidence; critical-NAVAID register; published limitations.	ANSP CNS / airspace and procedure design
ABAS and SBAS-supported procedures	Vol. II, Chapters 2 and 3	Use commissioning or special flight checks to confirm procedure/design correlation, continuous guidance, operational usability and indications of interference. Do not create routine periodic flight checking unless selected by the State.	New or materially changed procedure; suspected interference; database/design anomaly; State-selected periodic check.	Flight-validation/check record; procedure-data correlation; interference findings; operational decision and publication status.	Regulator / procedure design / flight validation

NAVAID or programme element	Doc 8071 basis	CONOPS application	Planning baseline or trigger	Required evidence	Responsible function
GBAS ground system and VDB	Vol. II, Chapter 4	Verify ground subsystem and VDB performance, data integrity, coverage, interference environment and each runway/approach served. Confirm Final Approach Segment data and configuration control.	Initial commissioning; each runway/approach; reconfiguration or corrective maintenance; procedure, configuration, site or antenna change; suspected interference; periodicity set by State/manufacturer.	Ground/VDB test report; flight-test report; FAS/data verification; coverage/interference results; configuration baseline; operational publication.	ANSP CNS / aerodrome / regulator
MON-critical facility assurance	Doc 8071 programme principles applied to CAR MON	Give MON-critical NAVAIDs priority for inspection scheduling, validity monitoring, backup/standby checks, defect recovery and coordinated ATS/AIM notification. Loss of inspection validity triggers an operational service-impact assessment.	Approaching validity expiry; overdue inspection; failure or degraded redundancy; prolonged outage; GNSS contingency readiness exercise.	MON inspection dashboard; validity and exception register; service-impact assessment; NOTAM/ATS record; restoration authorization.	ANSP operations and CNS / AIM
Special inspection and return to service	Vol. I and II facility-specific provisions	Define event-based special inspection criteria and the minimum ground/flight evidence needed before unrestricted return to service. Technical restoration does not by itself establish operational acceptability.	Fault, major maintenance, equipment replacement, monitor-limit change, site/environmental change, accident/incident concern, interference, abnormal pilot report or extended shutdown.	Work order; as-left ground results; required flight inspection; safety/operational review; signed return-to-service decision; publication closure.	ANSP CNS / accountable authority

Appendix E: ICAO Doc 9613 NAVAID Infrastructure and PBN Alignment Matrix

E.1 Scope. This matrix records the NAVAID-infrastructure aspects of Doc 9613 used by the CONOPS. It does not reproduce aircraft airworthiness or operational approval, crew training, navigation database approval or detailed procedure-design criteria. Those matters remain governed by the applicable Doc 9613 provisions, PANS-OPS and State requirements.

E.2 Regional principle. GNSS is the primary PBN enabler. Conventional NAVAIDs form a right-sized terrestrial reversion capability and transition layer; they are not retained simply to preserve the legacy inventory. DME/DME credit depends on validated coverage and geometry, aircraft capability and State authorization—not on the number of facilities alone.

Doc 9613 NAVAID topic	NAVAID-specific principle	CONOPS application	Required evidence or output	CAR applicability
PBN concept and NAVAID infrastructure	PBN applications require a navigation specification supported by suitable space- or ground-based infrastructure; infrastructure is assessed for the intended operation and reversion modes.	Record the permitted positioning source(s) and infrastructure dependency for each regional route, procedure and designated contingency operation.	Infrastructure dependency register; supporting NAVAIDs; approved operational concept.	All PBN applications
RNAV 10 and oceanic/remote operations	GNSS and approved long-range navigation systems provide the positioning basis; conventional terrestrial coverage is generally not assumed over oceanic areas.	Do not claim terrestrial MON coverage where geometry/range cannot support the operation. Define procedural, surveillance, communications and ATFM mitigations for GNSS degradation.	Operational assessment; contingency routes/levels; communications-surveillance dependencies; published limitations.	Oceanic and remote CAR airspace
RNAV 5 infrastructure	RNAV 5 may use GNSS, DME/DME, VOR/DME or INS/IRS as permitted; the ANSP assessment includes reversionary modes.	Retain and validate only facilities needed for the selected normal or contingency RNAV 5 concept. VOR use for PBN requires the applicable VOR/DME capability.	RNAV 5 infrastructure assessment; credited facilities; outage/reversion procedure; AIP/chart information.	En-route and selected terminal transitions
RNAV 1 and RNAV 2 infrastructure	The standardized infrastructure basis includes GNSS, DME/DME and DME/DME/inertial. DME coverage gaps can interrupt updating unless approved inertial integration bridges the gap.	Assess geometry and service volume for every segment where DME/DME is credited. Identify usable pairs, altitude limitations, gaps and cross-border dependencies.	Coverage and geometry study; usable-pair list; gap/mitigation register; fleet-equipage confirmation.	En-route and terminal operations
RNP 2 RNP 1 and Advanced RNP	GNSS is the baseline source. DME/DME use is permitted only where the navigation specification provides for it and the State gives the required authorization.	Do not assume that a DME network supports these RNP applications. Establish the authorization, aircraft capability assumptions and infrastructure performance before crediting terrestrial reversion.	State authorization basis; infrastructure assessment; equipage assumptions; published sensor limitations.	RNP applications where authorized
RNP APCH RNP AR and RNP 0.3	These specifications use GNSS-based positioning under Doc 9613. Conventional NAVAIDs do not become the PBN positioning source merely because they are available.	Use conventional aids, ILS and operational procedures as contingency or alternate capability. Define which approaches remain available during GNSS disruption.	Aerodrome contingency matrix; available conventional/ILS procedures; operating minima and restriction decision; NOTAM templates.	Approach and low-level operations
DME/DME geometry and service volume	DME/DME performance depends on line-of-sight coverage, geometry, facility characteristics, avionics selection rules and the flight-path/altitude assessed. Facility count alone is insufficient.	Model the network by route segment and altitude; avoid a uniform facility-density target for islands, mountainous areas, low altitude and over-water operations.	Validated coverage model; geometry metrics; terrain/altitude assumptions; flight-inspection correlation; identified gaps.	CAR MON DME backbone
Critical DME and redundancy	Two independent usable DME pairs provide full redundancy; pairs sharing one DME provide limited redundancy; one usable pair makes both stations critical for that segment.	Classify critical DMEs by application and segment. Assign enhanced monitoring, maintenance, inspection, spares, restoration and NOTAM priority.	Critical-NAVAID register; redundancy class; affected routes/procedures; maintenance and outage triggers.	DME/DME-supported RNAV

Doc 9613 NAVAID topic	NAVAID-specific principle	CONOPS application	Required evidence or output	CAR applicability
Navigation service monitoring	An individual facility outage does not necessarily mean loss of the PBN service; the operational effect depends on remaining geometry, redundancy and aircraft capability.	Integrate NAVAID alarms with service-impact assessment. Report whether the supported RNAV/RNP application remains available, restricted or unavailable.	Alarm-to-service assessment; availability decision; ATS/AIM notification; outage and restriction record.	Normal degraded and contingency modes
Infrastructure evolution and rationalization	NAVAID planning must support normal and contingency objectives. Removal of aids or associated procedures is an airspace change requiring safety assessment and consultation.	Coordinate MON and rationalization decisions with PBN implementation, equipment lifecycle, user equipage, adjacent FIRs, procedure withdrawal and outage-duration objectives.	Safety/operational assessment; stakeholder consultation; cross-border coordination; approved transition/decommissioning plan.	All retain replace or withdraw decisions
Aeronautical information	Infrastructure availability, sensor limitations and facilities critical to RNAV operations must be represented in appropriate aeronautical information and operational notifications.	Keep AIP/eAIP, charts, databases and NOTAM processes consistent with supporting/critical NAVAIDs and service-impact decisions.	Current AIP/chart/database entries; AIRAC record; timely NOTAM; post-change verification.	AIM lifecycle
Regional validation and governance	Doc 9613 implementation requires an assessment of infrastructure appropriate to the operation; CAR cross-border dependencies require common assumptions and coordinated evidence.	All CAR States and Territories validate their infrastructure/PBN entries. Establish an ad-hoc group to complete the regional matrix, reconcile cross-border DME use and recommend MON decisions.	State validation forms; regional issue log; agreed modelling assumptions; endorsed CAR MON roadmap.	ICAO NACC / States / ANSPs

E.3 Proposed regional completion process

a) ICAO NACC circulates the consolidated inventory and matrices to all CAR States and Territories for formal technical validation.
b) States identify the PBN routes, procedures and contingency scenarios that credit each NAVAID, including cross-border and military/TACAN dependencies where agreements permit.
c) The ad-hoc group applies common DME/DME modelling assumptions, classifies redundancy and critical facilities, and records geographic or altitude limitations.
d) States reconcile the validated infrastructure with AIP/eAIP, charts, navigation databases, NOTAM processes, inspection programmes and lifecycle plans.
e) The group submits a validated CAR Regional MON baseline and implementation roadmap to the NACC/WG, including gaps, investments, rationalization proposals and unresolved risks.

This matrix records the NAVAID-related Doc 9613 provisions incorporated into this CONOPS. It is intentionally limited to navigation infrastructure and does not reproduce aircraft approval, crew training or procedure-design requirements that are outside the NAVAID scope.

Doc 9613 NAVAID topic	NAVAID-specific principle	CONOPS application	Required evidence / output
PBN concept / NAVAID infrastructure	PBN applications depend on a navigation specification supported by appropriate ground- or space-based NAVAID infrastructure.	Define the infrastructure basis for each regional PBN application and ensure the permitted positioning source(s) are available.	Infrastructure dependency recorded for each route/procedure; supporting NAVAIDs identified.
RNAV 5 infrastructure	RNAV 5 can use VOR/DME, DME/DME, INS/IRS or GNSS; ANSP assessment must include reversionary modes.	Retain/validate only the facilities required to support the selected normal or contingency RNAV 5 concept.	RNAV 5 infrastructure assessment; outage/reversion procedure; AIP/chart identification.
RNAV 1 / RNAV 2 infrastructure	Standardized infrastructure is based on GNSS, DME/DME and DME/DME/inertial. DME coverage gaps can interrupt position updating.	Assess DME geometry and coverage for every segment where DME/DME is credited; account for approved inertial coasting where applicable.	Coverage/geometry study; list of usable DME pairs; identified gaps and mitigations.
RNP 2 / RNP 1 / Advanced RNP	GNSS is the baseline positioning source; DME/DME use is subject to specific State authorization where provided by the specification.	Do not assume DME/DME supports these RNP applications unless the State authorization and applicable performance criteria are established.	State authorization basis; infrastructure assessment; publication of limitations.
RNP APCH / RNP AR / RNP 0.3	These specifications use GNSS-based positioning under Doc 9613.	Treat conventional NAVAIDs as reversion/contingency infrastructure rather than as the PBN positioning source for these applications.	Contingency plan identifies available conventional alternatives and operational limitations.
Critical DME and redundancy	For DME/DME RNAV, two independent DME pairs provide redundancy; a shared DME gives limited redundancy; one pair makes both facilities critical.	Classify critical DMEs by application and give them appropriate maintenance, monitoring and outage priority.	Critical-NAVAID register; redundancy classification; maintenance/NOTAM triggers.
Navigation service monitoring	Loss of one individual ranging source does not necessarily equal loss of an RNAV/RNP navigation service; service depends on redundancy, geometry and avionics.	Monitor operational service impact as well as equipment status, with emphasis on critical NAVAIDs.	Service-impact assessment linked to alarms/outages; operational restriction decision records.
Infrastructure evolution and contingency	NAVAID planning must cover normal and contingency objectives; removal of conventional aids and procedures is an airspace change requiring consultation.	Integrate MON/rationalization decisions with PBN planning, outage-duration objectives and stakeholder consultation.	Safety/operational assessment; stakeholder consultation record; approved decommissioning/transition plan.
Aeronautical publication	Available NAVAID infrastructure and facilities critical to RNAV operations should be identified in appropriate publications/charts.	Ensure AIP/eAIP, charts and NOTAM processes reflect supporting/critical NAVAIDs and outages affecting the navigation application.	Current AIP/chart data; critical-facility notation where applicable; timely NOTAMs.

Appendix F: ICAO Doc 10066 PANS-AIM NAVAID Information and Data Governance Alignment Matrix

This matrix records only the provisions of ICAO Doc 10066 that directly affect NAVAID information, publication, data governance and operational-status notification. It does not reproduce AIM provisions unrelated to navigation aids.

Doc 10066 NAVAID topic	NAVAID-specific requirement / principle	CONOPS application	Required evidence / output
Definitions and PBN/NAVAID linkage	Area navigation may use ground- or space-based navigation aids. PBN performance is expressed through navigation specifications, and the availability of GNSS signal-in-space and/or other NAVAID infrastructure is considered within the airspace concept.	Use the NAVAID architecture as an explicit PBN enabler and contingency resource; maintain consistency between the infrastructure actually available and the navigation applications published.	Approved infrastructure baseline; PBN/MON assessment showing available navigation sources and reversion capability.
Data origination and quality	Aeronautical data must be quality assured through the data chain. Data quality encompasses accuracy, resolution, integrity, traceability, timeliness, completeness and format.	Treat CNS/engineering or the authorized service provider as the accountable originator for NAVAID technical data, with controlled transfer to AIS/AIM.	Data-originator designation; validation/check records; audit trail; discrepancy-resolution records.
GEN 2.5 - List of radio navigation aids	The AIP list identifies each radio navigation aid by identifier, station name, facility/aid type and whether it serves en-route, aerodrome or dual purposes.	Maintain a State master NAVAID inventory that is consistent with the technical asset register and operational use.	Current GEN 2.5 or referenced AIP data set; reconciliation record with CNS asset inventory.
ENR 4.1 - Radio navigation aids en-route	En-route NAVAID publication includes station name, magnetic variation/VOR declination as applicable, identification, frequency/channel, hours, antenna coordinates, DME antenna elevation, remarks, operating authority and coverage.	Use these fields as the minimum publication checklist for VOR, DME, VOR/DME and other applicable en-route facilities retained in the regional network/MON.	Current ENR 4.1 entries; facility coverage statement; operating authority and technical data verified.
ENR 4.3 - GNSS	GNSS elements providing en-route navigation service are described by element name, frequency where applicable, nominal service/coverage area and remarks.	Publish the applicable GNSS/SBAS service information used to support the regional navigation concept without implying availability beyond the approved service area.	Current ENR 4.3 description; service/coverage references; responsible service provider identified.
AD 2.19 / AD 3.18 - Radio navigation and landing aids	Terminal/approach NAVAID publication includes aid type, supported operation/classification, identification, frequency/channel, service provider, hours, antenna coordinates, DME/DME-P elevation, GBAS/SBAS elevation-related data, GBAS service volume and remarks, as applicable.	Use a commissioning/modification publication checklist so ILS, DME, GBAS, SBAS-related and other approach-supporting NAVAID data are synchronized with approved procedures.	Current AD 2.19/AD 3.18 entries; commissioning data package; procedure-to-facility cross-check.
AIP data set - radio navigation aid subject	The AIP data set includes radio navigation aid properties such as type, identification, name, aerodrome/heliport served, hours, magnetic variation, frequency/channel, position, elevation, magnetic/true bearing and zero-bearing direction, as applicable.	Where digital AIP data are used, make the data set the controlled source for downstream ATM/navigation consumers and maintain explicit handling of non-applicable properties.	AIP data set schema/conformance check; metadata; data-set validation report.
Replacement of textual AIP sections by data set	When the AIP data set is provided, specified sections including GEN 2.5, ENR 4.1 and AD 2.19/AD 3.18 may be omitted if the AIP references the availability of the data set.	Avoid duplicate uncontrolled sources. If textual sections are omitted, ensure operational users can reliably locate and access the authoritative data set.	AIP cross-reference to data set; availability/service-level evidence; configuration control.
Temporary status changes - NOTAM	NOTAM is the mechanism for timely distribution of information concerning establishment, condition or change in an aeronautical facility, service, procedure or hazard when operational knowledge is essential.	Issue timely NAVAID NOTAM for operationally significant outages, restrictions, testing or temporary changes, coordinated between CNS, ATS and AIS/AIM.	NOTAM log; outage start/end times; correlation with technical event and restoration record.
Permanent/planned change - AIP/AIRAC	Changes to facilities, services and procedures affecting aircraft	Synchronize NAVAID commissioning, frequency/channel change,	Approved change package; AIRAC effective date; AIP

Doc 10066 NAVAID topic	NAVAID-specific requirement / principle	CONOPS application	Required evidence / output
	operations are promulgated through the aeronautical information process and take effect in accordance with Annex 15/AIRAC principles.	relocation, decommissioning and dependent procedure changes with the applicable AIRAC/AIP process.	Amendment/Supplement; implementation checklist.
Metadata and traceability	Minimum metadata identify the organization/entity providing or acting on the data, the action performed, and the date/time; data sets also carry provider, provision time, validity and limitations.	Preserve end-to-end traceability for NAVAID data from engineering approval through publication and subsequent amendment.	Metadata record; change history; responsible organization; validity and use limitations.
Amendment No. 5 forward alignment	Amendment No. 5 updates the definitions of area navigation, navigation specification and PBN and becomes applicable on 26 November 2026.	Use the amended definitions prospectively while retaining the same NAVAID technical requirements from Annex 10 and the testing requirements from Doc 8071.	Document revision record showing Amendment No. 5 applicability date and implementation review.

Source basis for this appendix: ICAO Doc 10066, Procedures for Air Navigation Services - Aeronautical Information Management (PANS-AIM), First Edition (2018), consolidated text through Amendment No. 4, together with Amendment No. 5 approved on 22 April 2026 and applicable on 26 November 2026. Only NAVAID-relevant provisions have been incorporated.

APPENDIX G - GLOSSARY OF TERMS AND ABBREVIATIONS

This appendix defines the principal terms and abbreviations used in the Concept of Operations for Navigation Aids in the CAR Region. The explanations are provided for consistent interpretation of the CONOPS. Where an official ICAO definition applies, the current applicable ICAO provision remains authoritative.

E.1 Abbreviations and acronyms

Abbreviation	Term	Meaning and application in the CONOPS
ABAS	Aircraft-Based Augmentation System	An augmentation system that uses information available on board the aircraft to improve and/or integrate GNSS information and provide enhanced performance.
ADF	Automatic Direction-Finding Equipment	Airborne equipment that determines the bearing to an NDB.
ADS-B	Automatic Dependent Surveillance — Broadcast	A surveillance technique in which aircraft automatically broadcast position and other data derived from onboard systems, normally including a GNSS position source.
AIM	Aeronautical Information Management	The dynamic, integrated management of aeronautical information through quality-assured digital data and information services.
AIP	Aeronautical Information Publication	A State publication containing aeronautical information of a lasting character essential to air navigation.
AIRAC	Aeronautical Information Regulation and Control	The system for advance notification and implementation of operationally significant aeronautical information on predetermined effective dates.
AIS	Aeronautical Information Service	The service responsible for providing aeronautical data and information necessary for the safety, regularity and efficiency of air navigation.
ANSP	Air Navigation Service Provider	An organization responsible for providing one or more air navigation services, including CNS, ATS and AIM services.
APCH	Approach	A designation used in procedure and navigation specifications associated with the approach phase of flight.
ASBU	Aviation System Block Upgrades	The ICAO framework for planning and implementing operational improvements in a globally harmonized manner.
ATC	Air Traffic Control	A service provided to prevent collisions and expedite and maintain an orderly flow of air traffic.
ATFM	Air Traffic Flow Management	A service established to contribute to a safe, orderly and expeditious flow of air traffic by ensuring that ATC capacity is used to the maximum extent possible and traffic volume is compatible with declared capacity.
ATFM/CDM	Air Traffic Flow Management and Collaborative Decision-Making	Coordinated processes used by stakeholders to balance demand and capacity and share operational decisions during normal and degraded operations.
ATIS	Automatic Terminal Information Service	The automatic provision of current, routine information to arriving and departing aircraft throughout the day or a specified period.
ATS	Air Traffic Services	A generic term covering flight information, alerting, air traffic advisory and air traffic control services.
BDS	BeiDou Navigation Satellite System	A global navigation satellite system operated by China.
CADENA	CANSO ATFM Data Exchange Network for the Americas	A regional collaborative mechanism that supports operational information exchange and ATFM coordination in the Americas.
CAR	Caribbean Region	The ICAO Caribbean air navigation region addressed by this CONOPS.
CAT I/II/III	Instrument Landing System Performance Categories	Categories of precision approach and landing operations defined by decision height and runway visual range or visibility criteria.
CDM	Collaborative Decision-Making	A process in which relevant stakeholders share information and coordinate decisions to improve operational outcomes.
CNS	Communications, Navigation and Surveillance	The technical systems and services supporting air traffic management.
CNS/ATM	Communications, Navigation and Surveillance/Air Traffic Management	The integrated technical and operational environment used to manage air traffic safely and efficiently.
CONOPS	Concept of Operations	A document describing how a proposed system or operational concept is intended to function, including users, roles, operating environment, capabilities and transition arrangements.
D-ATIS	Data Link Automatic Terminal Information Service	ATIS information provided to aircraft through a data link service.
DFMC	Dual-Frequency Multi-Constellation	Use of signals on more than one frequency and from more than one GNSS constellation to improve performance, robustness and resilience.
DME	Distance Measuring Equipment	A ground-based radio navigation system that provides aircraft with slant-range distance from a ground transponder.
DME/DME	DME/DME Positioning	Area-navigation positioning based on distance measurements from two or more suitable DME facilities.
FIR	Flight Information Region	Airspace of defined dimensions within which flight information service and alerting service are provided.
FMS	Flight Management System	An integrated airborne system that supports navigation, flight planning and aircraft performance management.
GANP	Global Air Navigation Plan	ICAO strategic planning framework for the evolution of the global air navigation system.
GBAS	Ground-Based Augmentation System	An augmentation system in which the user receives augmentation information directly from a ground-based transmitter.
GLONASS	Global Navigation Satellite System	The satellite navigation constellation operated by the Russian Federation.

GLS	GBAS Landing System	A precision approach and landing operation based on GBAS guidance.
GNSS	Global Navigation Satellite System	A worldwide position and time determination system using one or more satellite constellations, aircraft receivers and system integrity monitoring, augmented as necessary.
GPS	Global Positioning System	The satellite navigation constellation operated by the United States.
GREPECAS	CAR/SAM Regional Planning and Implementation Group	The ICAO regional planning and implementation group for the Caribbean and South American Regions.
ICAO	International Civil Aviation Organization	The United Nations specialized agency responsible for international civil aviation standards, recommended practices and global policy coordination.
IFR	Instrument Flight Rules	Rules governing flight operations conducted by reference to instruments and applicable ATC clearances and procedures.
ILS	Instrument Landing System	A precision approach and landing aid that provides lateral and vertical guidance to aircraft.
INS/IRU	Inertial Navigation System/Inertial Reference Unit	Self-contained airborne equipment that derives position, velocity and attitude information from inertial sensors.
LNAV	Lateral Navigation	Lateral guidance used for selected PBN instrument approach operations.
LNAV/VNAV	Lateral Navigation/Vertical Navigation	Lateral and vertical guidance used for selected approach operations with vertical guidance.
LOC	Localizer	The component of an ILS that provides lateral guidance along the runway approach course.
LPV	Localizer Performance with Vertical Guidance	An SBAS-supported approach operation that provides angular lateral and vertical guidance without being classified as a precision approach.
MLAT	Multilateration	A surveillance technique that determines aircraft position from differences in the arrival time of transponder signals at multiple receiving stations.
MON	Minimum Operational Network	A right-sized network of selected terrestrial navigation facilities and supporting procedures retained to provide an acceptable level of operational continuity during GNSS degradation or outage.
NACC	North American, Central American and Caribbean	The ICAO regional office and regional context supporting States and Territories in North America, Central America and the Caribbean.
NAVAID	Navigation Aid	Any visual or electronic facility that supports aircraft navigation; in this CONOPS, the term principally refers to ground-based radio navigation aids.
NDB	Non-Directional Radio Beacon	A low- or medium-frequency radio beacon transmitting non-directional signals from which suitably equipped aircraft can determine bearing.
NM	Nautical Mile	A unit of distance equal to 1 852 metres, commonly used in air navigation.
NOTAM	Notice to Air Missions	A notice containing information concerning the establishment, condition or change of an aeronautical facility, service, procedure or hazard, timely knowledge of which is essential to personnel concerned with flight operations.
PANS-AIM	Procedures for Air Navigation Services — Aeronautical Information Management	ICAO procedures governing aeronautical information management and the provision and quality of aeronautical data and information.
PANS-ATM	Procedures for Air Navigation Services — Air Traffic Management	ICAO procedures supporting the provision and operation of air traffic services and air traffic management.
PANS-OPS	Procedures for Air Navigation Services — Aircraft Operations	ICAO procedures and criteria used for the design and operation of instrument flight procedures.
PBN	Performance-Based Navigation	Area navigation based on performance requirements for aircraft operating along an ATS route, on an instrument approach procedure or in designated airspace.
RAIM	Receiver Autonomous Integrity Monitoring	An ABAS function by which a GNSS receiver uses redundant measurements to assess the integrity of navigation signals.
RF	Radio Frequency	The portion of the electromagnetic spectrum used for radiocommunication, navigation and surveillance signals.
RFI	Radio-Frequency Interference	Unwanted radio-frequency energy that degrades, disrupts or prevents reception or use of an intended signal.
RNAV	Area Navigation	A method of navigation permitting aircraft operation on any desired flight path within the coverage of ground- or space-based navigation aids, within the limits of self-contained aids, or through a combination of these.
RNP	Required Navigation Performance	A PBN navigation specification that includes a requirement for onboard performance monitoring and alerting.
RNP APCH	Required Navigation Performance Approach	A navigation specification used for PBN instrument approach procedures.
RNP AR APCH	Required Navigation Performance Authorization Required Approach	An RNP approach specification requiring specific operational authorization and normally supporting operations where demanding procedure design criteria apply.
RPBANIP	Regional Performance-Based Air Navigation Implementation Plan	The regional planning framework supporting prioritized and harmonized air navigation implementation in the NAM/CAR Regions.
SARPs	Standards and Recommended Practices	Technical and operational provisions adopted by ICAO and contained in the Annexes to the Chicago Convention.
SBAS	Satellite-Based Augmentation System	A wide-area augmentation system in which the user receives augmentation information from a satellite-based transmitter.
SID	Standard Instrument Departure	A designated IFR departure route linking an aerodrome or runway with a specified significant point from which the en-route phase can begin.
SSR	Secondary Surveillance Radar	A surveillance radar system that uses ground interrogations and airborne transponder replies to obtain aircraft information.
STAR	Standard Instrument Arrival	A designated IFR arrival route linking a significant point, normally on an ATS route, with a point from which a published instrument approach can begin.
SWIM	System-Wide Information Management	Standards, infrastructure and governance enabling interoperable exchange of air traffic management information.
TMA	Terminal Control Area	A control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes.

VDB	VHF Data Broadcast	The GBAS data link used to broadcast augmentation and approach information to aircraft.
VHF	Very High Frequency	The radio-frequency band from 30 MHz to 300 MHz, used for aeronautical communications and navigation services.
VNAV	Vertical Navigation	A navigation function that supports aircraft operation along a vertical flight path.
VOR	VHF Omnidirectional Radio Range	A ground-based radio navigation system providing aircraft with bearing information relative to the facility.
VOR/DME	Collocated VOR and DME	A paired facility providing bearing and distance information for conventional navigation and selected RNAV applications.
WAAS	Wide Area Augmentation System	The United States implementation of SBAS.
WGS-84	World Geodetic System — 1984	The geodetic reference system used by international civil aviation for aeronautical coordinates.