



**Agenda Item 2: Follow-up to the implementation status of the performance based navigation systems plans for the CAR and SAM Regions and to the latest amendments to the ATM- and CNS-related SARPS**

**STATUS OF PERFORMANCE BASED NAVIGATION (PBN) IMPLEMENTATION IN THE UNITED STATES**

(Presented by the United States of America)

**SUMMARY**

This paper provides a summary of Performance-Based Navigation (PBN) implementation and plans in the United States (U.S.) National Airspace System (NAS). It also addresses the role of Satellite Based Augmentation System (SBAS) as a sensor input to PBN and notes recently updated and newly published U.S. guidance material for PBN.

**Strategic Objectives**

*This information paper is related to ICAO Global Performance Initiatives (GPI)  
GPI 5 – Performance Based Navigation  
GPI 11 – RNAV SIDs and STARs.*

**1. Introduction: PBN Planning in the U.S.**

1.1 PBN is considered a foundational technology of the U.S. Next Generation Air Transportation System (NextGen), which is a group of programs that will enable the U.S. National Airspace System (NAS) to meet the increased capacity needs of 2025.

1.2 U.S. PBN planning is a cooperative effort by the Federal Aviation Administration (FAA) with aviation industry stakeholders. Planning at a strategic level is primarily conducted through a government-industry forum, the Performance Based Operations Aviation Rulemaking Committee (PARC), which is chartered by the FAA Administrator. The PARC has several working groups that enable the technical expertise of aviation industry stakeholders to contribute to the framing and resolution of complex technical issues. PARC recommendations on PBN implementation priorities and FAA technical/operational guidance are submitted to the Associate Administrator for Safety, for use by FAA Flight Standards Service, Aircraft Certification Service, and Air Traffic Organization offices as appropriate.

1.3 Initial implementation plans for PBN, both Area Navigation (RNAV) and Required Navigation Performance (RNP) applications were contained in the *FAA Roadmap for Performance Based Navigation*, published in July 2003 and revised in August 2006. Since then, PBN planning has been incorporated into the Next Generation Air Transportation System (NextGen) planning documents, including the *NAS Enterprise Architecture*. Although annual implementation targets for RNAV and RNP routes and procedures are contained in the annual *FAA Flight Plan*, FAA is advancing PBN implementation through a more comprehensive integration of airspace and procedures plan, which includes advancements and commitments toward RTCA Task Force 5 recommendations. Potential benefits of this integration concept are the use of procedures to decouple flight paths in complex and adjacent airport airspace, improve access to runways, and increase terminal and en route throughput resulting in improved terminal and en route airspace efficiencies.



**Figure 1 U.S. PBN Planning Documents**

## 2. Current PBN Implementation in U.S. Domestic Airspace

### 2.1 En Route

2.1.1 The U.S. has implemented RNAV 2 in the en route domain. RNAV 2 routes above FL 180 are designated Q routes (e.g. Q5, Q13 etc). Almost every Q route can be flown either with GNSS or DME/DME/IRU. Routes below 18,000' are designated T routes (e.g. T213); GNSS is required.

2.1.2 As of September 2010 the U.S. has a total of more than 250 PBN routes implemented.

2.1.3 Generally, the main focus of Q route implementation has been in creating efficient routes that do not depend on ground-based nav aids (e.g. over the Gulf of Mexico) and on reducing flight distances (e.g. avoiding Special Use Airspace). In the near future, Q route development and implementation will focus on increasing system efficiencies, concentrating east of the Mississippi river. Routes implemented from 2010-2012 will focus in five geographic corridors: Upper Midwest to New York area, North-South routes along Atlantic Coast, Southwest to Northeast/Mid-Atlantic, Midwest to Florida, and Western Corridor airspace.

### 2.2 Terminal

2.2.1 The U.S. has implemented RNAV 1 Standard Instrument Departure (SID) procedures and Standard Terminal Arrival Routes (STAR) in this domain. All RNAV SIDs/STARs can be flown using GNSS. Almost all have also been authorized for DME/DME/IRU operation.

2.2.2 As of September 2010, the U.S. has published 395 RNAV SIDs and STARs.

### 2.3 Approach

2.3.1 There are 5,271 instrument runway ends in the U.S. NAS that potentially qualify for a vertically guided procedure. It must be noted that a final determination of the suitability of a specific runway end to support a vertically guided procedure is dependent on factors (e.g. penetration of Glideslope Qualification Surface (GQS)) that are assessed when an initial PANS OPS (U.S. –TERPS) design is developed.

2.3.2 The U.S. implements RNAV Global Positioning Satellite (GPS) procedures that are consistent with the ICAO PBN Manual Vol II navigation specification RNP APCH. Baro-VNAV provides vertical guidance. These are also referred to as Lateral Navigation (LNAV)/ Vertical Navigation (VNAV) procedures. As of September 2010, the U.S. has published over 2,100 of these procedures.

2.3.3 The U.S. has published over 250 public RNP Special Aircraft and Aircrew Authorization Required (SAAAR) approaches.

Note: RNP SAAAR is the U.S. term for ICAO RNP Authorization Required (AR) procedures. The next version of FAA Advisory Circular, AC 90-101, Approval Guidance for RNP Procedures with SAAAR, will change the U.S. term to RNP “Approval Required” or simply RNP AR.

2.3.4 The next draft of the ICAO PBN Manual includes SBAS enabled LPV operations, such as the U.S. Wide Area Augmentation System (WAAS). SBAS is considered to be a sensor input for PBN applications. SBAS receiver (TSO 145/146)-equipped aircraft with appropriate functionality can fly all U.S. RNAV 2, RNAV 1 routes/SIDs/STARs. The LNAV/VNAV minima line in all RNAV (GPS) procedures may be flown without the need for an approach-certified baro-VNAV capability. Some receiver models may also provide a descent angle on RNAV (GPS) LNAV-only procedures. ICAO Assembly Resolution A36-23 includes “augmented GNSS” as an acceptable implementation of the goal of an APV procedure to all instrument runway ends by 2016. As of September 2010, the U.S. has over 2,000 LPV procedures published.

### 3. Recent FAA Guidance Documents for PBN

3.1. The FAA has recently published updated guidance material for PBN implementation:

- FAA Order 8260.54A (Dec 2007) *United States Standard for RNAV Procedures* provides procedure design guidance for RNAV approaches (equivalent ICAO RNP APCH).  
*Note:* The U.S. uses the U.S. Standard for Instrument Procedure Design (TERPS) series of document, not ICAO PANS OPS. Design criteria are harmonized to the maximum extent possible.
- FAA Advisory Circular 90-105 (Jan 2009) *Approval Guidance for RNP Operations and Barometric Vertical Navigation in the U.S. National Airspace System* provides airworthiness and operational approval guidance for the conduct of baro-VNAV RNP approaches with LNAV/VNAV minima, Basic-RNP 1 SIDs and STARs.

3.2. The above paragraph addresses only two of the extensive series of guidance documents (Orders and ACs) relating to RNAV and RNP operations that is published by the FAA. The FAA makes all its guidance documents available at <http://rgl.faa.gov/>.

### 4. Conclusion

4.1 FAA plans recognize the need to quickly evolve procedural design and deployment to produce greater benefits. In FY 2011 and beyond, FAA will build on the successful introduction of PBN operations in the NAS through a continuous improvement process to optimize PBN procedures. Close collaboration between the FAA and aviation community, through forums such as RTCA and the PARC, as well as close coordination between the FAA’s air traffic and flight standards organizations will ensure success.

4.2 The meeting is invited to note the information in this paper.