Draft PBN Implementation Plan Papua New Guinea

Version 1 **12 April 2011**

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Acronyms

The following is a list of acronyms used in this document:

4DT	Four Dimensional Trajectory
ADS-B	Automatic Dependent Surveillance - Broadcast
ADS-C	Automatic Dependent Surveillance - Contract
ANSP	Air Navigation Service Provider
APCH	Approach
APV	Approach Procedures with Vertical Guidance
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Service
AWS	Automated Weather Station
Baro-VNAV	Barometric Vertical Navigation
CASA	Civil Aviation Safety Authority
CAR	Civil Aviation Rules
CDO	Continuous Descent Operations
CFIT	Controlled Flight into Terrain
CNS/ATM	Communication Navigation Surveillance/Air Traffic Management
CPDLC	Controller Pilot Data Link Communications
CTA	Controlled Airspace
DME	Distance Measuring Equipment
ETS	Emissions Trading Scheme
FANS	Future Air Navigation System
FMS	Flight Management System
GHG	Greenhouse Gas
GNSS	Global Navigation Satellite System
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INS	Inertial Navigation System
IRU	Inertial Reference Unit
MSSR	Mono-pulse Secondary Surveillance Radar
NAC	National Airports Corporation
NDB	Non Directional Beacon
PNGASL	Papua New Guinea Air Services Limited.
PNGDF	Papua New Guinea Defence Force
OCA	Oceanic Control Area
PBN	Performance Based Navigation
PSR	Primary Surveillance Radar
RAIM	Receiver Autonomous Integrity Monitoring
RCP	Required Communication Performance
RSP	Required Surveillance Performance

RNAV	Area Navigation
RNP	Required Navigation Performance
RNP AR	Required Navigation Performance Authorisation Required
SID	Standard Instrument Departure
STAR	Standard Instrument Arrival
TMA	Terminal CTA
VOR	VHF Omni-directional Radio-range
WAM	Wide Area Multilateration

Executive Summary

The implementation of Performance Based Navigation (PBN) in Papua New Guinea (PNG) controlled airspace will be delivered in three major phases with target implementation dates of 2013, 2017 and 2020.

Each phase will enable progressively greater dependence on PBN (concepts and enablers) and ensure that the corresponding improvements to safety, efficiency and environmental impact are delivered to industry stakeholders.

The implementation of PBN in Papua New Guinea controlled airspace will require the allocation of significant resources by each of the key industry stakeholders and the Civil Aviation Safety Authority (CASA). This investment is considered essential to securing the benefits for Papua New Guinea at the earliest opportunity. The benefits include:

- Safety improvements through greater adherence to a safe flight trajectory (e.g. use of Continuous Descent Operations (CDO) which is a key component of the ICAO strategy to address Controlled Flight into Terrain (CFIT) accidents).
- Efficiency improvements through changes to air route and approach procedure designs that minimise the air miles flown and enhance schedule reliability, provide greater conformance to the flight plan and reduce enroute traffic delays, which will collectively reduce total operating costs and improve on-time performance.
- Improved environmental performance through greater use of uninterrupted climb and descent trajectories which ensure that both Green House Gas (GHG) emissions and the noise footprint for aviation are minimised.

The key roles for stakeholders are:

CASA – Ensure that the relevant Safety Cases, CASA processes, Civil Aviation Rules and guidance material enable a safe and efficient PBN environment that aligns with both international and regional standards.

Aircraft Operators – Ensure that investment in aircraft fleet capability is aligned with both the performance specifications outlined in this plan and the timeframe associated with each phase.

PNG Air Services Limited (PNGASL) – Ensure that the national infrastructure (CNS/ ATM capability) will support the airspace concepts and the performance specifications associated with each phase of PBN implementation.

Aerodrome Operators – Ensure the supporting aerodrome infrastructure for PBN operations is coordinated with aircraft operators and PNGASL.

All Stakeholders ensure that sufficient trained and qualified personnel are available to support the implementation of PBN.

Introduction

ICAO Assembly Resolution A36-23 urged each member State to develop a national PBN implementation plan by the end of 2009, and for these plans to include Approach Procedures with Vertical guidance (APV) for all instrument runway ends, either as the primary approach or as a back-up for precision approaches, by 2016.

In Papua New Guinea, implementation of RNAV, RNP and APV procedures is now well advanced. The Civil Aviation Safety Authority, together with PNGASL and with the support from principle aviation industry stakeholders and interest groups have agreed that a State PBN Implementation Plan is needed to ensure that all sections of the industry are consulted and engaged appropriately in the change process.

The PBN Implementation Plan for PNG meets the intent of ICAO Assembly Resolution A36-23 and addresses the particular needs of the PNG aviation environment. The draft plan outlines how the ICAO PBN concept will be implemented in PNG to deliver improvements to: aviation safety, airspace access, capacity, predictability, operational efficiency and to minimise adverse environmental impacts from aviation activity. This plan is not binding and will be subject to change as PBN developments and user requirements evolve.

Both the ICAO Global and Regional PBN implementation plans provide a framework for the development of a National PBN Implementation Plan to enable a coordinated and cohesive global implementation programme for the aviation industry. This plan will enable the use of RNAV and RNP capabilities that will, when harmonised with ATM systems, deliver more efficient routes and predictability of service for the air transport industry, together with greater access to limited airspace resources for general aviation.

A PBN environment will deliver significant safety, economic and environmental benefits to all stakeholders. This is especially important as PNG and the rest of the world faces challenges from difficult economic conditions, volatile aviation fuel prices and climate changes driven by global warming.

The strategic objectives of the PNG PBN Implementation Plan are to:

1. Provide a high-level strategy for the evolution of navigation applications to be implemented within PNG airspace in the short term (prior to December 2013), medium term (2014-2017) and long term (beyond 2018) in accordance with the implementation goals of Assembly resolution A36-23 and also in line with the ICAO Asia Pacific Regional PBN Implementation plan;

2. Implement a strategy based on the concepts of PBN (includes RNAV and RNP specifications), that will be applied to IFR aircraft operations using instrument approaches, and ATS routes (including SIDs and STARs) in both oceanic and domestic airspace;

3. Ensure that the implementation of the navigation portion of the CNS/ATM system is based on clearly established operational requirements;

4. Ensure that navigation, surveillance, communications and ATM infrastructure is capable of supporting the operational airspace concept and the associated operational applications;

5. Establish equipment requirements that minimise the number of equipment types required on board aircraft and on the ground;

6. Establish common airworthiness and operational approvals for flight operations utilising PBN;

7. Provide a means of accommodating mixed-equipage operations; and

8. Recommend strategies to facilitate delivery of benefits and encourage equipage.

The PNG PBN Implementation Plan has been developed in consultation with the stakeholders of the aviation community and provides for a staged transition to RNAV and RNP based procedures. The following stakeholders have been consulted during the development of the National PBN Implementation Plan:

(a) Airspace operators and users (including PNGDF)

(b) PNGASL (air navigation services provider) and neighboring ANSP

(c) CASAPNG and Regulating Authorities from adjacent ICAO States

(d) National and international organizations

Refer to Appendix A for a list of aviation industry organizations consulted during the development of the Draft PBN Implementation Plan.

The PBN Implementation Plan will enable stakeholders of the aviation community to plan for regulatory changes, industry training, operational transitions and the associated investment strategies.

The following principles were applied in the development of the PBN Implementation Plan:

(a) Continued availability of essential conventional air navigation procedures during the transition period, to ensure appropriate technology and procedures design support for users that are not RNAV and/or RNP compliant;

(b) Development of airspace concepts and use of airspace modelling tools that enable real-time and accelerated simulations that identify the navigation applications that best support PBN implementation in specific airspace;

(c) Conduct of cost-benefit analyses to justify the implementation of the RNAV and/or RNP concepts;

(d) Conduct of pre- and post-implementation safety assessments to ensure the application and maintenance of the established target levels of safety.

(e) Harmonisation with the ICAO Asia/Pacific Regional PBN Implementation Plan.

An issue register has been developed and updated covering a range of issues to be addressed. This register will be used to identify work areas, resource requirements and organizations responsible for action. A work plan will then be developed with identified working groups, including technical representatives, to address these issues to ensure the PBN Implementation Plan is progressed.

Information on PBN developments and implementation work will be provided on the CASA PNG website http://www.casapng.gov.pg

The PBN Implementation Plan

1. Background

Ground based navigation aids (Navaids) have been the basis of IFR navigation for aircraft since the Second World War. Papua New Guinea has relied upon a network of ground based navigation aids (NDB, VOR/DME and ILS), which aircraft use to navigate along fixed routes (route navigation) and to conduct instrument approach procedures to land at aerodromes.

Ground based navigation systems limit the safety and efficiency of aircraft operations because of their inherent characteristics e.g. with the exception of ILS, they do not support approaches with vertical guidance. Ground navaids are constrained by the location, accuracy, terrain and other performance limitations associated with the aid.

To overcome the constraints of route navigation new navigation specifications have been developed to provide performance specifications firstly through RNAV specifications and more recently Required Navigation Performance (RNP). These are based on new navigation technologies including Global Navigation Satellite System (GNSS) and onboard aircraft systems. Area navigation allows an aircraft to fly any pre-defined path with high accuracy. The flight path is usually defined as a straight line between two points in space but some systems also have the capability to accurately fly curved paths. Area navigation systems generally have linear lateral performance requirements and they are recognised as necessary enablers to optimise aircraft operations, increase terminal area safety and provide flexibility in placement of aircraft flight path to minimise aircraft noise intrusion on the community. The key difference between the RNAV and RNP specifications is the onboard monitoring and alerting function that is associated with RNP.

The PBN concept represents a major shift from sensor-based to performance-based navigation.

The significant improvements in navigational performance provided by RNP and four dimensional trajectory (4DT - includes time dimension) will also be utilised by modern ATM systems to improve the sequencing of IFR Flights. Any sequencing delays that are needed in the future will be managed in a more strategic manner so that excess fuel burn can be minimised. This will deliver reduced operating costs to aircraft operators and improved environmental outcomes to both the local and global community.

2. Area Navigation (RNAV)

2.1 Capabilities

RNAV is the less capable of the two families of PBN navigation specifications. RNAV is suited to current and legacy aircraft operations however as a stand-alone specification it is insufficient to support many of the new Air Traffic Management (ATM) applications envisaged in strategic plans (eg: 3D, 4D ATM concepts).

2.1.1 The RNAV Specifications are:

(a) RNAV 10: intended for use in en-route Oceanic airspace (referred to as RNP 10. Explanation of this usage is provided in the ICAO PBN Manual Vol.1 para. 1.2.5.5)

(b) RNAV 5: intended for enroute navigation with future transition to RNP 2.

(c) RNAV 2: intended for use in Domestic Enroute airspace

(d) RNAV 1: intended for use in Domestic Terminal airspace and enhanced where required by the provision of SIDs and STARs.

RNAV specifications do not require on board navigation performance monitoring and alerting. RNAV tracks (e.g.: RNAV 5, RNAV 2, RNAV 1) will normally require monitoring by ATC surveillance systems to achieve desired performance and separation safety standards. This requirement implies near universal surveillance coverage for RNAV specifications. In oceanic airspace this surveillance is provided by ADS-C and in domestic airspace by a network of radar systems (PSR & MSSR). The surveillance of domestic airspace will also include WAM (Wide Area Multilateration) and ADS-B when these systems are approved and operational.

3. Required Navigation Performance (RNP)

3.1 Capabilities

RNP is the more capable of the two families of PBN navigation specifications having on board navigation performance monitoring and alerting. The on board navigation performance monitoring and alerting is a necessary enabler for many new ATM applications.

3.1.1 The RNP Specifications are:

(a) RNP 4: intended for use in oceanic operations (supports 30/30 separation)

(b) RNP 2: intended for use in continental en-route operations

(c) RNP 1: intended for use in terminal area operations

(d) RNP APCH

(e) RNP AR APCH

3.1.2 The RNP Approach Applications for PNG are:

(a) RNAV (GNSS) approach; which represents the application of RNP APCH navigation specification. This application can include APV where required and operationally feasible.

(b) RNAV (RNP) approach; which represents the application of RNP AR navigation specification. Barometric VNAV is an integral part of this application.

Both of these applications require the use of GNSS for navigation.

3.1.3 Responsibility for Navigation Performance Monitoring

RNP specifications require on board navigation performance monitoring and alerting. This assured aircraft performance allows lower separation standards to be applied and therefore ATC surveillance is not required.

Some of the RNP navigation specifications enable the application of more sophisticated functions available in RNP capable aircraft to further improve safety, reduce environmental impact and increase operating efficiency (e.g.: RNP AR APCH).

4. Current Status of RNAV & RNP Operations in Papua New Guinea

4.1 Published Procedures

RNAV and RNP procedures have been implemented within PNG airspace at selected airports and on selected routes based on performance specifications that align with those in the PBN Manual.

(a) RNP 10 (RNAV 10) and RNP 4 in Oceanic Airspace

(b) RNAV(GNSS) approach procedures at 17 locations.

(c) RNAV (GNSS) Arrival and departure procedures at selected regional aerodromes (Basic RNP 1 application).

4.2 Aircraft Fleet Equipage

As at December 1 2010 there are approximately 100 aircraft with PBN capability on the PNG Civil Aircraft Register. This is a significant proportion of the IFR capable fleet. However there is a diverse range of navigational capabilities of the aircraft operating in PNG airspace. The following table indicates the estimated state of PBN technical capability of major scheduled carriers in PNG as of December 2009:

Figure 1 – Current Estimated Airline Fleet PBN Capability

Aircraft Type	RNAV 2/ 1	RNP APCH Basic RNP 1	RNP AR APCH	APV (Baro-VNAV)
B767				
B757				
Fokker 100				
ATR 72				
DH8-Q400				
DH8-300				
DH8-200				
DH8-100				
L328				
Fokker 50				
DH6				

5. Airspace Concept

An airspace concept may be viewed as a general vision or a master plan for a particular airspace. Each airspace concept is based on an agreed set of principles that support the achievement of specific objectives. The strategic objectives which most commonly drive airspace concepts are safety, capacity, efficiency, access and the environment.

5.1 Key Airspace Concepts

The agreed concepts for PNG will be implemented through a three-phase process that will deliver incremental improvements to:

- Safety improvements (through more precise trajectory management & CDO that support the ICAO strategy to address CFIT accidents)
- Predictability and repeatability
- Efficiency (min air distance / optimum aircraft determined profile)
- Minimising environmental impact (eg from carbon dioxide, oxides of nitrogen and noise)
- Maximising capacity utilisation (aerodrome & airspace)
- Higher aircraft utilisation (sectors flown per day)
- Schedule reliability
- Cost effective investment
- Minimised quantity of CTA and optimised design

All ATS routes will be enabled by RNAV (or RNP, where required):

All runway ends with instrument approach procedures will be enabled by RNP (with APV where possible based on Baro-VNAV).

5.2 Operational Concept for Phase One

During Phase One the operational concept will be a mixed-mode navigation environment that allows continued use of legacy navigation applications while PBN capability is progressively implemented in aircraft fleets and the supporting infrastructure. The benefits to operators will be limited by the diversity of navigation performance and the ATM system's ability to manage this diversity. The ground infrastructure associated with legacy navigation systems will be reviewed and progressively adapted to reflect the progress made on implementation of PBN. General aviation VFR flight access to CTA will not be subject to any additional restrictions during this phase.

5.3 Operational Concept for Phase Two

During Phase Two the operational concept will move to a more exclusive PBN environment that places greater reliance on the level of PBN capability in the national fleet and infrastructure. This change will enable further realisation of the goals outlined in para 5.1. The ATM system will be managing a more homogeneous navigation capability and have greater ability to minimise the negative impact of aircraft that lack required navigation performance capability. General aviation VFR flight access to CTA may be restricted during periods of capacity constraint but only to the extent needed to ensure that the flight paths of PBN capable flights are not restricted.

5.4 Operational Concept for Phase Three

During Phase Three the operational concept will be a mature PBN environment with a comprehensive fleet and infrastructure capability that delivers the fullest expression of the airspace concept and goals outlined in para 5.1. A mature set of ATM tools will complement the airborne systems and will also enable the effective management of those aircraft that may experience a temporary loss of PBN capability without significantly impacting other airspace users. General aviation VFR flight access to CTA may be restricted during periods of capacity constraint but only to the extent needed to ensure that the flight paths of PBN capable flights are not restricted.

6. Challenges

6.1 Safety - Risks Associated with Major System Change

During the transition to a mature PBN environment the government and industry will face significant challenges. The government challenges will include support of Civil Aviation Rule changes and associated preparatory work. The industry challenges will involve resourcing and managing a diverse range of navigation systems with equally diverse requirements. Some of the key identified challenges are:

- Adoption of supporting Civil Aviation Rules
- PBN capability register and aircraft minimum equipment lists (MEL)
- Integration of PBN capability into the ATM system (Flight Plan data fields)
- Mixed fleet/system operations
- Safety monitoring of ATM system
- Approach naming and charting conventions
- Navigation database integrity and control
- GNSS system performance and prediction of availability service
- Continued involvement in CNS/ATM and PBN development
- Resources of the CAA, Airways and industry to implement PBN
- Education and training of personnel employed by the CASA, PNGASL and aircraft operators

6.2 Environment

Environmental challenges include minimising the impact of noise and emissions on both the communities in the proximity of aerodromes and the global environment. PBN will support the achievement of these goals while preserving aviation safety and efficiencies in the ATM system, but a collaborative approach will be essential to deliver all these objectives. The introduction of PNG's emission trading scheme (ETS) provides aircraft operators flying domestic routes with a commercial incentive to upgrade their fleet, including PBN capability. With the introduction of regional or global emissions trading schemes for aviation, this commercial incentive could significantly increase and extend to international aircraft operators flying to and from PNG.

Environmental challenges therefore include:

(a) Political developments/considerations

- Increased ATM system capacity due to PBN efficiency gains
- Emission control/management, including demonstrated efficiencies associated with PBN operations
- Noise control/management

(b) Technological developments

- Tension between noise outcomes and emissions reduction outcomes

6.3 Infrastructure Development

Design and implementation of RNAV routes and procedures is well advanced. Certificated Part 173 Procedure Design organisations have a significant workload in turning the design work into published documents. The following issues need to be addressed by CASA, PNGASL and the aviation industry:

(a) Terrestrial navaids

- Maintenance and upgrade of existing terrestrial navigation aid infrastructure
- Transition to GNSS based system
- Decommissioning of existing aids

(b) GNSS/RAIM prediction requirements including

- Overall GNSS status monitoring, reporting and recording
- Prediction of availability for a particular operation and aircraft

(c) Automatic Weather Station (AWS) for APV Baro-VNAV

- Implementation will require coordination between CASA, PNG NWS Met Service, PNGASL and NAC including other aerodrome operators
- Responsibilities for funding of these initiatives will need to be determined

(d) Approach design

(e) Runway infrastructure

- Aerodrome obstacle survey
- Aerodrome lighting (approach and surface)

(f) Use of GNSS

- Use of GNSS within PNG airspace is subject to the requirements of PNG CAR Part 91. The current Rule does not account for improvements to GNSS performance that have evolved over the last fifteen years and does not allow “Sole Use” navigation for domestic IFR flights. The limitations of the current Rule need to be removed to enable greater use of GNSS to support RNAV, RNP and new surveillance technologies.
- A formal Safety Case will need to be developed to determine whether the performance of GNSS within PNG airspace is adequate to support the planned increase in reliance on this technology by the aviation industry.

(g) DME/DME updating

RNAV 1 and 2 specifications require infrastructure support from either GNSS or DME/DME updating capability. The capability of the existing DME network to support DME/DME updating needs to be verified to ensure it will be adequate for planned future use in both en-route and terminal airspace.

7. Operational Efficiency Benefits

(a) Efficiency gains enabled through PBN include:

- Reduced separation standards for air traffic routes in oceanic and some portions of domestic en-route airspace
- Greater flexibility of airspace design in terminal area airspace
- Reduced track distance, noise and fuel consumption through PBN enabled ATS routes and approach procedures
- Reduced environmental impact.

(b) The synchronised integration of PBN and non-PBN air routes, airspace and aircraft will be vital if these efficiency gains are to be fully realised.

8. Approaches with Vertical Guidance

PBN approaches with vertical guidance in PNG will be based on Baro-VNAV specifications for the foreseeable future. The development of a GNSS enabled precision approach application will be monitored closely but early adoption is considered unlikely due to interoperability issues and the lack of suitable GNSS augmentation systems within PNG's airspace.

The PNGASL Aeronautical Design and Development Unit has an implementation schedule for En-route, Terminal and Approach procedures in PNG detailed in Appendix.

9. Implementation

9.1 Short Term (PNG Implementation Target December 2013)

The ICAO time frame for short term implementation is 2011 – 2013.

9.1.1 En-route

Oceanic – Retain RNP 10 (RNAV 10) and RNP 4 with existing communications and surveillance requirements (CPDLC and ADS-C where necessary to support application of 30/30 separation standards).

As at December 2010, approximately 50% of current PNG oceanic airspace users are FANS 1A capable and therefore able to benefit from the 30/30 separation standard: traffic forecasts do not indicate capacity will be constrained with current standards.

Domestic – Specify RNAV 2 for all promulgated routes above A145 or FL245 in domestic CTA, subject to infrastructure capability.

Surveillance will be provided by the existing MSSR network, supplemented by ADS-B and WAM systems when these are commissioned, integrated with the ATM system and certified for use.

Communications provided by VHF network.

ATM system capability as available in 2011.

9.1.2 Terminal Areas (Departures and Arrivals)

Specify RNAV 1 for all terminal routes with surveillance services and **Basic RNP 1** for routes without surveillance services.

Where a surveillance service is available, it will be provided by the existing PSR/ MSSR network, supplemented by ADS-B and WAM systems when commissioned, integrated with the ATM system and certified for use.

Communications provided by VHF network.

ATM system capability as available in 2011.

9.1.3 Approach Procedures

Facilitate a mix of ground based approaches, RNP APCH (RNAV GNSS) including Baro-VNAV enabled Approach with Vertical Guidance, where possible and RNP AR APCH.

Where a surveillance service is available, it will be provided by existing PSR/MSSR network or ADS-B and Wide Area Multilateration systems when these are commissioned, integrated with ATM system and certified for use.

Communications provided by VHF network.

ATM system capability as available in 2011.

9.1.4 Helicopter Operations

No change to existing procedures but will be implemented as required.

9.2 Medium term (PNG Implementation Target 2017)

The ICAO time frame for the medium term is 2013 – 2017.

9.2.1 En-route

Oceanic – RNP 10 (RNAV 10) & RNP 4 (with CPDLC & ADS-C) in OCA CTA. There are no operational drivers to change navigation performance requirements from those used in phase one.

Domestic – RNAV 2 (Exclusive airspace above A145). Surveillance will be provided by the existing MSSR network or ADS-B and WAM systems.

Communications provided by VHF network.

ATM system capability as available in 2011.

9.2.2 Terminal Areas (Departures and Arrivals)

Terminal CTA – RNAV 1 & Basic RNP 1 (Exclusive airspace). Where a surveillance service is available, it will be provided by the existing PSR/MSSR network or by ADS-B and WAM systems when these are commissioned, integrated with ATM system and certified for use.

Communications provided by VHF network.

ATM system capability will be enhanced with:

a) An improved version of the Collaborative Arrival Manager (CAM) and;

b) New ATC tools designed to improve sequencing of arrivals and departures and;

c) Improved ATM system trajectory modelling.

9.2.3 Approach Procedures

Approach Procedures – RNP APCH (RNAV GNSS) with APV where possible & RNP AR APCH.

Where a surveillance service is available, it will be provided by the existing PSR/ MSSR network or ADS-B and WAM systems when these are commissioned, integrated with ATM system and certified for use.

During this phase transition away from dependency on ground based approaches with the exception of ILS at major international airports and those ground based approaches that are considered essential for contingency purposes.

Communications provided by VHF network.

9.2.4 Helicopter operations

As per the medium term for aircraft operations listed above but further approach design criteria changes are expected from ICAO over the period 2010 – 2011. These will be incorporated as considered appropriate.

9.3 Long term (PNG Implementation Target 2021)

The ICAO time frame for the medium term is 2018 – 2022)

9.3.1 En-route

Oceanic – RNP 10 (RNAV 10) & RNP 4 (with CPDLC & ADS-C) in OCA CTA. There are no operational drivers to change navigation performance requirements from those used in phase one / two.

Domestic – RNAV 1 / RNP 1 exclusive airspace above A145. Retain a minimal contingency infrastructure using terrestrial navigation systems (a VOR/DME network).

Surveillance provided by ADS-B with limited WAM contingency for the core of the main trunk network.

Communications provided by VHF network and possibly CPDLC.

9.3.2 Terminal Areas (Departures and Arrivals)

Terminal CTA – RNP 1 exclusive airspace (& Advanced RNP 1 limited to locations with specific operational requirements).

Retain minimal contingency infrastructure using terrestrial navigation systems (VOR/DME network).

Surveillance provided by ADS-B with limited WAM contingency for core of main trunk network.

Communications provided by VHF network and possibly CPDLC.

9.3.3 Approach Procedures

Approach Procedures - RNP APCH (RNAV GNSS) with APV where possible & RNP AR APCH. The standard approach procedure will be GNSS based.

Consider location specific application of GNSS based precision approach where operational requirement and business case justifies this application.

Retain ILS at major international airports and those ground based approaches considered essential for contingency purposes.

Surveillance provided by ADS-B with limited WAM contingency for key airports in the network.

Communications provided by VHF network and possibly CPDLC.

9.3.4 Helicopter Operations

As per Long Term for aircraft operations listed above but with some special helicopter requirements.

10. Technology Recommendations

Aircraft equipment and ATM requirements will change as PBN is implemented with new technology needing to be utilised in the aviation system. These include the following which will be reviewed by the PBN technical groups to set specific timeframes and requirements.

10.1 GNSS Equipment

These requirements will be determined based on new equipment availability and industry developments. There will be a transition from single GPS to multi-constellation GNSS equipment.

This may include requirement for TSO C145/146 from 2018.

10.2 ATC Transponder

Possibly by 2012 the Transponder requirements will need to become Mode-S Elementary (minimum) and Mode-S Enhanced (recommended). Additionally ADS-B using Modes-S 1090Mhz extended squitter (DO260A or later) will be implemented toward the final phase in 2018.

Appendices

Appendix A – List of PNG organisations consulted and representative details

Organisation	**Title**
PNG Air Services Limited	Chief Operating Officer
PNG Air Seravices Limited	Executive Manager and Industry liaison
Air Services Australia	Senior Engineer Corporate and International Affairs
Air Services Australia	Corporate and International Affairs
ASA	Aeronautical Operational/Engineer advisor
Air Niugini	General Manager Operations
Airlines PNG	General Manager, Line Operations
Civil Aviation Safety Authority	Flying Operations Inspector (Airways)
Civil Aviation Safety Authority	Chief Operating Officer
PNG ASL	Managing Director
Civil Aviation Safety Authority	Representative on ATM project
PNGDF	Director of Operations
PNGDF	Commanding Officer Air Wing
Civil Aviation Safety Authority	Director & CEO
Civil Aviation Safety Authority	Team Leader – Flying Operations
Civil Aviation Safety Authority	ATS & ANS Inspector
National Airports Corporation	
PNG ASL	Executive Management