



Western and Central African Office

Twenty-first Meeting on the improvement of Air Traffic Services over the South Atlantic (SAT/21)

Lisbon, Portugal, 8-10 June 2016.

Agenda Item 2: Performance Based Navigation (PBN) in the South Atlantic**2.5 PBN Implementation in Cabo Verde**

(Presented by Cabo Verde)

SUMMARY

The objective of this working paper is to present the actions performed by Cabo Verde aiming the implementation PBN

Reference:

- ICAO Resolution A36-23 and A37-11
- ICAO Doc 9613
- ICAO Doc 8168

1. Introduction

PBN is a term used to describe the broad range of technologies that are reducing aircraft reliance on conventional, ground-based radio-navigation infrastructure. An aircraft flying a PBN path uses on board equipment and procedures to follow a defined trajectory.

It is well known that ICAO adopted the Resolution A36-23 requiring Regions to complete PBN Implementation Plan by 2009 and ICAO Assembly Resolution A37-11 urges States to develop their own PBN implementation plan as a matter of urgency and is geared towards achieving the global PBN performance objectives.

These global performance objectives are required to ensure that the national PBN implementation efforts, coordinated at the regional levels by the ICAO Regional PBN task forces, are aligned and consistent with the ICAO Global ATM operational concept and Air Navigation Plan.

The Global PBN performance framework set by ICAO Assembly Resolution requires the implementation of approach procedures with vertical guidance (APV Baro-VNAV and/or SBAS) for all instrument end, either as the primary approach or as a back-up for precision approaches by 2016. In line with the Global PBN performance framework, Cabo Verde developed its PBN implementation plan.

2. PBN navigation specification

Two fundamental aspects of any PBN operation are the requirements set out in the appropriate navigation specification and the navigation aid infrastructure (both ground- and space-based) allowing the system to operate. A navigation specification is a set of aircraft and aircrew requirements needed to support a navigation application within a defined airspace concept. The navigation specification defines the performance required by the RNAV system as well as any functional requirements such as the ability to conduct curved path procedures or to fly parallel offset routes.

a) RNAV 10 / RNP 10

RNP 10 supports 50 NM lateral and 50 NM longitudinal distance-based separation minima in oceanic or remote airspace. Aircraft equipped with at least two independent long range navigation systems; any combination of INS/ IRU or GNSS meets the RNP 10 requirements. During operations in airspace or on routes designated as RNP 10, the lateral total system error must be within ± 10 NM for at least 95% of the

total flight time. RNP 10 is implemented in EUR/SAM corridor, where SAL FIR is inserted. After safety assessment, in the framework of SAT, RNP 4 will replace RNP10 operations.

RNP 10 was introduced in 2009 (AIC 002/2009), as was decided by SAT group.

b) RNP 4

RNP 4 is designed for Oceanic or Remote area airspace (where ground-based NAVAID infrastructure is not available). RNP 4 currently supports 30 NM lateral and 30 NM longitudinal distance-based separation minima in oceanic or remote area airspace and requires GNSS avionics such as TSO-C129a or C145/6. At least two LRNSs (Long Range Navigation System) capable of navigating to RNP 4, and listed in the flight manual, must be operational at the entry point of the RNP airspace.

The global navigation satellite system is the primary navigation sensor that supports RNP4, either as a stand-alone navigation system or as part of multi-sensor system. The implementation of RNP 4 will be consistent with the decisions of SAT group for EUR/SAM corridor. The implementation of RNP 4 will need a safety assessment to be done by SATMA.

3) Navigation functional requirements

Both RNAV and RNP specifications include requirements for certain navigation functionalities. At the basic level, these functional requirements may include:

- a) continuous indication of aircraft position relative to track to be displayed to the pilot flying on a navigation display situated in his primary field of view;
- b) display of distance and bearing to the active (To) waypoint;
- c) display of ground speed or time to the active (To) waypoint;
- d) navigation data storage function; and
- e) appropriate failure indication of the RNAV system, including the sensors.

4. Existing CNS infrastructure in Cabo Verde

There are two VOR/DME stations installed in Cabo Verde for approach and en route navigation. One is located in Sal airport and another in Praia airport. Aircraft flight management system, with the location of VOR/DME stations and their exact coordinates, can calculate the deviation from the intended flight track. The limitation of VOR/DME utilisation is the low accuracy of radial angle measurement. Taking into account the navigation system errors (NSE) and the flight technical errors (FTE), VOR/DME can meet only RNAV5 navigation specification requirements not further than 110-120 km from their installation location.

VOR accuracy can typically meet the accuracy requirements for RNAV 5 up to 60 NM from the navigation aid.

The introduction of RNAV1 SID and STARS will rely on the use of GNSS. RNP APCH operations (APV Baro-VNAV) will be based on GNSS and the vertical guidance will be based on barometric altimetry. Given that the vertical path is based on barometric inputs, it is very important that the correct local pressure setting (QNH) is entered into the system. The final descent is also influenced by temperature which must be published on the chart. Today in all airports there is reliable pressure and temperature information (QNH).

There are three radar stations installed in Cabo Verde, in Morro Curral (Sal), Monte Tchota (Santiago) and Pedra Rachada (Santo Antão). They are used to provide surveillance in Cabo Verde TMA and in most part of Sal Oceanic. Additional surveillance is provided by ADS within and beyond radar coverage. As long as there surveillance is always provided, it is foreseen the introduction of RNAV1 SIDs and STARS instead of RNP1 SIDs and STARS.

Today there are two VHF ER stations providing stable and reliable communications for air traffic management in domestic and international operations. Beyond VHF coverage, communication is provided by CPDLC.

5. Implementation strategy

Cabo Verde airspace (Sal Oceanic FIR) is located along EUR /SAM corridor and the introduction of any navigation specification for upper airspace must be discussed with SAT members and be approved in this forum.

The PBN implementation includes also RNAV (GNSS) approach procedures, replacing the conventional procedures and reorganization of airspace if needed. RNP 10 was introduced in 2009 (AIC 002/2009), as was decided by SAT group. After safety assessment, in the framework of SAT, RNP 4 will replace RNP10 operations.

The PBN implementation plan in Cape Verde includes implementation of PBN routes in Sal FIR and RNAV (GNSS) approach procedures, replacing the conventional procedures and reorganization of airspace if need. Flex routes may also be implemented. The Global Plan Initiative (GPI -7, doc 9750) states that routes need not to be fixed to pre-determined waypoints except where required for control purposes.

Flex routing structure was introduced in Sal Oceanic FIR in April 2011 (S01/2011). Its implementation aimed to remove the constraints imposed by the fixed route structure and through the optimized use of all the airspace benefits of capacity, flexibility, flight efficiency and cost savings, while maintaining safety standards.

The implementation targets are:

- RNP APCH (with Baro-VNAV) or APV in all instrument runways by 2016
- RNAV-1 or RNP-1 SID/STAR for all international airports by 2016
- RNAV-1 or RNP-1 SID/STAR for domestic airports where there are operational benefits
- Implementation of RNP 4 after safety assessment and SAT decision
- Implementation of additional RNAV/RNP routes if required.

At Sal airport, APV may be used as a backup for precision approach. RNP APCH were developed for Boa Vista and Mindelo Internacional Airports and will be soon approved.

6. ACTION BY THE MEETING

The meeting is invited to:

- a) Note the information contained in this paper
- b) Encourage SAT States to implement PBN
- c) Make comments regarding RNP 4
- d) Bring any suggestion regarding to the implementation of PBN in Cabo Verde

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