



**Performance Based
Navigation (PBN)
Implementation Plan**

PAKISTAN

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1. Background

1.2 ICAO Assembly vide resolution A36/23 urged all States to implement RNAV and RNP air traffic services (ATS) routes and terminal/approach procedures in accordance with the ICAO PBN concept laid down in the Performance Based Navigation Manual (Doc 9613). There is unanimous consensus among the aviation world that the modern navigation technologies have promising potential for efficient, reliable air navigation and utilization of airspace. The new aviation challenges can be met by establishing new navigation system that enhances airspace capacity in line with the projected aviation demand, ensuring fuel saving and reduced environmental impact. The future demand on aviation operations in Asia and Pacific is also expected to vastly increase due to economic expansion as compared to other regions. 418 new aircraft deliveries were made to the region in 2007 whereas 1000 new orders were placed in the same period. APANPIRG/18 vide its Conclusion 18/52-55 and 44th DGCA Conference vide Action Item DGCA 44/6 also fully supported the ICAO PBN program.

1.3 Pakistan is a signatory to the convention and a member State of Asia/Pacific Region. This Performance Based Navigation Implementation Plan (Roadmap) has therefore been prepared in order to acknowledge the initiatives of APANPIRG, DGCA Conference and ICAO Assembly. It is also intended to assist aviation stakeholders in understanding operational goals, determining requirements, and considering future investments. The Roadmap focuses on addressing future efficiency and capacity needs while maintaining or improving the safety of flight operations by leveraging advances in navigation capabilities on the flight deck. This Roadmap provides a high-level strategy for the evolution of navigation capabilities to be implemented in three timeframes i.e. short term (2009-2012), mid term (2013-2016), and far term (2017 and beyond). The strategy rests upon two key navigation concepts, Area Navigation (RNAV) and Required Navigation Performance (RNP). It encompasses instrument approaches, Standard Instrument Departure (SID) and Standard Terminal Arrival (STAR) operations, as well as enroute operations.

2. Status of RNAV operations and PBN implementation in Pakistan

2.1 Eleven RNAV routes were established in Pakistan during implementation of EMARSSH routes programme. Domestic route has not been designated as RNAV so far. Terminal and Approach operations were not being conducted till 2007 at any of the airport in Pakistan. The first RNAV Approach Procedure based on RNAV GNSS criteria was developed for RWY07L at JIAP Karachi. The procedure has been operationally trialed by two major operators M/s PIAC and Emirates. It is now under review for compliance with PBN APCH criteria prior to promulgation.

2.2 Recognizing the benefits of PBN and requirement for its implementation, CAA Pakistan established a steering committee in June 2008 to plan and monitor PBN implementation activities in Pakistan. Representatives from all stakeholders including ANS providers, Regulators and major operators are the members of this committee. An ATM team has also been established to develop airspace concept. Information on available navaid infrastructure has been assessed as well as equipage detail of all Pakistan registered aircraft has been obtained. It has been ascertained that most of the civil commercial aircraft are capable of complying RNAV5 specifications for enroute operation using available sensors. However, the following constraints exist:

- a) Currently available navaid infrastructure within Pakistan does not support terminal operations using DME/DME or DME/DME/IRU sensors for RNAV 1/2 or Basic RNP 1 navigation applications.
- b) Sufficient surveillance coverage is available in TMAs established around major international airports. RNAV1 using GNSS sensor will support terminal operations in these TMAs. However, Basic RNP-1 applications will be implemented at all other airports where no suitable surveillance is available.
- c) Currently onboard GNSS equipage is available on limited aircraft. As such benefits of RNAV1 and Basic RNP1 using GNSS will be limited to few aircraft.
- d) Upgradation of equipage on available fleet of major operators to allow RNAV1/2, Basic RNP1 and RNP APCH capabilities may not be economically viable.

2.3 Based on the above considerations, RNAV 5 is envisioned as primary navigation application for enroute operations in Pakistan utilizing any allowable sensor. However, GNSS would be the primary sensor for all terminal and approach applications. Due to existing limited GNSS equipage and in order to facilitate the capable aircraft, ANSP have to support mixed environment for a prolonged period.

2.4 Pakistan has acquired the capability of Instrument Procedure Designing in accordance with new PBN design criteria by training two procedure designers in ICAO ENAC PBN design course held at New Delhi in June 2008. Moreover, the efforts to acquire procedure design software are also in hand which will allow meeting the timelines set in this roadmap.

3. Challenges/Solutions

3.1 Enroute:

3.1.1 Measures are required to be introduced to increase airspace capacity to cater for growing air traffic demands. A possible measure of RVSM has already implemented in the region. New measures could be double or multiple tracking of parallel routes, restructuring of airspace and improving air traffic management. The present ATS route network in Pakistan is generally connected by ground-based navigation aids such as VOR/DME whether designated as conventional or RNAV routes. The major flow of traffic between Europe/America to Far East /South Asia overflies Pakistan from West to East and vice-versa. However, significant traffic also exists between Middle East and destinations East of Pakistan. These traffic flows generally conflict at several waypoints within Pakistan airspace resulting in complexity for ATC and increased controller workload. In future, most aircraft are expected to have the capability for advanced RNAV and RNP. Hence, longitudinal separation can be minimized while ensuring safety. This will result in airspace capacity enhancement.

3.1.2 In order to improve operating efficiency, enroute operations will be systematically taken into account while developing new routes in future. Because RNAV allows the establishment of routes that are not anchored to the location of ground-based navigation aids, routes could be more easily re-aligned and parallel spaced based on the PBN navigation specification. This will allow the capacity of the system as a whole to increase without increasing controller workload allowing maximum aircraft at optimum profiles.

3.2 Terminal:

3.2.1 RNAV/RNP departure and arrival routes can be made shorter than routes that use VOR and other ground-based navigation aids. Although flights enter a terminal area from more than one direction, they must all finally converge onto courses that correspond to landing runways. This is the reason that simply developing RNAV routes alone cannot drastically increase the airspace capacity at busy airports. However, the result of Separation And Safety Panel (SASP) studies for separation application for Terminal PBN applications may lead to significant enhancements. Environmental issues are also an important challenge in the current scenario. RNAV/RNP can allow aircraft to fly ground tracks that better avoid noise sensitive areas appropriately addressing the issue. Operations on the published RNAV routes can also reduce the amount of controller workload significantly by reducing vectoring without jeopardizing the optimum profiles and reducing communication between the pilot and the controller. For airports without Airport Surveillance Radar (non-radar airports), RNAV could also be very effective in shortening routes as those procedures will generally facilitate transition from enroute to approach phase without coming over the facility serving the aerodrome.

3.3 Approach:

3.3.1 Major international airports in Pakistan are generally equipped with ILS serving one end of the runway. The approach operations at these airports to the other ends are normally conducted either using available non-precision approach or by visual circling due to terrain/airspace limitations. Besides non-availability of vertical profile, these approaches are not exactly aligned with the runways. In order to make approach operations more effective, RNP APCH along with Baro-VNAV will be implemented where practicable which would result in significant safety enhancement as well as accessibility to those non-instrument runways where conventional approaches are impracticable. RNP APCH designed will serve as primary approach procedure for Non-Precision and existing non-instrument runway ends and as secondary procedure for precision approach runway ends.

4 Benefits and Global harmonization

4.1 **Performance Based Navigation** is a framework for defining a navigation performance specification along a route, during a procedure, or in airspace within which an aircraft must comply with specified performance requirements. It provides a simple basis for the design and implementation of automated flight paths and for airspace design, aircraft separation, and obstacle clearance. Once the performance level is established on the basis of operational needs, the aircraft's own capability determines whether the aircraft can safely achieve the specified performance and thus qualify for the operation.

4.2 RNAV and RNP specifications facilitate more efficient design of airspace and procedures, which collectively result in improved safety, access, capacity, predictability, operational efficiency, and environmental effects. Specifically, implementation of RNAV and RNP in accordance with PBN concept will:

- Increase safety by using APV operations with perfect course guidance to the runway, which reduce the risk of controlled flight into terrain.
- Improve airport and airspace access in all weather conditions, and the ability to meet environmental and obstacle clearance constraints.
- Enhance reliability and reduce delays by defining more precise terminal area procedures.
- Optimum utilization Flight management systems (FMS) poised to save operators time and money by managing climb, descent, and engine performance profiles more efficiently.
- Improve efficiency and flexibility by increasing use of operator-preferred trajectories at all altitudes.
- Reduce workload and improve productivity of air traffic controllers.
- Reduce environmental impact as with shortening published routes and optimum fuel profile due to airspace capacity enhancement as well as using new techniques such as CDA/CDFA, greenhouse gasses (CO₂, etc.) will also be reduced during all operations including enroute, terminal, and approach procedures.
- Reduce noise exposure by avoiding populated areas and other noise sensitive areas by departures, arrivals, and approach procedures developed to help the community in the airport surroundings.
- Result in global harmonization of RNAV/RNP criteria thus facilitating all stake holders of aviation community.

5. Implementation

5.1 Pakistan airspace where main air traffic flow operates is generally continental airspace except some portions of Karachi FIR which falls over the Arabian Sea. There are only limited route segments which fall over this area therefore no separate consideration for segregation of oceanic and continental operations is required. This roadmap describes strategic objective and milestones set to meet ICAO timelines for implementation of RNAV/RNP operations. The transitions described fall into three timeframes, short term (2009-2012), mid term (2013-2016), and far term (2017 & beyond). The transition overview is summarized below, with mandates highlighted in the three phases:

a) Short Term (2009-2012)

1. Enroute Operations: RNAV Enroute operations in the Pakistan airspace i.e. Karachi and Lahore FIR on major traffic flow routes (Domestic & International) at or above FL290 up to FL410 inclusive will be conducted in accordance with RNAV 5 navigation specification.

i) Domestic Routes: Domestic direct routes established in Pakistan Airspace between major cities will be re-designated for PBN enroute applications by December 2010.

J157 Karachi (KC) – Islamabad (RN)

J158 Karachi (KC) – Peshawar (PS)

J159 Lahore (LA) – Quetta (QT)

J160 Islamabad (RN) – Quetta (QT)

J161 Lahore (LA) – Peshawar (PS)

J172 Karachi (KC) – Quetta (QT)

ii) Int'l Routes: Following RNAV and conventional routes in Pakistan airspace will be designated for PBN en-route application by Dec 2012.

RNAV Routes

L124 KEBUD – Panjgur (PG)

L750 ROSIE – Zhob (ZB)

M638 DOSTI -SAPNA

M875 D.I.Khan (DI) – GUGAL

M881 D.I.Khan (DI) – LAJAK

N644 D.I.Khan (DI) – PAVLO

N894 LATEM – TELEM

P500 D.I.Khan (DI) – PADDY

P518 KABIM – Panjgur (PG)

P628 VIKIT – Rahim Yar Khan (RK)

P757 Nawabshah (NH) – Panjgur (PG)

Conventional Routes

ATS BINDO – TIGER
A454 Karachi (KC) – TAPDO
A466 SAMAR – SITAX
B210 TASOP – Nawabshah (NH)
B466 Nawabshah (NH) – SERKA
G202 Zhob (ZB) – BINDO
G206 PURPA – SABAR
G208 PARTY – DANIB
G210 Panjgur (PG) – TELEM
G214 Panjgur (PG) – Lahore (LA)
G216 ALPOR – Karachi (KC)
G325 Jiwani (JI) – Zhob (ZB)
G326 Nawabshah (NH) – Zhob (ZB)
G452 DERBO – TIGER
G792 Rahim Yar Khan (RK) – ASLUM

New PBN routes with operational benefits will also be considered in accordance with regional requirement.

2. Terminal Operations: RNAV 1 SIDs/STARs are generally envisioned as PBN Terminal application at major airports in Pakistan. RNP-1 SIDs/STARs may also be used at airports where surveillance facility is not available or operationally beneficial. PBN Terminal Applications will be implemented at following airports during short term plan(2009-2012) in the under mentioned order :

- i) Allama Iqbal International Airport Lahore
- ii) Peshawar International Airport
- iii) Jinnah International Airport Karachi
- iv) Benazir Bhutto International Airport Islamabad
- v) Multan International Airport

3. Approach Operations: Due to non-availability of suitable augmentation system (SBAS/GBAS), RNP APCH with Baro-VNAV is generally envisioned as PBN Approach application at all airports in Pakistan. However, due to airspace limitations, Baro-VNAV may not be practicable at some airports. PBN Approach Application will be implemented at following airports during short term plan in under mentioned order:

- i) Allama Iqbal International Airport Lahore
- ii) Peshawar International Airport
- iii) Jinnah International Airport Karachi
- iv) Benazir Bhutto International Airport Islamabad
- v) Multan International Airport

Timelines for PBN Terminal and Approach operations at above airports is given in Appendix-A.

b) Medium Term (2013-2016)

1. Enroute Operations: RNAV Enroute operations on all international routes and selective domestic routes operationally beneficial will be implemented in the Pakistan airspace at or above FL290 up to FL410 inclusive will be conducted in accordance with RNAV 5 navigation specification by 2016.

2. Terminal Operations: Due to non availability of surveillance facility, RNP-1 SIDs/STARs will be implemented as PBN Terminal Applications at following airports during medium term plan (2013-2016) in the under mentioned order:

- i) Quetta International Airport
- ii) Faisalabad International Karachi
- iii) Gawadar International Airport
- iv) Turbat International Airport
- v) Nawabshah International Airport
- vi) Rahim Yar Khan Airport
- vii) Bhawalpur Airport
- viii) Dera Ghazi Khan Airport

3. Approach Operations: Due to non-availability of suitable augmentation system (SBAS/GBAS), RNP APCH with Baro-VNAV is generally envisioned as PBN Approach application at all airports in Pakistan. PBN Approach applications will be implemented at following airports during medium term plan (2013-2016) in the under mentioned order:

- i) Quetta International Airport
- ii) Faisalabad International Karachi
- iii) Gawadar International Airport
- iv) Turbat International Airport
- v) Nawabshah International Airport
- vi) Rahim Yar Khan Airport
- vii) Bhawalpur Airport
- viii) Dera Ghazi Khan Airport

Timelines for PBN Terminal and Approach operations at above airports is given in Appendix-A.

c) Long Term (2017 & beyond)

1. Enroute Operations: Requirement of a stringent enroute navigation specification (RNAV1/2) for implementation on selective routes will be assessed viz-a-viz operational benefits, aircraft equipage and regional requirements.
2. Terminal Operations: Remaining all domestic airports having limited flight operation will be covered beyond 2017.
3. Approach Operations: Remaining all domestic airports having limited flight operation will be covered beyond 2017. Requirement of RNP AR APCH for implementation on selective airports will also be assessed viz-a-viz operational benefits and aircraft equipage.

5.2 The avionics equipage, development of airspace concept, controllers training and other arrangements for airworthiness and operational approvals is a complex and time consuming process which will be undertaken Stage-by-Stage during transition to PBN. Therefore close liaison within all stake holders necessary to develop transition strategy would be required from service provider and operators perspective. To make transition from conventional navigation environment to Performance Based Navigation smooth and to support mixed operation during transition to accommodate non compliant aircraft, existing ground based navigation system will be retained. These navigation aids will also serve as reversionary mode in case of any failure. It is also required for low level general aviation aircraft operations. The possibility of withdrawal of existing ground based nav aids infrastructure will only be considered in the far term period on the basis of on-board equipage, reliance on PBN implemented during first two terms, safety assessment and after consultation with all stake holders.

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