



WORKING PAPER

**SPECIAL AFRICA-INDIAN OCEAN (AFI)
REGIONAL AIR NAVIGATION (RAN) MEETING**

Durban, South Africa, 24 to 29 November 2008

Agenda Item 6: Development of a set of comprehensive work programmes in the air navigation field, aimed at improving efficiency of the air navigation system (Efficiency Committee)

**PERFORMANCE-BASED NAVIGATION (PBN) CONCEPT, BENEFITS
AND IMPLEMENTATION GOALS**

(Presented by the Secretariat)

SUMMARY

This paper details the PBN concept, its benefits, the global PBN objectives and actions undertaken by ICAO and serves as the background for WPs/11 and 12.

Action by the meeting is in paragraph 3.

1. INTRODUCTION

1.1 The ICAO specialized committee on future air navigation systems (FANS) identified that the method most commonly used over the years to indicate required navigation capability was to prescribe mandatory carriage of certain equipment for flying in airspace. This constrained the optimum utilization of modern on-board equipment. To overcome this problem, the committee developed the concept of required navigation performance capability (RNP). The parameter RNP was to be defined in terms of lateral and along track position fixing accuracy. The concept was approved by the ICAO Council and was assigned to the Review of General Concept of Separation Panel (RGCSP) for further elaboration. RGCSP, in 1990 noting that measured performance was more relevant for airspace planning than the designed-in capability, changed RNP to required navigation performance (RNP).

1.2 Implementation of RNP and area navigation (RNAV) took different directions in different regions and States. In particular, the definitions and concepts related to RNP and RNAV and the naming conventions associated with RNP varied from State to State and from region to region. This variation of implementation resulted in a lack of harmonization between RNP and RNAV applications in different areas of the world.

1.3 The Eleventh Air Navigation Conference (22 September to 3 October 2003, Montreal, Canada) took note of this lack of harmonization in the implementation of RNP and RNAV and recommended that ICAO address this issue and also expedite the implementation of RNP and RNAV in a harmonized manner (Recommendation 6/5 refers).

1.4 Based on Recommendation 1/1 of the fourth meeting of the Global Navigation Satellite System Panel (GNSSP/4), RNP Special Operational Requirements Study Group

(RNPSORSG) was created on 10 June 2003 by the Air Navigation Commission to act as focal point for addressing several issues related to RNP/RNAV. The RNPSORSG developed the concept of performance-based navigation (PBN) in May 2007.

1.5 The RNPSORSG developed the Performance-Based Navigation Manual that is currently in final draft. In order to expedite implementation, State letter AN 11/45-07/22, *Guidance material for the issuance of performance based navigation (PBN) operational approvals* was issued on 27 April 2007. The letter enclosed relevant guidance from the manual to facilitate implementation of air traffic services (ATS) routes and flight procedures based on PBN.

1.6 AFI Planning and Implementation Regional Group (APIRG) at its sixteenth meeting held in Rubavu, Rwanda from 19 to 23 November 2007, discussed various issues related to the implementation of PBN in the AFI Region. The Group was provided with the details on the PBN concept in the context of a performance-based global air traffic management (ATM) system, the benefits of PBN, recent actions by ICAO at the global and regional levels regarding PBN implementation and what role APIRG, the States and stakeholders should play relating to implementation.

1.7 The group recalled that at the 36th Session of the ICAO Assembly held at Montreal, Canada from 18 to 28 September 2007, it was recognized that implementation of approaches with vertical guidance was still not widespread, that the global air navigation plan has identified global plan initiatives (GPIs) to concentrate on the incorporation of advanced aircraft navigation capabilities into air navigation infrastructure and that continued development of diverging navigation specifications would result in safety and efficiency impacts and penalties to States and industry. The Assembly adopted Resolution A36-23 to support speedy implementation of PBN globally. The resolution urged all States to implement RNAV and RNP ATS routes and approach procedures in accordance with the ICAO PBN concept laid down in the PBN Manual.

2. DISCUSSION

2.1 Concept and benefits

2.1.1 The concept of PBN is based on technologies which are available now and the experience gained over previous years with RNP and RNAV implementation in different geographical areas of the world. In developing the PBN concept, the RNPSORSG harmonized some RNAV and RNP specifications and nomenclature which were proliferating and presenting operational approval and other difficulties. The concept of PBN includes navigation specifications not only for oceanic and remote airspace but also for continental enroute, terminal airspace and approach, which were not sufficiently covered in the earlier concept of RNAV and RNP.

2.1.2 The earlier concept of RNP and RNAV included the requirement for accuracy only. Considering that the navigation containment is based not only on accuracy but includes functional integrity, continuity and system availability, RNPSORSG classified the performance requirements into two groups. Applications of performance-based navigation without the requirement of on-board performance monitoring and alerting are now designated as RNAV and applications with a requirement for on-board performance monitoring and alerting are now designated as RNP.

2.1.3 Another important difference between the earlier concept of RNP and RNAV and the PBN concept is that it not only refers to the performance required of the RNAV system but also to:

- a) functionalities that the RNAV system must have to achieve performance;
- b) navigation sensors to be integrated in the RNAV system to achieve performance;
- and

- c) requirements placed on air crew to achieve the required performance from the RNAV system.

2.1.4 With the changes as detailed above in paragraphs 2.1.1 to 2.1.3, PBN and the related guidance material now offer a solid basis for implementation, and allow for many benefits over sensor-specific ATS routes and builds on the earlier concepts of RNP and RNAV. Some of the benefits are listed below:

- a) reduced need to maintain sensor-specific routes and procedures, and their associated costs;
- b) avoids need for development of sensor-specific operations and procedures with each new evolution of navigation system which is costly;
- c) facilitates more efficient use of airspace;
- d) in true harmony with the way in which RNAV systems are used;
- e) facilitates the operational approval process for operators by providing a limited set of harmonized navigation specifications intended for global use;
- f) the navigation function is performed by highly accurate and sophisticated on-board equipment thus allowing reduction in cockpit workload while increasing safety;
- g) ATS routes can be designed to optimize traffic flows for maximum efficiency and capacity, as it is not necessary for the routes to pass over locations marked by conventional nav aids; and
- h) PBN based arrival and departure routes can complement and even replace radar vectoring, thereby reducing approach and departure controllers' workload.

2.1.5 The PBN Manual, Volume I contains information on PBN concepts and general implementation requirements; Volume II contains the navigation specifications with harmonized airworthiness and operator requirements, implementation guidance and recommendations for pilot and controller training for different RNP/RNAV categories.

2.2 PBN Implementation

2.2.1 In order to expedite global harmonized implementation, the 36th Session of the ICAO Assembly, agreed to the PBN implementation goals as contained in Resolution A36-23 as follows:

- a) States and planning and implementation regional groups (PIRGs) complete a PBN implementation plan by 2009 to achieve:
 - 1) implementation of RNAV and RNP operations (where required) for en-route and terminal areas according to established timelines and intermediate milestones; and
 - 2) implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS) for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 per cent by 2010, 70 per cent by 2014.

- b) ICAO develop a coordinated action plan to assist States in the implementation of PBN and to ensure development and/or maintenance of globally harmonized SARPs, procedures for air navigation services (PANS) and guidance material including a global harmonized safety assessment methodology to keep pace with operational demands; and
- c) States are urged to include in their PBN implementation plan provisions for implementation of approach procedures with vertical guidance (APV) to all runway ends serving aircraft with a maximum certificated take-off mass of 5 700 kg or more, according to established timelines and intermediate milestones.

2.2.2 To facilitate the achievement of the PBN implementation goals, ICAO has established a global PBN programme that addresses the need for potential new operational requirements to avoid a proliferation of standards and to coordinate and facilitate the global implementation of PBN.

2.2.3 Currently, the programme is coordinating the development of a regional PBN implementation plan as well as assisting in actual implementation activities with each ICAO region. This includes developing training for operational approval, flight procedure design and airspace planning. In order to expedite implementation, APIRG/16 endorsed the establishment of a PBN Task Force for the AFI Region. To give direction to the taskforce it is essential to set high-level performance objectives. These objectives are detailed in WP/11 and submitted for approval by the meeting.

2.2.4 Furthermore, the programme is actively involved in the establishment of ICAO regional Flight Procedure Offices (FPO's) on a worldwide basis to address the critical shortage of procedure design capability in the States. A plan for an Asia/Pacific office is well under way and other regions have shown great interest. WP/12 addresses a proposal for such an office for the AFI region.

2.2.5 Critical in the implementation of PBN, is the availability of geographical coordinates in the commonly agreed reference system: WGS-84, as well as the availability of electronic terrain and obstacle data for approach and departure procedures. In more general terms the PBN concept requires improved effectiveness and efficiency by States in the AFI Region to publish the integrated aeronautical information package. This requirement was first addressed by APIRG/15 Conclusion 15/43 and confirmed by APIRG/16 Conclusion 16/41 which called for the establishment of a centralized-Africa-Indian Ocean AIS database (AFI-CAD). WP/13 addresses the need for WGS-84 coordinates and electronic terrain and obstacle data, as well as the establishment of the AFI-CAD. On this basis, the meeting is invited to adopt the following recommendation:

Recommendation 6/x – PBN implementation support

That recognizing the important safety, efficiency and environmental benefits of PBN, States should develop their implementation plans as a matter of priority to meet the PBN implementation goals set by Assembly resolution A36-23.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- a) note the information presented in this paper when discussing WPs/11, 12 and 13; and
- b) approve the draft Recommendation at paragraph 2.2.5 above.