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North American, Central American and Caribbean Office (NACC)
**Seventh Central Caribbean Working Group Meeting**
**(C/CAR WG/7)**
Mexico City, Mexico, 13 to 16 July 2009

**Agenda Item 2: Review of Air Navigation matters**
**2.3 Air Navigation specific activities**
**2.3.1 Air Traffic Management (ATM)**

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

(Presented by the United States)


| **SUMMARY** | |
|---|---|
| The paper provides a summary of PBN (RNAV and RNP) implementation and plans in the United States National Airspace System (NAS). It also addresses the role of 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)*<br>*GPI 5 – Performance Based Navigation*<br>*GPI 11 – RNAV SIDs and STARs.* |


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

1.1 Performance Based Navigation (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 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 RNAV and 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.* Therefore, no further editions of the FAA PBN Roadmap are planned. Yearly implementation targets for RNAV and RNP routes and procedures are contained in the annual *FAA Flight Plan.*

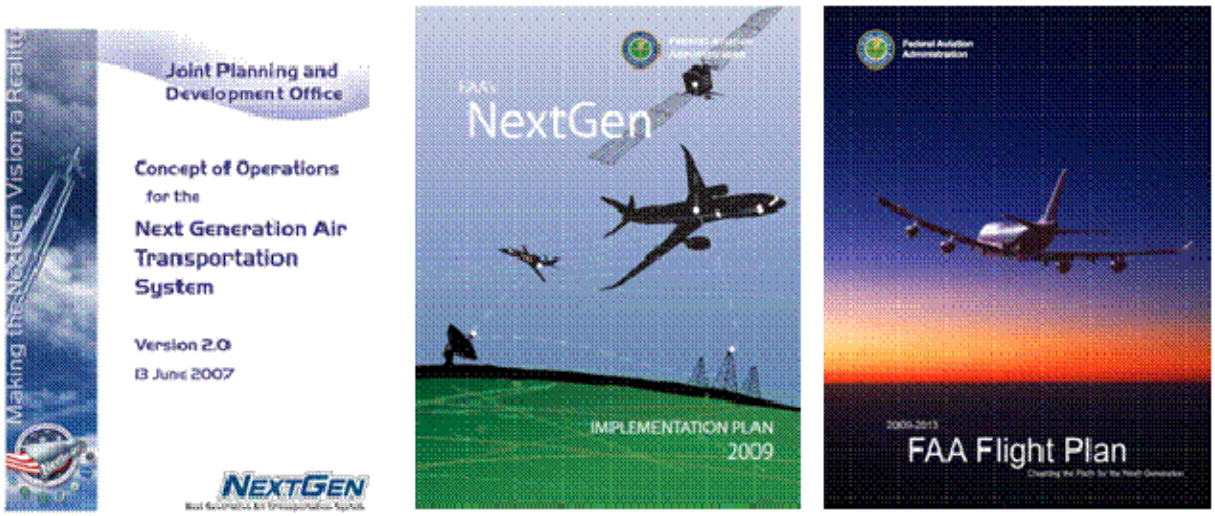


***Figure 1 U.S. PBN Planning Documents***

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

### *2.1 Enroute*

2.1.1 The U.S. has implemented RNAV 2 in the enroute 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. Additionally, the U.S. assesses conventional routes for lower Minimum Enroute Altitudes (MEA) enabled by GNSS.

2.1.2 As of March 2009 the U.S. has a total of 137 Q/T/GNSS MEA routes implemented. Twelve implementations are planned for Fiscal Year (FY) 2009 (1 Oct 2008 – 30 Sept 2009), mainly in Alaska. Q-42 will accommodate westbound departures from Philadelphia and New York.

2.1.3 Generally, the main focus of Q route implementation has been in creating efficient routes that do not depend on ground-based navaids (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 March 2009, the U.S. has published over 350 RNAV SIDs and STARs. In FY 2009, the FAA plans to implement 50 RNAV SIDs/STARs, and another 50 in FY 2010.

*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 (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 LNAV/VNAV procedures. As of March 2009, the U.S. has published over 1600 of these procedures. Approximately 450 procedures are planned for FY 2009 and 2010.

2.3.3 The U.S. has published over 130 public RNP Special Aircraft and Aircrew Authorization Required (SAAAR) approaches. 50 procedures are planned for FY 2009 and another 50 in FY 2010. *Note: RNP SAAAR is the U.S. term for ICAO RNP Authorization Required (AR) procedures. The next version of the applicable FAA Advisory Circular, AC 90-101(), will change the U.S. term to AR.*

## 3. Role of GPS Space Based Augmentation Systems (SBAS) in U.S. PBN implementation

3.1 At present, the ICAO PBN Manual does not include the LPV operation that is enabled by SBAS, such as the U.S. Wide Area Augmentation System (WAAS)**.** However, 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.They can fly the LNAV/VNAV minima line in all RNAV (GPS) procedures 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.

3.2 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 March 2009, the U.S. has over 1500 LPV procedures published. The FAA plans to implement approximately 500 LPV minima procedures in FY 2009 and 2010.

## 4. Recent FAA Guidance Documents for PBN

4.1. 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, and will also support RNP 2 operations when the ICAO PBN Manual navigation specification is developed.

4.2 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 **www.rgl.faa.gov.**

## 5. Conclusion

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

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