



CIVIL AVIATION AUTHORITY OF THE PHILIPPINES



PBN Implementation Plan

VERSION 2.0 AIRSPACE & FLIGHT PROCEDURE DESIGN DIVISION – AIR TRAFFIC SERVICE

Contents



1. Introduction
 - ICAO Mandate and PBN Global Perspective
 - Status of RNAV Operations in the Philippine
2. Objectives
3. Challenges
4. Development of PBN Implementation Plan
5. Implementation Plan
6. Benefits of PBN
7. Safety Assessment



Introduction

Airspace Capacity

The relentless increase of oil prices and the global financial meltdown did not dampen the air traffic growth in the Philippines. The country's premier airport, Ninoy Aquino International Airport (NAIA), posted 6.46% increase in aircraft movement for the year 2010. Aircraft movement in NAIA has more than doubled in the last ten years.

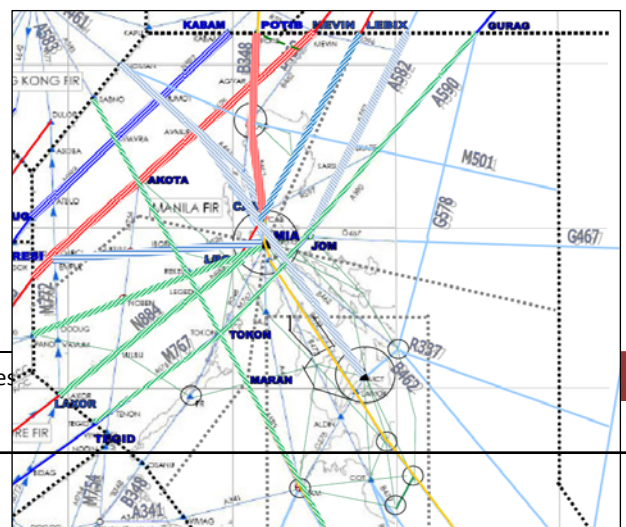
Traffic in NAIA reaches its maximum capacity during peak hours resulting to flight delays. This increase in international and domestic traffic not only in NAIA but in other airports in the country can be attributed to the aggressive promotion of low cost air travel attracting more passengers who used to take the services of the shipping lines.

In order to decongest traffic in NAIA, ATC procedures and infrastructure improvements are currently being implemented. Runway 13 of NAIA has been upgraded to allow instrument operations. Simultaneous operations between Runway 06/24 and Runway 13 became possible with the implementation of LAHSO operations which allowed aircraft weighing 25,000 kilograms and below to land on Runway 13 during VMC thereby increasing runway capacity.

Air Traffic Flow Management (ATFM) was implemented on the second quarter of 2010 with the same objective of increasing airport capacity while still ensuring safety and efficiency of operations.

High Density Routes

- Singapore – Taipei
- Manila – Hongkong
- Manila – Singapore
- Manila – Cebu
- Manila – Iloilo/Bacolod

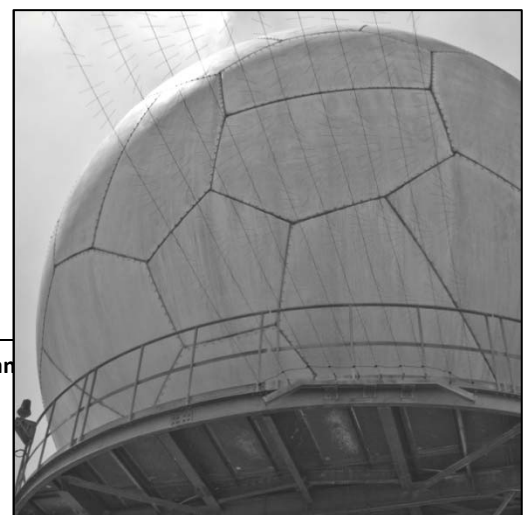




Dependency to Ground Navigational Aids

In June 2010, the outage of the Manila DVOR/DME and ILS system brought air traffic to a halt. The very low visibility did not help the situation. Scores of flight have to be diverted to nearby airports displacing thousands of air travellers for days. Normal flights to Manila resumed when authorities assured that a safe landing can be made.

While the present situation can be managed, operational difficulties have been observed. The mounting complaints about delays in queuing either at the end of the runway waiting for departure clearance or holding/waiting in flight for landing require a comprehensive approach to improve the situation.





material and to support the Asia-Pacific PBN Task Force established by APANPIRG/18.



ICAO Mandate

The 36th Session of the ICAO Assembly held in Montreal in September of 2007 adopted Resolution A36-23 urging all States to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with ICAO PBN concept described in the *Performance Based Navigation Manual* (Doc 9613).

During the 44th Director General Civil Aviation Conference of Asia and Pacific Region on October 2007 held in Xi'an, China, Action Item 44/6 urged States to implement PBN as per ICAO guidance

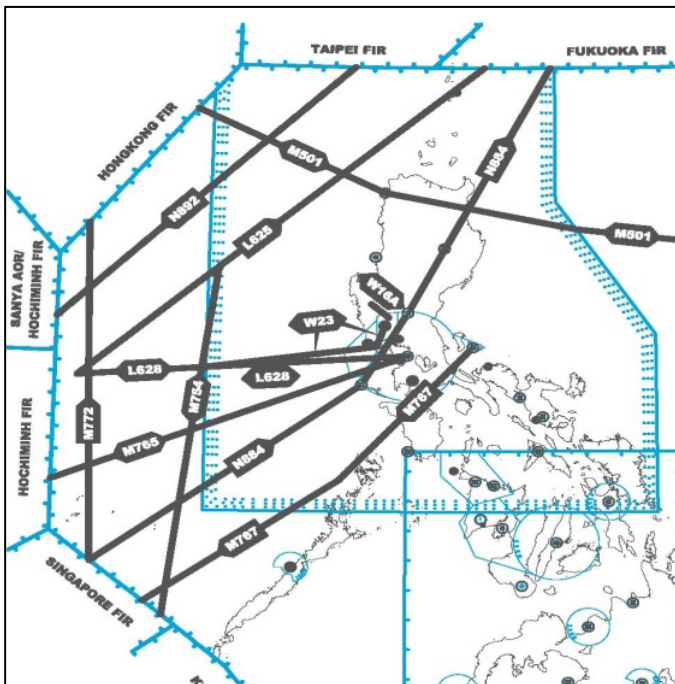
PBN Concept

Performance Based Navigation (PBN) is a concept that encompasses both area navigation (RNAV) and Required Navigation Performance (RNP) and revises the current RNP concept.

The development of PBN concept recognized that advanced aircraft RNAV systems provide enhanced and predictable level of navigation performance accuracy which, together with an appropriate level of functionality, allows a more efficient use of available airspace to be realized.

The PBN concept specifies RNAV and RNP system performance requirements in terms of accuracy, integrity, availability, continuity and functionality needed for the proposed operations in the context of a particular airspace concept, when supported by the appropriate navigation infrastructure.

The PBN concept represents a shift from sensor-based to performance-based navigation. Performance requirements are identified in navigation specifications which also identify the choice of navigation sensors and equipment that may be used to meet the performance requirements. These navigation specifications are defined at a sufficient level of detail to facilitate



global harmonization by providing specific implementation guidance for States and operators.

RNAV enroute procedures were established within the Philippine airspace on November 2001 with the implementation of four (4) one-way parallel RNAV 10 routes. The following year, Reduced Vertical Separation Minima (RVSM) airspace was prescribed within the controlled airspace between FL290 and FL410, except in the Manila South Sector areas that remained between FL310 – FL410.

Since July 2008, eleven (11) RNAV routes have been established. Airways N892, M501, N884,

M772, M767 and L625 satisfy the requirements of RNAV 10 specifications while W23 and W16A suits RNAV 5 specifications.

Effective August 26, 2010, lateral separation standard on the four parallel routes with RNP 10 specifications, airways N884, M767, N892 and L625 within the Manila FIR was reduced from 60 NM to 50NM.

Global Harmonization



In 2003, Federal Express Corporation requested the CAAP for the authorization to use RNP 0.3 RNAV (GPS) Approach procedures and RNP 1.0 RNAV (GPS) Standard Instrument Departures (SID)

procedures which were flight validated and certified by US Federal Aviation Administration (FAA). The request was approved allowing use of the RNAV procedures to four (4) international airports in the country where the company operates. RNAV (GPS) departure and approach procedures were designed and exclusively available only to FedEx fleet in the following airports: Ninoy Aquino International Airport, Mactan-Cebu International Airport, Diosdado Macapagal International Airport and Subic Bay International Airport which was its hub in Asia at that time.



One of the primary intents of PBN is to unify the system that has been available for over forty years and implemented in a variety of ways worldwide. To be consistent with the PBN objective, the approach procedures developed for and used by FedEx which were designed using US RNP SAAAR (Special Aircraft and Aircrew Authorization Required) criteria were re-assessed in accordance with ICAO PBN Concept described in the Doc 9613 and were submitted for flight validation.

Among the re-assessed procedures were the RNAV (GNSS) approaches for both runways of the NAIA. The two procedures served as alternative procedures during the outage of the ground navigational aids after completing the re-evaluation of the procedure using PANS-OPS criteria and a successful flight validation using one of the local airline aircraft.

Following the outage of the DVOR at NAIA in June 2010, the CAAP published and allowed local airlines to use RNAV (GNSS) approach procedure starting July 3, 2010. This procedure served as a contingency measure to allow aircraft operations to continue while the air navigation engineers tried to restore the DVOR to operational status. Flights had to be cancelled or diverted because of the navigational aids outage. On the day that the RNP APCH procedure was implemented, successful landings were recorded.



Objectives of the PBN Implementation Plan

- To take full advantage of the benefits of PBN;
- To be consistent in the implementation of RNAV and RNP ATS Routes and approach procedures with that of the Asia Pacific Region ICAO PBN Implementation Plan;
- To ensure that the implementation of the Navigation aspect of CNS/ATM system is based on established operational requirements;
- To develop a transition strategy from sensor-based navigation to area navigation that will minimize multiple equipment required on board an aircraft and on the ground;
- To provide the time frame for the aviation community to comply with the corresponding requirements of different navigation applications that are defined to facilitate global harmonization of PBN implementation, and,
- Ensure a safe transition from conventional means of navigation to performance-based navigation.



Challenges

CHALLENGES

Infrastructure Development



Obstacle and Data Survey

The survey of forty-one out of eighty-one airports have been completed in May 2010. However, the GPS raw data requires further processing to meet the criteria set in DOC 9674 where the coordinates must be based from an ITRF station. ETOD database still needs to be developed.

Accessibility

A number of airports in the country are not capable to support IFR operations due: (1) terrain limitations , (2) limited budget to improve runway

conditions,(3) no available aerodrome lighting system and (4) no air traffic service in place. These limitations result to either flight cancellation or diversion to other airport in cases of low visibility or inclement weather.

CAAP is planning to upgrade select airports such as Dumaguete, Legaspi and Naga to accommodate operators' requests to allow jet aircraft operations during IMC. RNP AR approach procedure will be considered in the design of procedures for specific airports to enhance airport accessibility.

Fleet readiness

Consultative meetings with local airline operators have been conducted since 2007 to determine the airlines' capability to perform RNAV procedures. Successive surveys were conducted in 2009 and 2010. In 2009, only two (2) out of the five (5) local airlines signified capability to meet the navigational accuracy requirements. By the end of 2010, 90% of domestic registered aircraft are ready and equipped with GNSS avionics necessary to perform RNAV procedures.

In contrast, general aviation operators are appealing for consideration taking into account the huge investment necessary for refurbishing the aircraft to meet RNAV requirements.

Challenges

Taking into consideration aircraft that do not meet the RNAV requirements, conventional navigation will still be authorized. CAAP will set timelines for operators to comply with the RNAV requirements and ensure that operation in mixed navigation environment, that is, RNAV and non-RNAV, is still in accordance with international standards without sacrificing efficiency and viability.

with terminal radar surveillance facilities. These airports are Ninoy Aquino International Airport, Mactan-Cebu International Airport, Subic Bay International Airport and Diosdado Macapagal International Airport. Enroute control provided by Mactan ACC in the southern portion of the Manila FIR is not covered by radar.

GNSS RAIM Prediction Requirements

The requirement for GNSS prediction, monitoring of the status of GNSS and issuance of timely warning of outages is outlined in the PBN Manual. However, the location of the Philippines have sufficient satellite coverage so prediction information may not be necessary.

Training

Flight Procedure Designers



Available CNS infrastructure

Different RNAV navigation specification requires different navigation infrastructure. RNAV operations require sufficient radar coverage to augment on-board aircraft equipment to assure safety of operations. CAAP's radar surveillance capability is still limited. Only four international airports out of 15 instrument airports are equipped





Implementing the PBN Roadmap entails creation of departure, arrival and instrument approach procedures. Building procedure designers competency have been priority and is ongoing. States with advanced expertise in procedure design offered technical assistance. Further training shall be availed to address airports which may require RNP AR procedures.

ATC, Aircrew and Regulators' Training

Implementation of RNAV procedures require training hundreds of air traffic controllers to safely and effectively transition from conventional navigation to performance-based navigation. The transition period is significant, expecting mixed-equipage aircraft in the same airspace. Air traffic controllers' training will be conducted to increase their awareness of the aircraft capabilities and requirements, improve situational awareness and enhance decision-making skills.

Aircrew training is mandatory when applying for approval for PBN operations.

Regulators' training is most important as they will bear the responsibility of developing the PBN Operational Approval Manual as well as its implementation for operators to comply.

Decommissioning of VOR Stations

Aircraft upgrade is expensive and down time for the installation of equipment and software updates varies depending on the aircraft age. It is expected that operators will appeal for more time before they can comply with PBN specifications. Non-compliant aircraft will continue to use guidance provided by VORs. The decommissioning of the said stations will rely in the ability of all stakeholders, particularly the general aviation operators, to equip the aircraft to become RNAV capable.

The decommissioning shall consider the development of RNAV as well as back-up procedures in case of GNSS malfunction or outage.

There is a need to develop a plan specific to the gradual decommissioning of VOR stations while the RNAV procedures are yet to be fully established in the country.



Development of CAAP PBN Implementation Plan

CAAP PBN Task Force

Some of the country's neighboring States are already reaping the benefits of PBN due to its decision to implement early on. Recently, local airline companies signified a more active participation in the implementation of PBN in the country. Effective implementation requires a collaborative effort from all sectors that will be affected by the change. The proposed involvement of airline companies are a welcome development.

The CAAP has identified all possible stakeholders in the the PBN implementation and conducts consultative meetings to foster a cooperative approach in the PBN implementation from formulating the master plan to identifying strategic objectives to achieve the different timelines set for the APAC region.

In February 10, 2010, in one of the consultative meetings, a working group called CAAP PBN Task Force was established. The Task Force is composed of experts from different field in the aviation industry who will be involved in the PBN implementation. The Task Force shall include air traffic controllers, representatives from airline operators and pilot associations, flight check inspectors, maintenance engineers, airport engineers, Aeronautical Information officers, CAAP regulators with representatives from the Flight Standards Inspectorate Service and Aerodrome

and Air Navigation Safety Oversight Office, and flight procedure designers.

Planning

One of the PBN Task Force functions is ensuring that the regulations pertaining to PBN implementation is compliant with the State's Civil Aviation Regulation (CAR), ICAO PBN Manual, Civil Aviation Regulation for Air Navigation Services (CARANS) and other related regulations. Safety assessment shall be conducted in different stages of implementation to achieve smooth transition from conventional navigation to performance-based navigation.

Implementation of PBN requires a collaborative effort within the aviation community. The Task Force shall study the request(s) and/or recommendations of the users. The safe, efficient and effective implementation begins with the determination of requirements of the different navigation specification and comparing these with available infrastructure/data at CAAP to arrive with an applicable and feasible plan. The role of the Task Force is to ensure that the commitment described in this implementation plan will be effectively carried out.

Further, balance must be met between meeting the increasing demand for air transportation services and environment-friendly ATM solutions that will improve airspace utilization and access to airports without jeopardizing safety of operations.

PBN Implementation Plan



The CAAP PBN Implementation Plan shall be consistent with the Asia/Pacific Regional Performance-Based Navigation Implementation targets to ensure regional harmonization.

Implementation shall be done in three phases: Short-Term, Medium-Term and Long-Term. The goal is to develop consistent RNAV operations from departure to arrival.

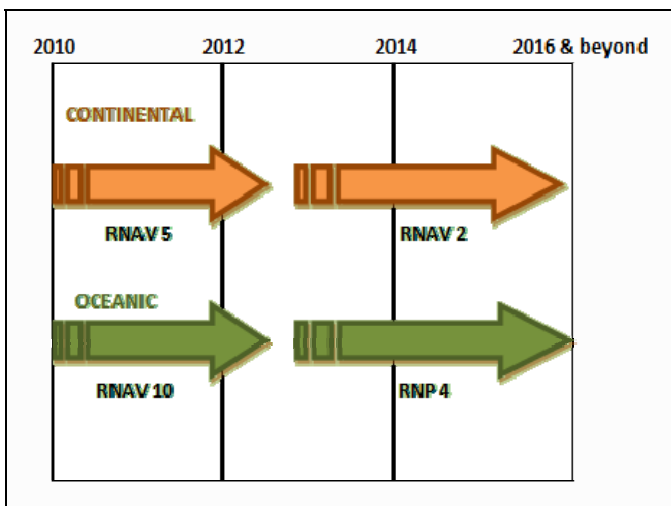
Short Term (2010-2012)	Medium Term (2013-2016)	Long Term (2016 and beyond)
<ul style="list-style-type: none"> ➤ Preparation/ Obstacle survey ➤ Establish the National Working Group for PBN <p>EN ROUTE</p> <p>Continental</p> <ul style="list-style-type: none"> ➤ RNAV-5 <p>Oceanic</p> <ul style="list-style-type: none"> ➤ RNAV10 <p>TERMINAL</p> <p>RNAV-1 SIDs/STARs in APs with Radar Surveillance capability</p> <p><i>Airports:</i> NAIA, MCIA, DMIA</p> <p>RNP 1 SID/STAR in Non- Radar APS</p> <p><i>Airports:</i> Davao, Bacolod, Cagayan De Oro, Puerto Princesa and Iloilo</p> <p>Other APs to be upgraded: Dumaguete, Tagbilaran and Butuan</p>	<p>EN ROUTE</p> <p>Continental</p> <ul style="list-style-type: none"> ➤ RNAV-2 ➤ Implementation of additional RNAV/RNP routes <p>Oceanic</p> <ul style="list-style-type: none"> ➤ RNP-4 ➤ 30/30 NM lateral/longitudinal <p>TERMINAL</p> <p>RNAV-1 SIDs/STARs in APs with Radar Surveillance capability</p> <p><i>Airports:</i> SBIA</p> <p>RNP-1 SIDs/STARs in non-Radar APs</p> <p><i>Airports:</i> Zamboanga, Kalibo, General Santos, Laoag, Roxas, and Tacloban</p> <p>AP to be upgraded:</p>	<p>Performance-Based Operations</p> <ul style="list-style-type: none"> ➤ RNP airspace at and above FL290 ➤ Mandate RNP in busy en route and terminal airspace ➤ Introduction of landing capability using GNSS and its augmentation <p>APPROACH</p> <p>Other APs catering to aircraft with Maximum certificated take-off mass of 5700 kg or more</p>

APPROACH

- RNP APCH with Baro VNAV in



ENROUTE



Oceanic Routes

Manila shall continue to work closely with neighboring States to be consistent with the Regions' implementation Plan. RNAV 10 routes will continue to be implemented until 2012 and will switch over to RNP 4 beginning 2013. To mandate RNP airspaces at FL290 and above is among the long term goal being considered in 2016.

Unidirectional parallel routes between Manila - Bangkok and Manila - Taipei are under study. An ATS Conditional Route has been established named **Z902**. The route reduces aircraft flying time from Singapore to mainland US and is operational between 1700UTC to 2000UTC. This route was

established considering operator request. Philippines participated in the ASPIRE (Asia South Pacific Initiative to Reduce Emission) Program conducted in 2009 and will continue to be involved in activities that seek to improve the condition of the environment.

Procedures for large scale weather deviations and strategic lateral offsets in oceanic airspace in the Manila FIR are being developed. This will set an important milestone when established considering that the Philippines is geographically located near the equator and tropical cyclones are normal occurrence throughout the year.

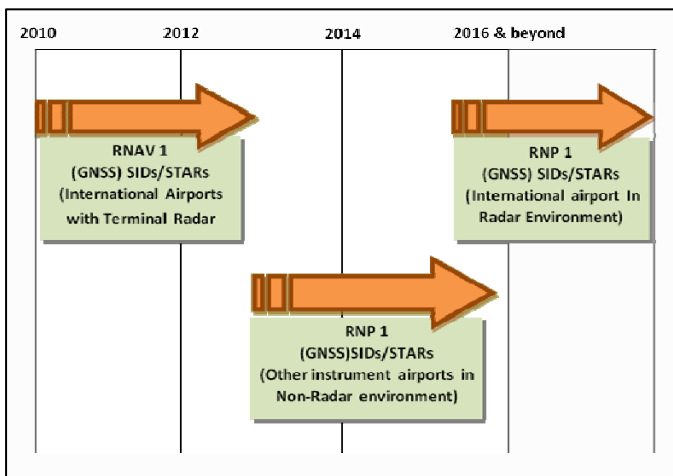
Continental Routes

Manila South Sector routes will be restructured to decongest traffic from the Enroute to Terminal. The route IPATA-BATAY RNAV 5 once established will decongest traffic between Manila ACC and Mactan ACC while DINNO-SAN JOSE RNAV 5 will help air traffic controllers separate aircraft with different speeds. More RNAV 5 routes will be established between 2010 to 2012 to avoid discontinuity of routes. RNAV 2 Routes will be introduced beginning 2013.

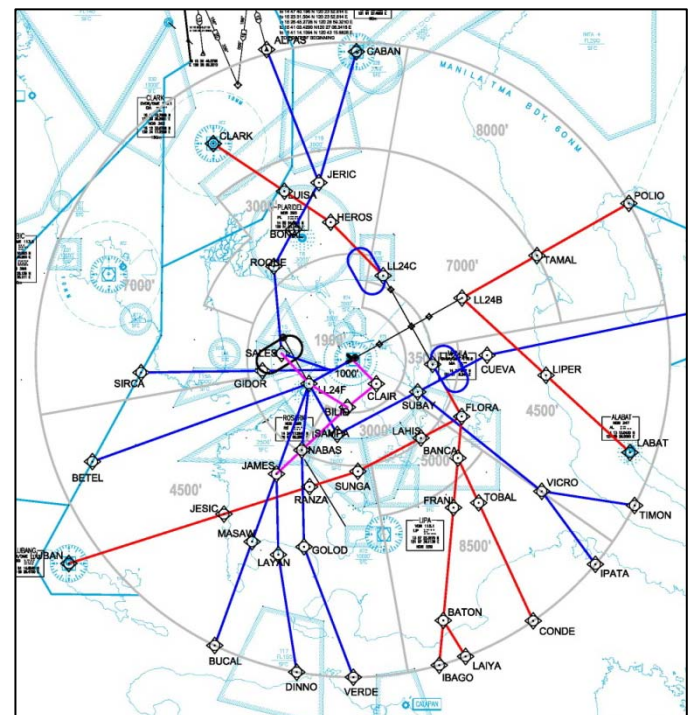


TERMINAL

Airport, Diosdado Macapagal International Airport and Subic Bay International Airport.



Easing the congestion of traffic in NAIA will be given priority. Moreover, the application of specific procedures such as a continuous descent operations (CDO) will be incorporated in the design which can help operators save on fuel consumption through the application of optimized profile descents.



Short Term

RNAV 1 SID/STARs will be introduced to help controllers keep up with the growing traffic demand at the terminal airspace. The RNAV 1 specification will be established between 2010-2012 in the following airports with terminal radar and considering the increasing number of flights in these airports: Mactan-Cebu International

Medium Term

From 2013 to 2016, SID/STAR with RNP 1 specifications will be applied to non-radar terminal airspaces of the following airports: Laoag, Puerto Princesa, Davao, Tambler, Zamboanga, Kalibo, Bacolod, Tacloban, Cagayan De Oro, Iloilo and Roxas. Upon operators' requests, RNP1 departure and arrival routes will be set up in Legaspi, Butuan and Dumaguete APs to improve accessibility in the said airports.



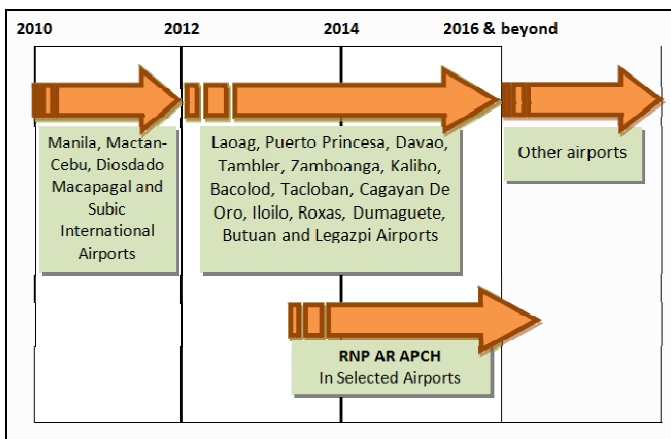
Long Term

Mandating RNP 1 in busy airports such as NAIA, MCI, and DMIA (which requires higher level of navigational performance and FMS functionality) is among the long term goals of this PBN Plan.

initial approach fixes of conventional approach procedures. This will serve as back-up to precision approaches and provide vertical guided approaches for runways without precision approach capability.

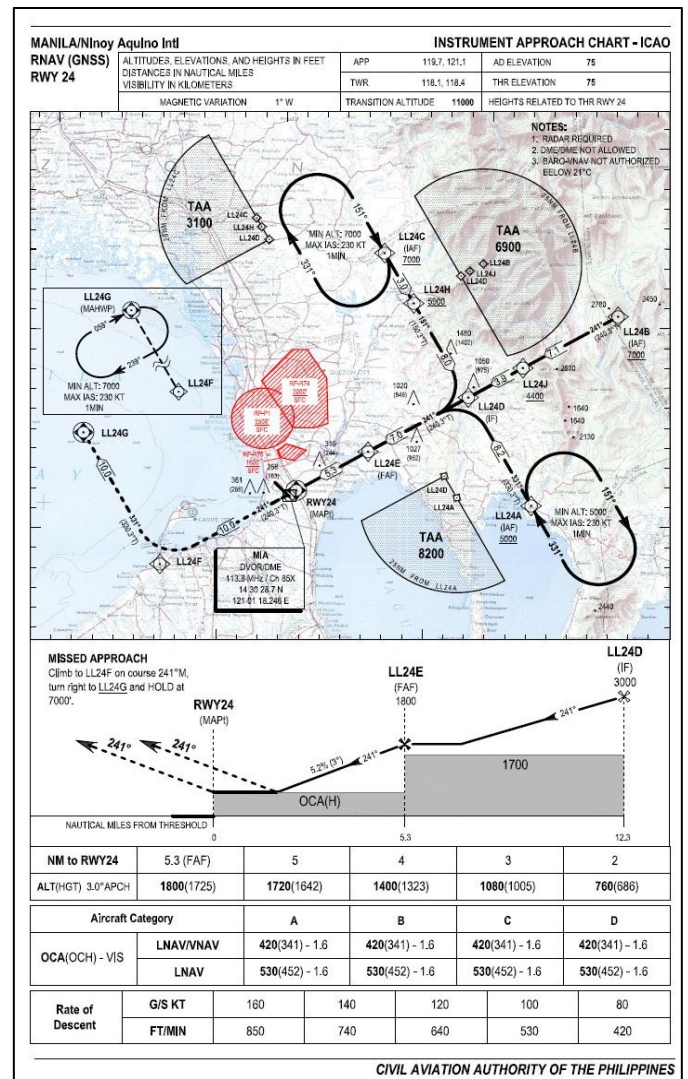
It is expected that mixed traffic environment will

APPROACH



Designing conventional approaches will be kept to a minimum. Mostly RNP APCH has been developed in the year 2010. Non-precision approaches will be maintained throughout the operational life of the navigational aids. ILS approaches will be maintained and a periodic review of the procedures will be conducted every five years or as the need arises.

The initial approach waypoints of RNAV procedures will be designed as overlay of existing





keep air traffic controllers busy. The new approach procedures will be designed as an overlay of existing approach procedures to prevent increasing the air traffic controller workload.

During the transition, the new procedures may be implemented during designated hours of the day where RNAV capable aircraft are expected to achieve greater operational benefits.

Short Term

Re-assessment of the existing RNAV (GPS) approach procedures of NAIA, MCI, DMIA and SBIA using PBN criteria is ongoing. Practicability of the design will be studied considering the design had a specific operator's requirements. The RNP APCH with APV Baro-VNAV will be introduced in the country's international airports between 2010 to 2012.

High traffic domestic airports will be included in the short term priority such as Davao, Butuan, Dumaguete and Tagbilaran airports all located south of Manila. Except for Davao AP, the three airports mentioned have no existing conventional approaches. These airports will be prioritized to increase airport accessibility and to enhance flight safety.

Medium Term

Designing RNP approaches utilizing GNSS will be continued in non-radar airports in the second phase of RNP APCH implementation. Medium to high traffic domestic airports include Puerto Princesa, Cagayan de Oro, Iloilo, Bacolod, Tacloban, Zamboanga, Tambler, Kalibo, Roxas, Cotabato, Laoag and Legaspi Airports.

To improve accessibility to terrain challenged airports, RNP AR approaches with RF turns will be designed if necessary.

Long Term

RNP APCH procedure will be designed for other domestic airports. VFR airports will be upgraded based on traffic statistics, operator's requests and traffic forecasts.

CAAP will monitor the development of approach technology that use satellite-based navigation such as GBAS and study the feasibility of introducing such technology to the country's airports.

Benefits of PBN



Safety and Accessibility

Developing airport arrival and departure paths in all weather conditions will increase airport accessibility thus avoiding aircraft diversions. Conventional approach procedure can not be established in some airports like Legaspi and Dumaguete Airports because of terrain limitations. The possibility of meeting critical obstacle clearance and environmental requirements through the application of optimized RNAV or RNP paths will allow safe aircraft operations. Since establishing RNAV procedures will not require installing expensive sensors such as VOR or NDB, more airports will be accessible.

APV, when established in airports, will serve as back-up to airports with precision approaches and for airports without precision approach capability, APV will provide vertically-guided approaches for runways. It will also allow aircraft operations to continue even during outages of ground navigational aids (ILS, VOR or NDB).

A more stabilized approach will be expected since the design of RNP APCH procedure allows the final approach course to be aligned with the runway centerline. Re-designing existing conventional procedures as overlay of RNP APCH will be an option to increase safety of aircraft operations.

Efficiency

Efficient use of airspace may be achieved through RNAV implementation. Establishing RNAV routes is one of the measures considered to address the problem of congestion especially in the airspace of Manila. Reduction of crossing points and installation of check points shall be considered in the design of STARs and SIDs to reduce aircraft proximity incidents. The end of RNAV arrival routes shall be connected to the initial approach fix of the approach procedure providing straight-in approaches thereby increasing operational efficiency.

Through the specified navigational specification, reduced lateral and longitudinal separation between aircraft may be applied to accommodate more traffic. As previously mentioned, 60 NM lateral separation has been reduced to 50 NM in 2010 on the four parallel RNP 10 routes in the Manila FIR which increased airspace capacity.

Economy

Aircraft operators will benefit in the reduced track miles of en-route, departure and arrival routes. Arriving traffic required to execute a procedure/base turn in conventional approaches will be minimized considering that the end of the



RNAV arrival route is connected to the initial approach fix thereby reducing track miles.

Continuity of RNAV routes from departure to arrival shall be ensured. The location of ground sensor is insignificant in enroute design allowing for more direct routing.

Continuous Descent Operations (CDO) technique will be considered in the design of arrival routes to maximize the benefit of reducing fuel burn.

Environmental Impact

Any reduction in track miles of any aircraft operation will decrease the amount of fuel burned and carbon emission. The flexibility of the RNAV concept will be maximized so that routes can be designed to avoid noise sensitive areas. Continuous Descent Operations (CDO), shorter distances with optimized climb and descent profiles, will help reduce the impact of aircraft noise within airport vicinity.





Safety Assessment

Safety assessment shall be conducted to evaluate the risks associated with the introduction of new RNAV procedures every airport. The effects of the proposed change will be evaluated to help set the safety objective(s) for every hazard identified and establish the means to mitigate the effect(s) of the foreseen risk(s).

Safety assessment cycle shall be applied to all airports given the uniqueness of situations in each airport.

Pre-Implementation

All stakeholders shall be included in the operational hazard assessment including the effect on ATC and pilots. CAAP shall develop the PBN Operational Approval Manual to ensure that aircraft and aircrews are qualified to fly the new RNAV procedures.

It is important to assess the readiness of ATCs to identify points of confusion and prevent resistance against introduction of new procedures.

Evaluation of ATC competency shall be conducted during the transition period taking into account RNAV and non-RNAV capable aircraft sharing the same airspace.

Surveillance and Monitoring

Continuous surveillance shall be conducted throughout the implementation period to determine whether the goals were reached or not. Factors that caused failure to meet targets on time and to formulate mitigating measures to ensure that the objectives are met to create effective alternatives if the goals are not met as planned.

Post-Implementation

A post-implementation review at the end of each period will be conducted to assess the PBN implementation's success or shortcomings. This will become the basis for the succeeding stage of implementation to refine planning and evaluate whether the objectives of CAAP's PBN Implementation Plan has been achieved.