Agenda Item 4: Report on GESEA activities and deliverables and Subgroups

AIRSPACE OPTIMIZATION PROJECTS FOR TERMINAL CONTROL AREAS (TMA)

(Prepared by Brazil)

SUMMARY

This Working Paper presents the progress achieved in the airspace optimization projects for the Belo Horizonte and Rio de Janeiro Terminal Control Areas (TMAs), developed by the Brazilian Department of Airspace Control (DECEA).

These initiatives are part of Brazil's continuous airspace modernization program and aim to enhance operational efficiency, reduce air traffic management complexity, improve operational safety, promote environmentally sustainable operations, and mitigate the impact of aircraft noise on communities located in the vicinity of airports.

The projects include the implementation of new Performance-Based Navigation (PBN) routes, optimization of arrival and departure procedures, application of Continuous Climb Operations (CCO) and Continuous Descent Operations (CDO), as well as the use of modern procedure design techniques that contribute to reducing fuel consumption and carbon dioxide (CO_2) emissions.

References:

- Conclusion GREPECAS/23/02 – Include operational improvements in national and regional planning to optimize efficiency and reduce emissions
- Global Air Navigation Plan (GANP)
- Doc 4444 – Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM)
- Doc 9613 – Performance-Based Navigation Manual
- Doc 9992 – Manual on the Use of PBN in Airspace Design

1. Background

1.1 The continuous growth of air transport demand in Brazil's major metropolitan areas presents increasing challenges related to airspace capacity, operational complexity, flight efficiency, and environmental sustainability. In this context, the Brazilian Department of Airspace Control (DECEA) maintains a continuous airspace modernization program aligned with the strategic objectives of the International Civil Aviation Organization (ICAO), APTA Operational Drivers (Improvement of Arrival and Departure Operations), seeking to implement solutions based on Performance-Based Navigation (PBN) and modern Air Traffic Management (ATM) concepts.

1.2 These initiatives are developed in accordance with the principles established in the Global Air Navigation Plan (GANP) and the Aviation System Block Upgrades (ASBU) Framework, **Conclusion GREPECAS/23/02** – *Include operational improvements in national and regional planning to optimize efficiency and reduce emissions*, using ICAO Doc 4444 – Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM), Doc 9613 – Performance-Based Navigation (PBN) Manual, Doc 9992 – Manual on the Use of PBN in Airspace Design, and the ICAO manuals related to Continuous Climb Operations (Doc 9993) and Continuous Descent Operations (Doc 9931) as their primary technical references.

1.3 These documents recommend that airspace organization be driven by operational requirements, promoting predictable flight paths, reduced operational complexity, efficient traffic flow management, fewer tactical ATC interventions, and the implementation of PBN navigation specifications compatible with the available CNS infrastructure and aircraft capabilities.

1.4 Within this framework, DECEA is currently developing the Airspace Concept Projects for the Belo Horizonte and Rio de Janeiro TMAs, continuing the modernization initiatives previously implemented in other Brazilian regions, such as the São Paulo TMA Neo Project and the ViraCO_2pos Project.

2. Analysis

The projects follow a structured airspace concept development methodology comprising planning, operational design, validation through simulations, implementation, and post-implementation assessment. Throughout all phases, collaborative processes are conducted involving air traffic controllers, procedure designers, airspace planners, pilots, airspace users, and other relevant stakeholders. This multidisciplinary approach is fully aligned with the recommendations of the GANP and PANS-ATM regarding the implementation of structural changes in complex terminal environments.

2.1 Belo Horizonte TMA Project

2.1.1 The Belo Horizonte TMA Project is currently in the implementation phase, encompassing the development and publication of Air Navigation Procedures, as well as the training and qualification of Air Traffic Controllers, with operational implementation scheduled for the November 2026 AIRAC cycle. The project was developed to adapt the terminal airspace structure to the traffic growth observed in recent years by reducing conflicts between IFR and VFR traffic flows, simplifying airspace organization, and improving operational efficiency.

2.1.2 The new concept incorporates procedures designed in accordance with the criteria established in ICAO Doc 9613, expanding the application of Performance-Based Navigation and enabling more predictable and accurate flight paths.

2.1.3 Among the project's main innovations is the implementation of radius-to-fix (RF) legs segments for instrument approaches to both runway thresholds at Confins International Airport (SBCF). The use of RF Legs provides greater lateral navigation accuracy, improves flight path containment in complex terminal environments, and reduces the need for tactical ATC interventions, in accordance with the recommendations of the ICAO PBN Manual for RNP operations.

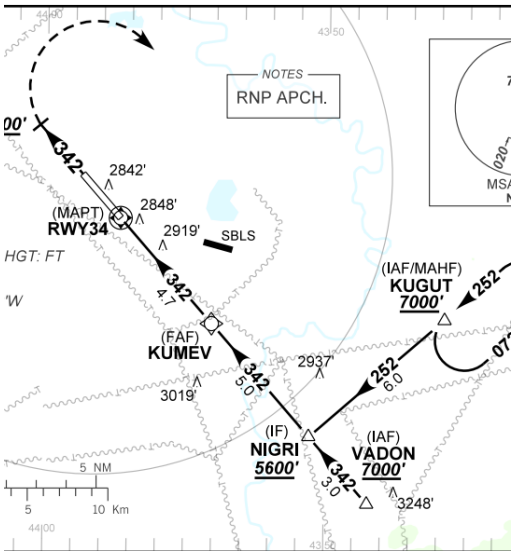

Figure 1: Current IAC RNP RWY 34

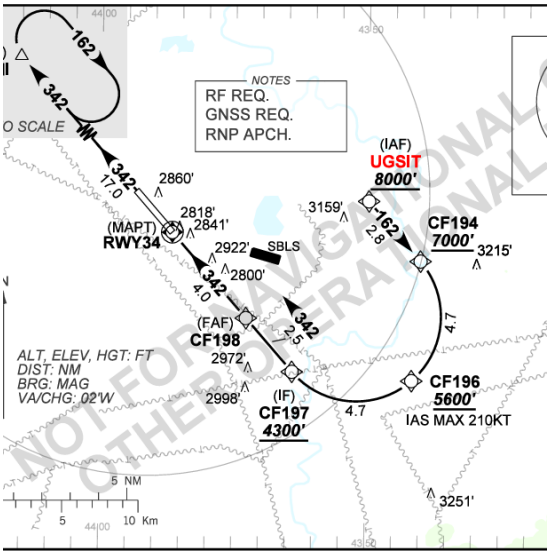

Figure 2:Proposed IAC RNP RWY34

2.1.4 Arrival and departure procedures have also been redesigned to facilitate the implementation of Continuous Climb Operations (CCO) and Continuous Descent Operations (CDO), enabling more efficient vertical profiles, reduced fuel consumption, lower greenhouse gas emissions, and decreased workload for both flight crews and air traffic controllers.

2.1.5 Another significant aspect of the project is the adoption of specific aircraft noise mitigation techniques. The new Standard Instrument Departures (SIDs) incorporate turns initiated at specific altitudes, distributing departure trajectories after takeoff and reducing the concentration of overflights above a single area. This solution balances operational efficiency with environmental protection by reducing aircraft noise exposure for surrounding communities without compromising operational safety.

2.1.6 Furthermore, the redesigned traffic structure significantly reduces crossing points between arrival and departure flows, minimizing potential conflicts and increasing traffic predictability, in accordance with ICAO Doc 4444, which recommends organizing airspace to reduce ATM complexity.

2.1.7 The operational benefits of the new airspace concept were assessed through Fast-Time Simulation (FTS) conducted by the Air Navigation Management Center (CGNA) using a representative peak traffic demand scenario for the Belo Horizonte TMA. The simulation results indicate significant operational and environmental benefits, including an estimated monthly reduction of approximately 7,582 nautical miles flown, fuel savings of approximately 52,378 kilograms, and a reduction of approximately 165,514 kilograms of carbon dioxide (CO_2) emissions. These results demonstrate the benefits achieved through trajectory optimization, the implementation of CCO and CDO, and the reorganization of arrival and departure traffic flows.

2.2 Rio de Janeiro TMA Project

2.2.1 The Rio de Janeiro TMA Project is currently in the development and operational validation phase, with implementation scheduled for the June 2027 AIRAC cycle. The project includes a comprehensive restructuring of the terminal airspace involving Galeão (SBGL), Santos Dumont (SBRJ), Jacarepaguá (SBJR), and the intense offshore traffic operating within the region.

2.2.2 The new airspace concept addresses limitations identified in the structure implemented in 2013, particularly those related to SID/STAR interaction, IFR/VFR segregation, vertical profiles, and the organization of arrival and departure traffic flows.

2.2.3 Among the project's major enhancements is the update of the navigation specification used within the so-called **Rio de Janeiro–São Paulo airspace corridor (Túbulo)**, which will transition from **RNAV 5** to **RNAV 2/RNP 2**. Based on the recommendations contained in ICAO Doc 9613, this change enables improved navigation accuracy, reduced protection areas, more efficient flight paths, and more effective use of the available airspace infrastructure.

2.2.4 The adoption of the **RNAV 2/RNP 2** navigation specification made it possible to reduce the lateral spacing between the corridor airways to **8 NM**, while maintaining the required operational safety criteria. This reduction allows arrival and departure procedures to join and leave the airways over shorter distances, thereby reducing the total distance flown. As a result, increased operational efficiency, lower fuel consumption, reduced carbon dioxide (CO_2) emissions, and improved utilization of the airspace infrastructure are expected.

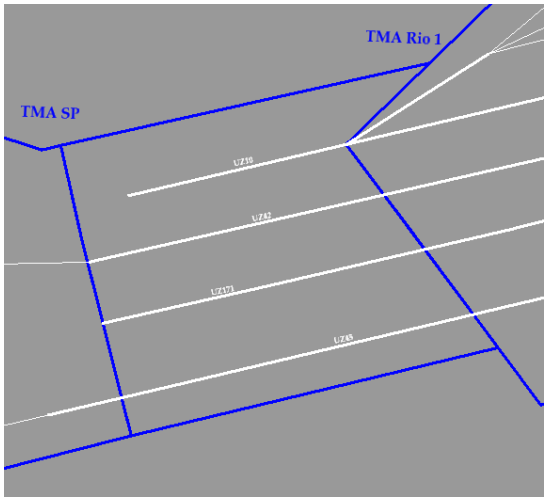

Figure 3: Current Airspace Structure

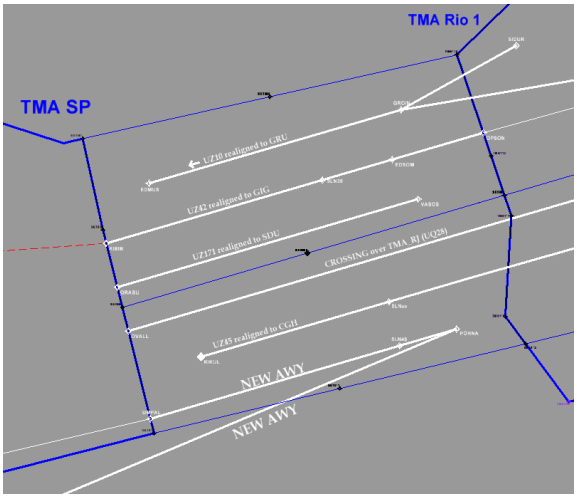

Figure 4: Proposed Airspace Structure

2.2.5 During the validation phase, FTS were conducted using the simulators of the Brazilian Air Navigation Management Center (CGNA), and the results were verified using airline operational software. In addition to the operational assessment of the proposed scenarios, aircraft operators validated both the procedures and navigation databases within their respective Flight Management Systems (FMS), ensuring full compatibility with aircraft operations.

2.2.6 The analyses indicate that the proposed airspace organization is expected to result in significant operational and environmental benefits. The analyses indicate an **estimated annual net impact** corresponding to a reduction of approximately **205,700 nautical miles**, fuel savings of approximately **1.64 million kilograms**, and a reduction of more than **5,190 tonnes of carbon dioxide (CO_2) emissions**, highlighting the benefits achieved through the optimization of flight trajectories and vertical flight profiles.

2.2.7 In parallel with the operational studies, specific aircraft noise assessments are being conducted in coordination with the Jacarepaguá Airport Noise Committee. These analyses seek to optimize the proposed flight paths while balancing operational benefits with the reduction of aircraft noise exposure for communities located around the airports, in accordance with ICAO's environmental sustainability objectives.

3. Conclusion

3.1 The Belo Horizonte and Rio de Janeiro TMA Projects represent another important milestone in Brazil's continuous airspace modernization program, incorporating advanced ICAO-recommended Air Traffic Management concepts and applying Performance-Based Navigation solutions to improve operational efficiency and environmental performance.

3.2 The operational assessments and FTS indicate that the proposed solutions are expected to provide measurable operational and environmental benefits. Both projects resulted in significant reductions in flight distance, fuel consumption and carbon dioxide (CO_2) emissions, as summarized in Table 1, confirming the benefits achieved through the modernization of the Brazilian airspace structure.

Project	Flight Distance (NM/year)	Fuel (kg/year)	CO_2 (kg/year)
Belo Horizonte TMA	-90,000	- 628,000	- 1,980,000
Rio de Janeiro TMA	-205,700	- 1,640,000	- 5,190,000

Table 1: Estimated Operational and Environmental Benefits of the Belo Horizonte and Rio de Janeiro TMA Modernization Projects

3.3 By aligning the TMA structures with the recommendations contained in the GANP, the ASBU Framework, and ICAO documentation related to Air Traffic Management and Performance-Based Navigation, DECEA reinforces its continuous strategy for modernizing the Brazilian Airspace Control System. This approach strengthens the system's capability to accommodate current and future aviation demand with high levels of operational safety, efficiency, predictability, environmental sustainability, and resilience, while also contributing to regional harmonization and the sharing of best practices.

4. Suggested Actions

The Meeting is invited to:

a) to take note of the progress of the Brazilian airspace modernization and planning program, including the projects for the restructuring of the MTAs of Belo Horizonte and Rio de Janeiro, as a reference for the practical application of the APTA concepts recommended by ICAO;

b) to recognize that strategic planning and periodic review of airspace structures are essential tools for improving the operational efficiency, capacity, predictability of operations and environmental sustainability of the ATM system;

c) note that certain airspace design and optimization practices can represent solutions that are quick to implement and relatively low-cost, providing significant operational and environmental benefits without necessarily requiring complex investments in physical infrastructure;

d) encourage States to evaluate and develop projects for the restructuring, restoration or optimization of their airspace, especially in terminal areas and routes of high demand, in order to improve safety, reduce distances flown, reduce fuel consumption and CO_2 emissions, and increase the efficiency of air operations;

e) promote the regional exchange of experiences, methodologies and best practices related to airspace planning and modernization, including operational evaluation processes, safety studies, simulations and environmental and economic benefit analyses; and

f) invite States and International Organizations to consider cooperative initiatives and joint airspace modernization projects that contribute to regional harmonization,

ATM interoperability, and the implementation of the objectives set out in the ICAO GANP and ASBU Framework.

END