



Performance Based Navigation Implementation Plan – Revised 2017 New Zealand



Ministry of **Transport**
TE MANATU WAKA



Civil Aviation Authority of New Zealand (The CAA)

Level 15, 55 Featherston Street

P O Box 3555, Wellington, New Zealand.

T +64 4 560 9400

F +64 4 560 2024

E info@caa.govt.nz

www.caa.govt.nz

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Primary author:

Ray Harvey, Manager Aerospace Programmes, CAA

Supported by:

Steve Kelly, CRUX Navigation

Peter White, Aeronautical Services Officer, CAA

David Harrison, Principle Aviation Examiner, CAA

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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
AMAN	Arrival Manager
ANSP	Air Navigation Service Provider
APCH	Approach
APV	Approach Procedures with Vertical Guidance
ATC	Air Traffic Control
ATM	Air Traffic Management
ATPL	Air Transport Pilot Licence
ATS	Air Traffic Service
Baro-VNAV	Barometric Vertical Navigation
CAR	Civil Aviation Rule
CCO	Continuous Climb Operations
CDO	Continuous Descent Operations
CFIT	Controlled Flight Into Terrain
CNS/ATM	Communication Navigation Surveillance/Air Traffic Management
CONOPS	Concept of Operations
CPDLC	Controller Pilot Data Link Communications
CPL	Commercial Pilot Licence
DME	Distance Measuring Equipment
ETS	Emissions Trading Scheme
FANS	Future Air Navigation System
FMS	Flight Management System
GANP	Global Air Navigation Plan
GBNA	Ground Based Navigation Aid
GBNA RP	Ground Based Navigation Aid Review Panel
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HF	High Frequency
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INS	Inertial Navigation System
IR	Instrument Rating
IRU	Inertial Reference Unit
LNAV	Lateral Navigation Guidance
LRCS	Long Range Communication Systems
MEL	Minimum Equipment List

MON	Minimum Operating Network
MoT	Ministry of Transport
MSSR	Mono-Pulse Secondary Surveillance Radar
MTCA	Medium Term Conflict Alert
NAANP	National Airspace Air Navigation Plan
NAVAID	Navigation Aid
NDB	Non-Directional Beacon
NZDF	New Zealand Defence Force
OCA	Oceanic Control Area
OPD	Optimum Profile Descent
PANS	Procedures for Air Navigation Services
PBCS	Performance Based Communication and Surveillance
PBN	Performance Based Navigation
PBN IWG	Performance Based Navigation Implementation Working Group
PIRGS	Planning and Implementation Regional Groups
PPL	Private Pilot Licence
PSR	Primary Surveillance Radar
RCP	Required Communication Performance
RF	Radius-to-fix
RSP	Required Surveillance Performance
RNAV	Area Navigation
RNP	Required Navigation Performance
RNP AR	Required Navigation Performance – Authorization Required
RNP AR APCH	Required Navigation Performance – Authorization Required Approach
RNP AR DP	Required Navigation Performance – Authorization Required Departure Procedure
SARPS	Standards and Recommended Practices
SBAS	Satellite Based Augmentation System
STCA	Short Term Conflict Alert
SID	Standard Instrument Departure
STAR	Standard Instrument Arrival
TSO	Technical Standard Order
VHF	Very High Frequency
VOR	VHF Omni-directional Radio-Range
VNAV	Vertical Navigation Guidance
WAM	Wide Area Multilateration

Executive Summary

The Civil Aviation PBN Regulatory framework is under review, introducing new navigation specifications and capturing the decisions made regarding aviation infrastructure and operations. The regulatory framework will support implementation of PBN, enabling the stakeholders to focus on achieving a complete PBN environment by 2023, with the reduction of mixed mode operations and optimisation of PBN routes and procedures across New Zealand.

Implementation of PBN is driven by the stakeholders and users of the system focusing on the strategic benefits and objectives outlined in the plan from a national perspective.

The goal of the plan is to focus all stakeholders and users to work collaboratively when considering: safety, operational benefit and impact, implementation costs, infrastructure, environment, state security and resilience and services that support PBN. This should be delivered through the use of coordinated and agreed workgroups and processes.

The plan was first issued in 2009, focusing on satisfying International Civil Aviation Organisation (ICAO) Assembly Resolution A36-23. Since then, ICAO replaced A36-23 with A37-11 which continued to encourage all states to implement PBN while recognising that not all airports have infrastructure to support Approach Procedures with Vertical Guidance (APV) or aircraft operating with the capability to fly APV.

New Zealand has focused on meeting the ICAO requirements and already has a mature PBN environment deployed, with completion of PBN in controlled airspace by 2019 and uncontrolled airspace by 2023.

The objective of this plan is to achieve a full PBN IFR operating environment within New Zealand by 2023. Aircraft operating under IFR will navigate using Global Navigation Satellite System ((GNSS) Global Positioning System (GPS)) as the primary source of navigation. There will be a Minimum Operating Network (MON) of ground based navigation aids to support safe recovery of aircraft in the event of the loss of GPS navigation capability. The MON will also support contingency capability between Auckland, Wellington and Christchurch and in addition provide a contingency capability to most regional airports.

Airspace and infrastructure will be optimised based upon PBN capability. Safety will be improved through PBN procedures with Baro-VNAV to runways where practicable. The ATM system will take full advantage of PBN.

Implementation of a full PBN operational environment is the responsibility of the stakeholders and users of the system (refer to section 6). The state and the stakeholders will focus on deployment based upon the following benefits:

Aviation Safety	Operator Efficiency	Environmental
Airspace Capacity & Efficiency	Operator Accessibility	Societal
Optimisation of Infrastructure	Fuel Efficiency	

1 Background

Ground based navigation aids (conventional navigation) have been the basis of IFR navigation for aircraft since the 1940s. New Zealand has relied upon a network of conventional navigation aids (Non-Directional Beacon (NDBs), Very High Frequency (VHF) Omni-directional Radio-Range/ Distance Measuring Equipment (VOR/DMEs) and Instrument Landing System (ILS)). Aircraft utilise these to navigate along fixed Air Traffic Service (ATS) routes, to conduct instrument departure procedures 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 in that they do not support approaches with vertical guidance (except for ILS), do not support flexible routes, and are expensive to maintain. Navigation aids are constrained by the location, accuracy and other operational limitations associated with the aid. Conventional navigation aids have expanding lateral performance requirements dependant on the distance from the navigation aid. This can impose obstacle clearance and route spacing restrictions.

To overcome the constraints imposed on IFR navigation by conventional navigation aids, PBN utilising RNAV and RNP specifications has been developed. These specifications are based on advanced navigation technologies including GNSS and on-board aircraft systems. Both RNAV and RNP specifications allow an aircraft to fly any pre-defined path between two points in space with a prescribed accuracy. RNAV and RNP navigation specifications have linear lateral performance requirements. This can reduce obstacle clearance areas, enable the optimisation of aircraft operations, increase safety through higher navigation accuracy and provide flexibility in the placement of aircraft flight paths to minimise aircraft noise intrusion on the community.

The significant improvements in navigation performance delivered by PBN and four-dimensional trajectory (4DT) are also being 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 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.

1.1 International Civil Aviation Organisation (ICAO) alignment

As an ICAO member state, New Zealand has followed the advice contained within the ICAO Global Air Navigation Plan (GANP), in developing its own NAANP which was published in 2014.

As outlined in the “PBN implementation Plan – New Zealand 2009”, deployment of PBN was to satisfy the objective of ICAO Assembly Resolution A36-23. In 2010 this was superseded by ICAO Assembly Resolution A37-11, which has been adopted by New Zealand. PBN has been implemented in accordance with the guidance of ICAO PBN Manual (Doc 9613) 4th Edition and associated Standards and Recommended Practices (SARPs).

1.2 New Zealand context

In the years since the “PBN implementation Plan – New Zealand 2009” was published, there have been a number of significant developments that have influenced the deployment of PBN in New Zealand.

The NAANP was developed by the CAA in conjunction with operators and other sector stakeholders, and signed off by Cabinet in June 2014. It follows the guidance of the ICAO Global Air Navigation Plan (GANP), in reviewing Aviation System Block Upgrades (ASBUs). The NAANP selects the appropriate technology and operations for New Zealand, providing a context for a New Zealand aviation system. The NAANP is being delivered by the New Southern Sky (NSS) programme, established in 2014.

The NSS programme focuses on delivery of particular capabilities, enabled by operational and technology change. This is being achieved through a collaborative approach with government agencies and industry, through a variety of working groups and sub working groups.

Decisions and activity since the initial issue of New Zealand's PBN Implementation Plan that have influenced PBN from a New Zealand perspective and have been key in the need for a revision to the plan are:

- GNSS (specifically the GPS constellation) has been selected as the navigation service for deployment of PBN in New Zealand
- New Zealand is aiming for a full PBN operational environment by 2023
- A Ground Based Navigation Aid (GBNA) Strategy has been developed to allow for the rationalisation of the conventional ground based navigation infrastructure to support GNSS based PBN operations. Sector stakeholders are developing recommendations for this strategy.
- The CAA and the NSS programme have considered safety of the aviation system while planning for PBN implementation.
- National security and resilience is being addressed by the MoT and other agencies
- A Concept of Operations (CONOPS) has been developed by NSS stakeholders, to describe the aviation system that will exist in 2023
- CAA has published advisory circulars (ACs) and advice to industry in regard to PBN equipage, approvals and procedures
- Ongoing deployment of PBN has led to a better understanding of implementation processes
- PBN operational and technical workgroups have been established
- Current and future deployment of PBN is driven by the operational needs of the system
- A Civil Aviation Authority (CAA) PBN Regulatory Framework project has been initiated to enable full PBN capability to be delivered as outlined in the CONOPS

This revised plan takes account of the objectives set out in the NAANP and takes consideration of the changes since its original issue in 2009. This plan also focuses on identification of the system stakeholders who are responsible for, or involved in PBN implementation, identifying the need for continued engagement to fully realise the benefits of PBN at an operator and state level.

2 Strategic Objectives

The objective of this plan is to achieve implementation of the selected ICAO ASBUs for navigation, as outlined in the ICAO GANP, and ICAO Assembly resolution 37-11.

It will also achieve the goals of the NAANP which puts the ICAO guidance into a New Zealand aviation system framework.

Specifically, the strategic objectives for New Zealand are to:

- Implement PBN, within the New Zealand context, in accordance with the implementation goals in the Assembly resolution 37-11 (Refer to Appendix A)
- Deliver safety, economic, environmental and social benefits from the use of PBN, through the NSS programme
- Achieve a total PBN environment, using appropriate ICAO PBN Navigation Specifications, for all IFR aircraft operations conducting instrument approaches, standard instrument departure (SID) procedures, standard instrument arrival (STAR) procedures, and ATS routes in both oceanic and domestic airspace
- Develop a risk-based, fit-for-purpose and efficient regulatory environment to support PBN deployment, including aircraft equipment, operational procedures, and training
- Ensure that navigation, surveillance and communications infrastructure are capable of supporting the PBN elements of the CONOPS
- Optimise the use of current and emerging navigation, air traffic management and aircraft avionics systems
- Address current and forecast airspace capacity and operational efficiency issues through the application of PBN
- Promote and support regional and global PBN interoperability

3 PBN Benefits

ICAO Assembly resolution 37-11 recognises that the implementation of PBN creates a number of safety and efficiency benefits.

In particular, the resolution identifies:

- That straight-in approaches provide significant safety enhancements
- That approaches with vertical guidance provide further safety enhancements
- That the optimization of the terminal control area through implementation of RNP and RNAV SIDs and STARs will provide for more fuel-efficient aircraft operations

Achieving a full PBN operational environment in New Zealand is driven by the benefits that can be, and are already being, delivered through the implementation of PBN. Refer to the NSS PBN Benefits Map at [Appendix B](#)

Implementation of a full PBN operational environment is the responsibility of the stakeholders in the system. When stakeholders are considering enablement and implementation of PBN they will make decisions regarding individual, operator and state outcomes based upon achieving:

- Safety enhancement
- Operator efficiency
- Operator accessibility
- Airspace capacity
- Fuel efficiency
- Infrastructure optimisation
- Environmental benefits
- Social benefits

Realisation of these benefits will be monitored and reported through the NSS programme.

3.1 Safety enhancement

PBN allows for straight-in instrument approach procedures which have been demonstrated to reduce the risk of controlled flight into terrain (CFIT) by a factor of twenty-five. Furthermore, these procedures can be an additional eight times safer, for suitably equipped aircraft, if the approach is designed to provide vertical guidance.

In the terminal control area SIDs and STARs can be created to ensure safe separation by design between arriving and departing aircraft.

3.2 Operator efficiency

Standardisation of instrument procedures allows for simplification of operational procedures and training.

Reduced flight variance and greater reliability allows for more predictable operations and better use of expensive resources.

3.3 Operator accessibility

Lower landing minima from straight-in approaches may result in reductions in the number of weather cancellations and diversions.

The combination of lower minima and stabilised straight-in approaches may reduce the probability of missed approaches and improved airfield accessibility.

Capability to utilise defined turning paths with narrow lateral containment can allow enhanced access to terrain challenged airfields in all weathers.

3.4 Airspace capacity

Reduction in airborne holding in the terminal control area due to airspace and airport capacity gains.

Ability to utilise 4DT methods to achieve time based spacing to reduce the need for holding at lower levels.

Potential reductions in separation standards enabling more aircraft to operate on optimum trajectories.

Potential to reduce contingency fuel requirements due to improved system predictability and reliability.

3.5 Fuel efficiency

Potential for shorter flight tracks in the enroute, terminal areas and approach phases of flight reduces fuel burn.

Optimum profile descent (OPD) capability, continuous climb operations (CCO) and continuous descent operations (CDO) improve fuel efficiency.

3.6 Infrastructure optimisation

Investment in ground based navigation aid replacement and maintenance may be reduced.

Narrower separation requirements and more efficient use of airspace may allow for simplification and reduction in the size of airspace.

Improved airport capacity may defer or remove the need for additional runways at airfields.

3.7 Environmental benefits

PBN can result in significant reductions of CO₂ emissions and fuel consumption.

There can be significant reduction in other pollutants (e.g. mono-nitrogen oxides and carbon monoxide).

Specification of shorter flight paths and the use of optimum vertical profiles allow aircraft to operate at lower engine thrust levels and with reduced aerodynamic noise. This reduces the noise associated with aircraft operations.

There is an increased opportunity for the placement of flight paths over non-noise sensitive areas.

3.8 Social benefits

PBN can deliver benefits to society through the safety and environmental gains listed above. In addition, PBN allows for shorter flight times through more direct routes, reducing passenger time in aircraft.

Weather can be a significant disruption to flight operations. PBN provides more reliability of service in all weather. Fewer diversions and cancelled flights means fewer passenger having their business or recreational travel disrupted, and avoiding the numerous resulting cost and stress.

In short, PBN can make it easier and faster for people to safely and reliably get to where they would want to go, improving productivity, passenger wellbeing, and social connections.

4 PBN Decisions and Assumptions

Since 2014, a significant amount of work has been delivered under the NSS programme which has involved the MoT, CAA, Airways (as New Zealand's Air Navigation Service Provider (ANSP)), New Zealand Defence Force (NZDF), Land Information New Zealand (LINZ), MetService, Airports and aircraft operators. This has resulted in the following key decisions and assumptions that this revised PBN implementation plan is based upon:

- PBN in New Zealand is principally dependent on the GPS constellation operated by the United States. Other GNSS constellations and multi-constellation equipment have been considered, equipment standards and system development will be monitored for possible future use.
- The aircraft equipment standards for GNSS based PBN operations in New Zealand will be TSO-C129 (with approved FDE capability), TSO-C145 and TSO-C146.
- New Zealand will maintain a minimum operating network (MON) of ground based navigation aids. The MON is designed to ensure a safe transition and recovery of IFR aircraft in the event of the loss of GPS navigation capability.
- The MON will also provide a contingency capability to allow for operations between Auckland, Wellington and Christchurch in the event of any loss of GNSS navigation capability. The MON will also allow support a significant level of regional operations in the same scenario.
- CAA rules and other regulatory mechanisms will be revised or created to enable operators to participate in the full PBN operational environment.
- New Zealand will seek to ensure there is optimised connectivity of PBN enroute ATS routes, SIDs, STARs and approach procedures.
- Where possible, airspace will be optimised based upon PBN.
- In order to gain efficiency from a PBN environment, New Zealand will configure the Air Traffic Management (ATM) system for optimisation to support PBN.
- New Zealand will align PBN deployment with other states' airspace to optimise connectivity.
- New Zealand will have a full PBN operational environment by 2023. This will include a significant reduction in mixed mode (PBN and conventional navigation) operations and a priority given to PBN capable aircraft.

5 PBN Concept

PBN is the navigation element of the airspace concept that also includes communications, surveillance and ATM. Implementation of PBN must be considered with respect to the whole airspace system and not as a standalone change relating to navigation only, otherwise the benefits of PBN will not be fully realised.

The PBN concept is based on a shift from sensor-based to performance based navigation. The PBN concept specifies the required capability of the aircraft area navigation system performance in terms of availability, accuracy, integrity, continuity and functionality. It explains and describes the performance-based RNAV and RNP navigation specifications that can be applied to oceanic, enroute and terminal airspace, so as to improve safety, efficiency and capacity, as well as reduce the environmental impact of aircraft operations. These specifications may detail the navigation sensors and equipment necessary to meet the performance requirements.

As this plan focuses on implementation it is important to understand the stakeholders engaged in PBN enablement and deployment. A pictorial view of the stakeholders and the relationship is shown in Figure 1 and described in more detail below.

The PBN element of the NSS programme focuses on the engagement of stakeholders to work towards delivering the objectives set out in section 2 and realising the benefits in section 3. NSS promotes an all stakeholder approach to supporting a full PBN operational environment by 2023.

The MoT and CAA are responsible for enabling PBN through delivery of regulatory and guidance material to enable all other stakeholders to safely adopt PBN within a whole of system approach. The MoT also has the role of ensuring the system delivers an acceptable level of security and resilience from a national perspective.

Delivering the controlled airspace ATM capability, which encompasses air traffic services, communications, navigation aids and surveillance is the responsibility of the ANSP (Airways).

New Zealand procedure design capability is provided by Civil Aviation Rule (CAR) Part 173 approved design organisations.

Under the auspices of NSS there are a number of implementation working groups and panels that provide the means to influence infrastructure by delivering recommendations as well as considering PBN implementation issues as they arise.

All IFR operators need to be part of the implementation in order to achieve the desired outcome of a full PBN operational environment by 2023. These operators have to consider the operational requirements, their aircraft fleet capability, training needs and operational approvals. This should be considered in the context of achieving the benefits in section 3.

New Zealand airports play a key role in the deployment of PBN, enabling IFR operations and engaging with local councils and residents as a fundamental part of the implementation of PBN based IFR operations. Airports will also engage with MoT on security and resilience from a regional capability perspective.

The NSS programme offers engagement to all stakeholders for the implementation of PBN.

It is recommended that the stakeholders outlined above and shown in Figure 1 participate in the delivery of PBN to play a role in meeting the objective of a full PBN operational environment by 2023.

Successful implementation requires Organisations/ Groups outlined in blue to collaborate and focus on benefits outlined in section 3

Performance Based Navigation Concept

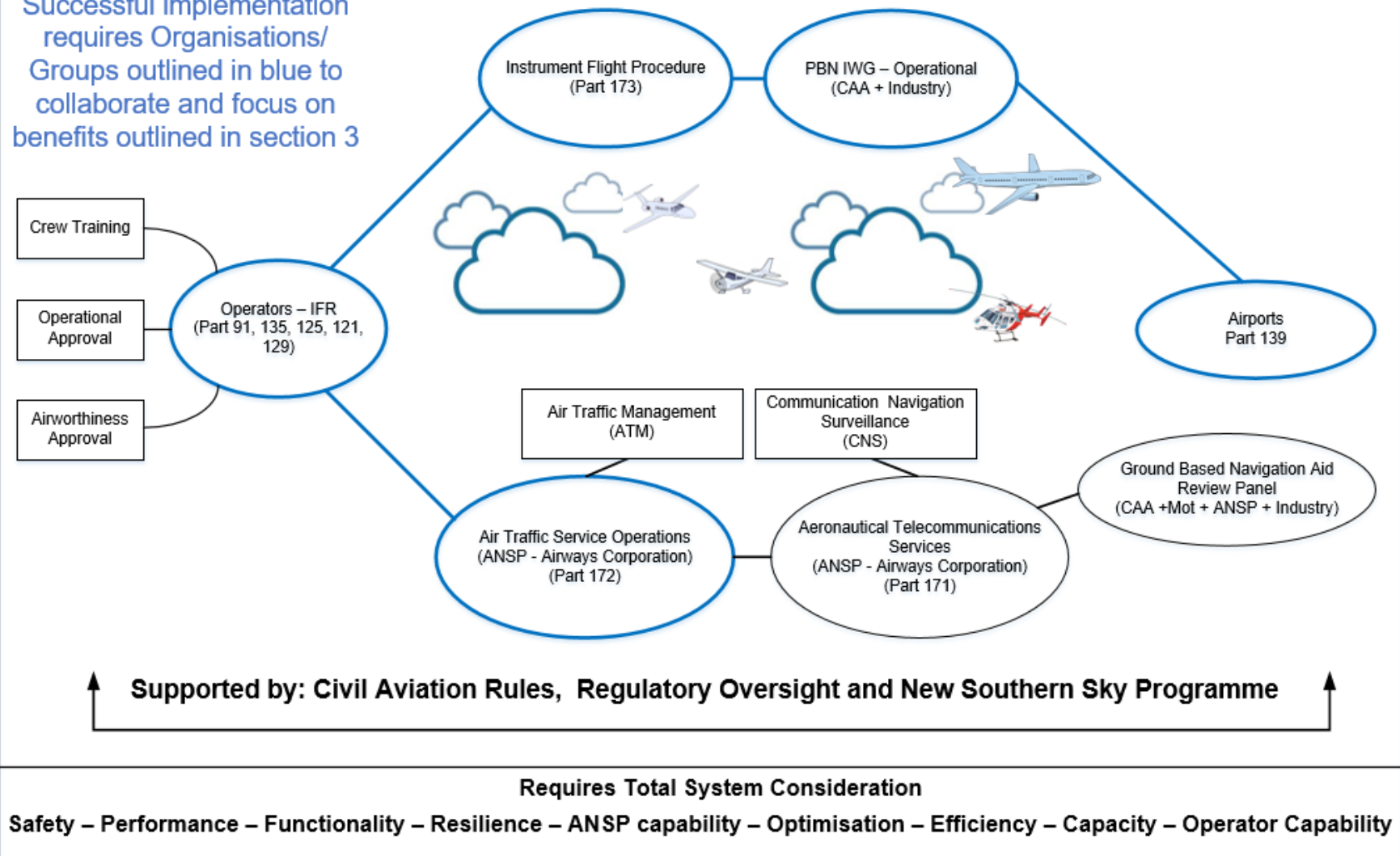


Figure 1: Stakeholders of the PBN concept in New Zealand

6 Plan Coordination

This plan represents a New Zealand state view of PBN in line with the objectives set out by ICAO. As described the benefits of PBN are significant and have a broad reach. It is clear from Figure 1 that deployment of PBN involves a wide spectrum of stakeholders. As part of NSS, the CAA is delivering a regulatory framework to enable PBN operations and ensure conformity with ICAO standards and recommended practices.

Stakeholders have the responsibility for deployment and operational use of PBN, these are summarised as:

- Approved Flight Procedure organisation – Flight Procedure Design (Part 173)
- Airways – Air Traffic Service (Part 172)
- Airways – Aeronautical Telecommunication Services (Part 171)
- Aviation Meteorological Service Organisations – Certification (Part 174)
- Aeronautical Information Service Organisations — Certification (Part 175)
- NZ Airports – (Part 139)
- Operators (Part 91, 135, 125, 121 and 129)
- MoT – National Security and Resilience; regulatory development
- NZDF

Plan coordination is best served by the stakeholders above working collaboratively through the NSS framework to deliver PBN within the regulatory framework, ensuring safety and the benefits of PBN can be realised by New Zealand as set out in the NAANP.

6.1 Plan responsibility

The CAA is responsible for leadership and delivery of the plan, reporting on the PBN capabilities in New Zealand, outlining the adoption of future capabilities and reviewing progress against the state PBN plan and the objectives set by ICAO.

The ANSP – Airways, together with the PBN Implementation Working Group (PBN IWG) - Operational (CAA led) will provide oversight of PBN implementation. Airways will follow existing protocols of consultation; operators are urged to engage on the implementation proposals set out by Airways. The decision on implementation should be measured against the benefits identified in section 3.

Points of contact:

- Airways – pbn@airways.co.nz
- CAA - Aeronautical Services Unit

6.2 Plan review

This plan will be reviewed and may be re-issued by the CAA in 2020. The review will be conducted with input from all stakeholders through the NSS programme.

If there are significant changes in the aviation system or environment, ICAO guidance, or technological development, stakeholders can agree to an earlier review.

6.3 Stakeholder commitment

The stakeholders that have been identified and consulted with in relation to this plan have committed to actively pursuing PBN implementation in New Zealand. As aviation participants in New Zealand the stakeholders accept joint responsibility for ensuring that a full PBN IFR environment is achieved in New Zealand by 2023.

Stakeholders:

- CAA New Zealand
- MoT
- Airways
- IFR Operators
- Part 139 Certified Airports
- NZDF
- Aeropath

7 PBN Navigation Specifications

New Zealand has a mature but not yet complete PBN environment. The PBN specifications that have been, and continue to be deployed in New Zealand are selected from, and based upon ICAO Doc 9613 PBN Manual Edition 4. This section identifies the RNAV and RNP specifications currently in use and those specifications expected to be adopted by 2023.

Selection of a navigation specification is based on available infrastructure and the cost and benefits that can be achieved.

7.1 AREA Navigation – RNAV and Required Navigation Performance - RNP

RNAV is the more basic of the two families of PBN navigation specifications. RNAV is a stand-alone navigation which does not provide any on-board navigation performance monitoring and alerting to aircrew. Typically, the use of RNAV specifications is supported by an ATS surveillance service.

Currently, in domestic airspace, surveillance is provided by a network of radar systems as well as ADS-B and WAM (Wide Area Multilateration). It is possible to allow domestic use of RNAV specification operations outside of surveillance service, provided a safety case is developed and accepted by the CAA prior to implementation.

In Oceanic airspace RNAV Operations are based upon procedural ATS separation with no requirement for surveillance.

RNP is the more advanced of the two families of PBN navigation specifications. It provides on-board navigation performance monitoring and alerting to aircrew, therefore, it can be deployed without an ATS surveillance service, with consideration of complexity and density. The on-board navigation performance monitoring and alerting is a necessary enabler for many new ATM applications.

It is important to note that the accuracy requirements of RNAV and RNP navigation specification are identical. The accuracy requirements are specified by a numerical value in nautical miles following the specification.

Domestic RNAV and RNP specifications require direct controller pilot communications (DCPC) in the form of VHF radio.

7.2 PBN Specifications Implemented

The following navigation specifications are deployed and in use in New Zealand. All procedures based on the deployed specifications are published in the New Zealand AIP (<http://www.aip.net.nz>).

All of the implemented specifications require GNSS, with the exception of RNP 10 (RNAV 10) which can be achieved using approved Inertial Navigation System (INS).

Flight Phase	Navigation Specification	Navigation Type
Oceanic	RNP 10 (RNAV 10)	LNAV
	RNP 4	LNAV
Domestic Enroute	RNAV 2	LNAV
Arrival procedures	RNAV 1	LNAV
	RNP 1	LNAV
Approach procedures	RNAV (GNSS) ¹	LNAV
	RNAV (GNSS) ¹ + BARO VNAV ²	LNAV/VNAV
	RNP AR APCH ³	LNAV/VNAV
	RNP AR APCH (Special) ⁴	LNAV/VNAV
Departure procedures	RNAV 1	LNAV
	RNP 1	LNAV
	RNP AR DP (Special) ⁵	LNAV

Table 1: PBN Specifications Implemented in NZ

Note 1: RNP APCH operational approvals enables RNAV (GNSS) approaches. Approach procedures are labelled RNAV (GNSS) RWY. Note: ICAO is looking at identifying these procedures on the charts as RNP APCH, this is planned for introduction commencing 2022.

Note 2: Approach with vertical guidance (APV) in New Zealand is based upon Baro VNAV. Satellite Base Augmentation System (SBAS) is currently not available in New Zealand so APV based on SBAS will be reassessed if this situation changes.

Note 3: RNP AR APCH requires authorisation from CAA to conduct the procedure. RNP AR APCH has the additional functionality of radius-to-fix (RF) turns. Lateral accuracy will be 0.3 – 0.1nm on approach and 1 – 0.1nm during the missed approach. These procedures are designed in accordance with ICAO Doc 9905 Required Navigation Performance Authorisation Required (RNP-AR) Procedure Design Manual.

Note 4: RNP AR APCH (proprietary) procedures are specific to an operator and aircraft type/engine combination and do not necessarily meet all of the design requirements of ICAO Doc 9905. They can have lateral accuracy requirements down to 0.1nm on approach and between 0.1nm and 1nm during the missed approach.

Note 5: Currently all Required Navigation Performance – Authorization Required Departure Procedure (RNP AR DP) in New Zealand are Proprietary (i.e. not based on an ICAO published design criteria) and are specific to an operator and aircraft type/engine combination. The PBN Manual Doc 9613 is being revised to provide a specification for a standard RNP AR DP, this is expected in 2020.

7.3 PBN Specifications Future Capability

The PBN regulatory framework described in section 9 will enable the use and deployment of the following additional PBN specifications by 2023. The actual deployment of a particular PBN capability will be driven by stakeholder assessment of operational need and based on a review of costs and benefit.

Flight Phase	Navigation Specification	Navigation Type
Oceanic	RNP 2	LNAV
Domestic Enroute	RNP 2	LNAV
	RNP 0.3(H) ¹	LNAV
Arrival Procedures	RNP 0.3(H) ¹	LNAV
Approach Procedures	RNP 0.3(H) ¹	LNAV
Departure procedures	RNP 0.3(H) ¹	LNAV
	RNP AR DP ²	LNAV
Enroute, Terminal and Approach Procedures	A-RNP ³	LNAV & LNAV/VNAV ⁴

Table 2: Future PBN Specifications

Note 1: RNP 0.3(H) is for use by helicopters only.

Note 2: Implementation of RNP AR DP in New Zealand that will follow the guidance and criteria issued by ICAO in a revised PBN Manual Doc 9613 and other manuals.

Note 3: Advanced RNP (A-RNP) is a specification that can encompass the following specifications: RNAV 5, RNAV 2, RNAV 1, RNP 2, RNP 1, RNP APCH, it also enables additional functions such as RNP Scalability, RF Legs and BARO VNAV.

Note 4: Advanced RNP (A-RNP) offers VNAV capability (Baro VNAV), however it is not mandatory.

8 ICAO Assembly Resolution A37-11

8.1 A37-11 Introduction

As an ICAO state, New Zealand has been working towards satisfying the intention of ICAO Assembly resolution A37-11 Performance Based Navigation Global Goals (Refer to [Appendix A](#))

A summary of the principles are to:

- Ensure safe and efficient performance of the global air navigation system through implementation of PBN
- Ensure the navigation system is harmonised, requiring collaboration of all stakeholders
- Deploy area navigation supported by the GNSS, enabling track and velocity keeping, maintaining separation through curves and enabling flexible approach line ups.
- Deliver procedures for both fixed and rotary wing aircraft to enable lower minima in obstacle rich or constrained environments
- Implement where possible APV operations (BARO VNAV for NZ) and LNAV approaches enhancing safety using straight-in approaches versus circling approaches.
- Optimise the terminal areas using RNP and RNAV SIDs/STARs to provide more fuel efficient aircraft operations
- Ensure navigation specifications remain aligned to a common standard ensuring safety and efficiency can be maintained/delivered.
- Recognise that not all airports have the infrastructure to support APV operations and that not all aircraft are currently capable of APV.

A summary of the stated objectives are to:

- Develop and deliver a PBN implementation plan that focuses the state on delivering PBN capability and achieves the identified outcomes and benefits
- Implement RNAV and RNP for enroute and terminal areas
- Implement approach procedures with vertical guidance (APV), including LNAV only minima for all instrument runway ends as the primary approach or as a back-up for precision approaches
- Implement straight-in LNAV only procedures (as an exception to the bullet point above), for all instrument runways at aerodromes where there is no local altimeter setting available and where there are no aircraft suitably equipped for APV operations with a maximum certified take off mass of 5700kg or more
- Urge implementation of approach procedures with vertical guidance (APV) to all runway ends serving aircraft with a maximum certified take off mass of 5700kg or more.

8.2 New Zealand compliance with A37-11

New Zealand delivers a PBN implementation plan status update to ICAO on an annual basis, this focuses on the current state of PBN in New Zealand and New Zealand's compliance with ICAO resolution A37-11.

A summary of the current status of PBN in New Zealand as reported to ICAO:

- An initial state PBN implementation plan was published in 2009, detailing the specifications and milestones (phases) for implementation of PBN. Progress against the initial plan has been positive and successful PBN deployment has been achieved. With the progress made to date, New Zealand can be considered to have a mature but not complete deployment of PBN.
- Since the 2009 PBN implementation plan there have been developments, decisions as well as lessons identified in the implementation of PBN. This 2017 PBN implementation plan has been produced to capture the lessons identified and accommodate new specifications that have been published since 2009. A key objective of this plan is to focus on delivery of benefits through PBN deployment by engagement of all stakeholders. It is also to ensure that New Zealand, as a state, maintains focus on complying with the ICAO Assembly resolution.
- New Zealand PBN implementation status is summarised as follows (percentages relate to the objectives above):
 - Oceanic enroute – 100% implementation
 - Domestic enroute – 100% implementation
 - International Airport ¹ Approach – 100% implementation
 - International Airport ¹⁺² Arrival/Departures – 90% implementation
 - Domestic Certified Airport Approach³ – 86% implementation
 - Domestic Certified Airport Arrival/Departure – 68% implementation

Note 1: For ICAO reporting New Zealand International Airports are Auckland (NZAA), Wellington (NZWN), Christchurch (NZCH) and Queenstown (NZQN).

Note 2: NZWN SIDS scheduled for implementation May 18, this will achieve 100% implementation.

Note 3: Only airports served by aircraft operating at or above 5700kg were considered. For VNAV deployment only airports served by aircraft suitably equipped for APV were considered. Not all runways ends allow for procedure implementation due to terrain constraints.

Note: As operators equip for PBN or extend operations to controlled and uncontrolled aerodromes, additional PBN deployment will be required to satisfy the LNAV and VNAV criteria (based upon aircraft capability).

Ongoing implementation of PBN to deliver safety, efficiency and environmental benefits will continue at controlled and uncontrolled aerodromes.

These procedures will be implemented based upon airspace change, fleet capabilities enhancement (RNP AR), changes to aircraft operations and the aerodromes they are operating to/from, consideration of non-certified aerodromes with aircraft less than 5700kg and ICAO introduction of new navigation specifications.

9 Regulatory Change

New Zealand has implemented PBN under the Part 91, 121, 125 and 135 rules with the support of Advisory circulars AC91-7, AC91-8, AC91-10 and AC91-21. A project has been established by CAA New Zealand to provide a complete PBN regulatory framework that will enable the establishment of a full PBN environment in New Zealand by 2023.

This project will:

- Consider all existing regulatory material, including but not limited to rules, to identify those that have a PBN element.
- Propose regulatory changes as required to ensure that the framework is capable of enabling a full PBN environment.
- Establish a mechanism for inclusion of future ICAO PBN specifications that are suitable and appropriate to the New Zealand environment i.e. A-RNP, RNP 0.3(H) and RNP AR DP.
- Consider existing and future aircraft equipage, navigation and surveillance infrastructure and proposed changes and other elements required to achieve the PBN benefits already described.
- Take a performance based approach to establishing the regulatory environment.

Recognising that PBN is well established in New Zealand, the CAA will be engaging with the aviation industry to determine the optimum way to ensure that the transition to a full PBN environment accounts for operator's needs, and achieves the desired benefits.

The regulatory change project will enable PBN, however, actual implementation of PBN remains with all stakeholders and will require a focus on the benefits in order to realise a complete PBN operating environment.

10 Aircraft Equipage

The New Zealand PBN environment will be based on GNSS as the primary means of navigation with no dependency on GBNA to support area navigation.

Relying on GNSS as the primary means of navigation does carry risks relating to the loss of GNSS navigation capability at an aircraft, regional or national level. Mitigation of this risk requires a MON to enable safe recovery of aircraft based upon the ability to recover to areas served by conventional navigation aids, and the continued carriage of equipment to utilise these aids. This will also provide a contingency capability to support continued operations between Auckland, Wellington and Christchurch in the event of a long term GNSS outage. There will also be significant contingency capability to other airports and regions. More information is available in the GBNA Strategy document (link below).

<http://www.nss.govt.nz/dmsdocument/27-ground-based-navigation-aid-strategy>

The recovery of aircraft in the event of loss of GNSS will be based upon VOR/DME stations. NDBs will be phased out in New Zealand, they are not being relied upon as part of the MON.

10.1 Aircraft engaged in Air Transport Operations

Transport aircraft are required, by CAR 121, 125 and 135, to have dual independent navigation systems so that in the event of a single system failure the aircraft can continue

to navigate on the route/procedure being flown. This will continue to apply to the requirement for GNSS installation.

These aircraft will require VOR/DME receiver installations (proposed) to allow for use of the MON in the event that GNSS navigation capability is lost.

Installed GNSS systems will need to meet defined TSO requirements and be compatible with future Automatic Dependant Surveillance – Broadcast (ADS-B) surveillance requirements.

10.2 Private Aircraft

Private aircraft operating IFR under CAR 91 are not required to install dual systems for domestic operations. If these aircraft are operating PBN enroute/terminal procedures, they will require a minimum of a single GNSS system.

The installation of a conventional receiver (VOR minimum, DME yet to be determined) will be required to allow for use of the MON in the event that GNSS navigation capability is lost.

Installed GNSS systems will need to meet defined TSO requirements and if operating within controlled airspace be compatible with future ADS-B surveillance requirements.

11 Pilot and Operator Training

Training for pilots and other operators in all IFR operations is designed to meet the Instrument Rating (IR) requirements defined in Rule Part 61 and as expanded in AC 61-17. The training is largely centred around legacy procedures based on GBNA, with VOR procedures as a mandatory flight test requirement. With the increasing use of GNSS, an additional section of the instrument rating was added as a stand-alone privilege to cover approaches based on GPS. This stand-alone section meets ICAO requirements for knowledge and competency demonstration and can be added at IR issue or as a separate competency test. Only those pilots holding GNSS privileges are currently qualified to fly a PBN approach.

11.1 Transition Arrangements

With the implementation of PBN enroute/terminal procedures the focus of IFR operations will necessarily become more and more reliant on RNAV/RNP procedures. In the short term, changes already made to AC 91-21 and AC 61-17 have cleared pilots holding current GNSS privileges to fly RNAV/RNP 2, RNAV 1 and RNP approach¹ procedures. Pilots may also access RNP 1 procedures subject to a demonstration of continued competency at their next annual check. The same privileges apply to pilots adding a GNSS rating at an issue or additional aid flight test.

As PBN procedures become the main IFR operating medium, there will be a need for all IFR pilots to meet PBN knowledge and competency standards. In the first instance, the knowledge requirements of the stand-alone GNSS rating will be subsumed within the syllabuses for the IR theory exams described in AC 61-17. These are mandatory exams for all pilots who wish to hold an IR (whether private pilot licence (PPL), commercial pilot licence (CPL) or air transport pilot licence (ATPL)), thereby ensuring all IFR pilots have the necessary knowledge that meet ICAO requirements. This work has commenced but timescales for implementation will depend on the outcome of PBN Regulatory Framework project; IR law being an integral knowledge requirement.

As PBN evolves, and the outcomes of the GBNA strategy are implemented, the format and competency requirements of the IR will be updated. PBN procedures and approaches will form the core of the test with the addition of the selected ground-based aid – VOR/DME. As now, if pilots wish to add other IFR aids (NDB, ILS etc.), these can be done as ‘additional’ competency items. It is probable that approaches will be split into ‘non-precision’ (RNP – LNAV, LNAV/VNAV, VOR, NDB) and ‘precision’ (ILS and in the future LPV) to provide a degree of future proofing and flexibility. For pilots operating under Part 91 these changes will be contained in Part 61 and the IR. For those operating under Parts 135, 125 or 121, the changes will be reflected in routine Oceanic Control Area (OCAs), line checks etc.

Further consideration is ongoing (in the training space) over the increased use of flight simulators for training and testing and in the development of dedicated PBN training airspace (training ‘sandpits’). These initiatives should deliver training, cost, and quality benefits whilst reducing pressure on increasingly busy airspace.

¹ RNAV (GNSS) RWY is equivalent to RNP APCH and will be labelled as such post 2022

12 Communication Navigation and Surveillance (CNS)

Communications, Navigation and Surveillance (CNS) are the backbone of all modern ATM systems.

Direct communication between pilot and air traffic controller in combination with an ATC surveillance service enables more efficient use of airspace and aerodromes. It also provides a safety net in the event of pilots requiring assistance in a wide range of emergency situations.

12.1 Communications

ICAO Doc 4444 (ATM), outlines the communications requirements for the various types of separation standard used by ATC to prevent collisions and to manage the airspace efficiently.

The closer aircraft are in the traffic stream, the more instantaneous the communications medium has to be to enable ATC to intervene in the event of an aircraft requiring a track deviation due to separation, weather or emergency condition, or just a complex airspace block.

New Zealand uses VHF for communication in domestic airspace and High Frequency (HF) in oceanic airspace. Controller Pilot Datalink Communications (CPDLC) is also used in oceanic airspace where possible and is dependent on aircraft equipage.

New Zealand is looking to introduce Satellite Voice (SATVOICE) communications for use in oceanic airspace. This may enable transport aircraft equipage of 1 HF and 1 SATVOICE system for Long Range Communication Systems (LRCS). Performance Based Communication and Surveillance (PBCS) is also being adopted in oceanic airspace. PBCS will ensure aircraft and ATC communications equipment is able to operate to prescribed performance standards that relate to: the type of air traffic service being provided, the type of airspace that the particular equipped aircraft is able to operate within, and the separation standard (being able to be provided by the use of the particular communication system with Required Communication Performance (RCP)).

12.2 Navigation

Reliance on conventional navigation aids will reduce over time as satellite based navigation systems mature to provide the continuity of services, navigation accuracy, signal integrity and relevant functionality. This will enable greater reliance upon GNSS navigation systems.

The ICAO PBN concept specifies that aircraft RNAV or RNP system performance requirements be defined in terms of availability, accuracy, integrity, continuity and functionality required for the proposed operations (in the context of a particular airspace concept, when supported by the appropriate navigation aid infrastructure).

The navigation concept for New Zealand is the establishment of a full PBN environment with PBN operations based upon GPS by 2023, as signalled in the NAANP released in 2014. New Zealand has opted to use the GPS constellation as the primary source for PBN in New Zealand domestic airspace. This will be supported by a MON that enables recovery of aircraft in the event of the loss of GPS navigation capability (aircraft, regional or national failure). There will also be a contingency GBNA network, allowing transport flight operations to continue in the instance of long-term GPS outage. A GBNA Review Panel (GBNARP) has been established to make recommendations for the MON and Contingency system. This panel has representatives from industry and government organisations. The GBNA Strategy document has been published.

Development of multi-constellation and multi-frequency GNSS technologies will be monitored for possible uptake in New Zealand. The current time frame for review is 2020, with possible operational uptake 3-6 years after.

12.3 Surveillance

The provision of an ATC surveillance service relies upon the presentation of an accurate position indicator showing where aircraft are in relation to airspace boundaries, air routes, other aircraft, aerodromes and instrument flight procedure tracks and waypoints.

ATC surveillance systems are rapidly developing. They are moving away from traditional radar systems towards more modern systems. These are based upon specific airborne equipment and either ground based receivers such as ADS-B or satellite based ADS-B which provides the controller with a more accurate indication and faster updates of aircraft positions. These technologies will enable more efficient ATM processes, especially in relation to optimum aerodrome usage rates.

New Zealand domestic surveillance will be primarily based upon ADS-B. Multi-Lateration and secondary surveillance radar (SSR) cooperative surveillance systems that do not rely on GNSS will be used as a contingency. Non-cooperative surveillance systems will be utilised at selected international airports. Airways is responsible for surveillance and is currently determining the final domestic surveillance infrastructure.

Separation in oceanic airspace can benefit from aircraft equipped with Automatic Dependent Surveillance - Contract (ADS-C) capability. Space based ADS-B developments are being monitored for operational benefits and cost effectiveness in oceanic airspace.

As referenced in section 12.1, PBCS includes surveillance performance which is currently being considered by the CAA. Use of Required Surveillance Performance (RSP) will have a direct correlation to the performance of communication and use of PBN.

13 Air Traffic Management (ATM)

13.1 ATM

The modern vision for the ATM system in New Zealand is based on the provision of services, with a view of becoming air traffic enabling rather than air traffic controlling.

An ATM system functions through the collaborative integration of humans, information, technology, facilities and services, and is supported by air, ground and/or space based communications, navigation and surveillance.

ATM is defined by ICAO as:

“The dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management – safely, economically and efficiently – through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.”

PBN enables reduced track spacing between adjacent routes and reduced track miles flown thereby reducing fuel burn and reducing exhaust emissions.

PBN accuracy and regularity combined with an enabled, connected and advanced ATM system will enable more efficient use of the airspace while maintaining the recognised target levels of safety.

13.2 Current status of ATM in New Zealand

The MoT has designated the CAA as the ATS Authority.

Airways is currently the sole certificated provider of ATC services in both the Domestic and Oceanic FIRs

13.3 ATM in an ADS-B surveillance environment

The introduction of ADS-B surveillance is being phased in. It is proposed that all aircraft operating in controlled airspace above Flight Level 245 will require an ADS-B transponder by 31 December 2018.

An assessment of the benefits of ADS-B coverage in areas below FL 245 is underway, and will determine implementation strategies for ADS-B transponders below FL245.

Furthermore, Airways have stated that ADS-B surveillance coverage will be available in all domestic controlled airspace. This will enable an increase in surveillance service availability, although not all controlled airspace will have an ATC surveillance service provided within it.

The use of an ADS-B surveillance system may provide:

- An increase in ATC capacity
- Improved aircraft track conformance and position accuracy on ATC displays which may lead to the ability to reduce spacing of routes and procedures with an increase in operational efficiency
- Improved pilot situational awareness if ADS-B In (optional) is installed in the aircraft (only ADS-B Out is proposed to be mandatory).

13.4 Automated SID and STAR Allocation

The current Airways ATM system, Skyline, includes the provision of automated SID and STAR allocation which:

- Improves aircraft track predictability and consistency via earlier provision of terminal tracking requirements to intercept the appropriate instrument approach procedure. This includes earlier advice of Required Time Arrival (RTA).
- Increased strategic air traffic control management as opposed to tactical air traffic control intervention which provides greater ATC efficiencies
- Reduced fuel burn due to more efficient climb and descent planning, reduced vectoring (especially at lower altitude)
- Improves routing for short sectors, e.g. Hamilton – Auckland, Wellington – Nelson
- Improves pre-departure planning
- Reduced ATC workload in the terminal area, reducing collision risk
- Improved trajectory modelling, which improves flow management

13.5 Flow management – Arrival Manager (AMAN)

Arrival manager (AMAN) is a decision support tool, which plans an initial strategic sequence for ATC and enables optimal descent profiles to be flown. It is currently only available at Auckland airport.

AMAN can provide:

- Approach profile predictability due to pilot knowledge of descent point and fix crossing time requirements
- Consistent speed control instructions
- ATM component harmonization

13.6 Future ATM system

Airways has initiated a project to upgrade the current ATM system (expected mid 2021).

Some of the enhancements proposed will include:

- Medium Term Conflict Alert (MTCA) which provides earlier conflict detection than the current Short Term Conflict Alert (STCA). MTCA has the potential to reduce tactical intervention by ATC
- ATC staffing efficiencies and more consistent ATM service
- Improved predictability of flight paths
- Reduced collision risk

13.7 DAPSS– Downlink of Airborne Parameters

DAPS involves the downlink (via the Mode S (EHS) transponder) of data from the aircraft's Flight Management System (FMS) which may be logged directly into the ATM system.

This has enabled the development of controller support tools that provide benefits to the safety and efficiency of ATC operations. Transponders with Mode S (EHS) enable additional down-link of airborne parameters. These currently include pilot selected attitude/flight level and IAS/Mach No. Additional data is available which may be utilised by the future ATM system.

14 Airspace Concept

The airspace concept is defined by ICAO Doc 9613 as:

“The outline and intended framework of operations within an airspace. They are developed to satisfy explicit strategic objectives such as improved safety, increased air traffic capacity and mitigation of environmental impact. Airspace concepts can include details of the practical organization of the airspace and its users based on particular CNS/ATM assumptions, e.g. ATS route structure, separation minima, route spacing and obstacle clearance”

The stated PBN benefits will be achieved through full deployment of PBN in the context of an airspace concept. These concepts will be enabled by PBN utilising selected New Zealand appropriate navigation specifications:

- For all ATS routes
- For all SIDs and STARs
- RNP APCH for all runway ends with IFR Operations (with APV based on Baro-VNAV provided where suitably equipped aircraft operate).

14.1 Phased changes to Airspace concept in New Zealand

The airspace concept in use within New Zealand will vary over time as PBN is implemented. As there is a need to obtain benefits or meet particular challenges, it will vary by region.

14.1.1 Mixed mode concept

Currently, the operational concept is a mixed mode navigation environment. This allows continued use of legacy navigation applications alongside PBN capability.

As PBN is progressively implemented in aircraft fleets and changes are implemented to supporting infrastructure the benefits to operators will be limited by the diversity of navigation performance and the ATM systems ability to manage this diversity. The GBNA infrastructure associated with legacy navigation systems will be reviewed and rationalised to reflect the progress made on implementation of PBN.

14.1.2 Majority PBN concept

The operational concept will move to a more exclusive PBN environment, resulting in a greater reliance on the level of PBN capability in the national fleet. Infrastructure will be rationalised accordingly, enabling more realisation of the PBN goals.

The ATM system will be managing a more homogenous navigation capability. It will have a greater ability to manage by exception aircraft that lack the required navigation performance capability. Priority will be given to those aircraft that are PBN capable.

14.1.3 Full PBN environment

The operational concept will be a mature PBN environment with comprehensive fleet equipage. PBN procedures will be provided at all certified IFR airports. GBNA infrastructure will be in accordance with the MON and this will only be utilised as means to mitigate GNSS failure risk and provide for safe recovery of aircraft.

A mature set of ATM tools will complement the airborne systems and the ATM tools will also enable the effective management of those aircraft that experience a temporary loss of PBN capability - without significant impact to other airspace users. Priority will be given to those aircraft that are PBN capable.

14.2 Safety – Risks Associated with Major System Change

During the transition to a full PBN environment the aviation industry will face challenges in managing a diverse range of navigation systems with equally diverse requirements.

Significant work to mitigate these risks has already been completed by stakeholders including:

Airways:

- Integration of PBN capability designations from the ATC flight plan into the ATM system
- Creation of systems to enable safe separation of mixed mode traffic at airports
- Provision of Receiver Autonomous Integrity Monitoring (RAIM) prediction services for approach operations

IFR Operators:

- Equipage with GNSS systems approved for PBN by the majority of operators
- Adoption of aircraft minimum equipment lists (MEL) which identify PBN components (specific to operators that require a MEL)

CAA:

- Provision of guidance material for Air Transport operators
- Arrangements for CAR 91 IFR pilots with GNSS ratings to transition to PBN approvals

Future work from stakeholders which will further mitigate against these risks:

- Adoption of a supporting regulatory framework including CAR
- Consideration to the establishment of an aircraft PBN capability register
- Equipage with GNSS systems approved for PBN by all IFR operators
- Adoption of PBN as the primary operation at all IFR airports
- Establishment of GNSS system performance monitoring
- Consideration (and if required) provision of RAIM prediction capability for enroute and terminal operations
- Continued industry wide involvement in PBN deployment
- Assurance there are appropriate resources available within CAA, Airways and industry to implement PBN
- Further changes to education and training of personnel employed by CAA, Airways and aircraft operators

14.3 Environment

Environmental challenges facing the aviation industry include minimising the impact of noise and emissions on communities in the proximity of aerodromes and the wider global environment.

PBN supports the achievement of these goals while preserving aviation safety and efficiencies in the ATM system. A collaborative approach will be essential to deliver all of these objectives as there is often a need to balance local and global needs. For example, there may be a need to compromise on aircraft efficiency (track miles) to reduce the impact of noise on local communities.

The introduction of a global Emission Trading Scheme (ETS) may provide aircraft operators with significant commercial incentives to upgrade their fleet's PBN capability.

14.4 Infrastructure support

Design and implementation of PBN ATS routes and Instrument Flight Procedures is well advanced. However, the following issues need to be addressed by stakeholders:

- (a) Implementation of the GBNA Review Panel (GBNA RP) recommendations on ground based navigation infrastructure:
 - Transition to GNSS based system
 - Rationalisation of existing navigation aids to support the MON and contingency capability
- (b) GNSS performance and prediction requirements including
 - Overall GNSS status monitoring, reporting and recording
 - Provision of prediction of GNSS availability for a particular operation and aircraft (e.g. RAIM)
- (c) Provision of local QNH to support future deployment of APV Baro-VNAV operations
 - Implementation will require coordination between CAA, MetService, Airways and aerodrome operators
 - Responsibilities for funding of these initiatives will need to be determined.
- (d) PBN instrument procedure design
 - Creation of design criteria by ICAO for future navigation specifications
 - Adoption of capability by New Zealand CAR 173 organisations
 - Provision of calibration aircraft capable of checking all PBN procedures
- (e) Runway infrastructure
 - Aerodrome obstacle survey
 - Aerodrome lighting (approach and surface) to match future PBN instrument approach procedures

(f) Use of GNSS

- Completion of the regulatory framework project to enable GNSS use in a manner which supports full PBN deployment
- Ongoing monitoring of multi-constellation and multi-frequency GNSS as a means of supporting PBN in New Zealand

(g) Use of DME/DME/IRU by capable aircraft

- DME/DME updating of Inertial Reference Units (IRU's) can support some PBN navigation specifications and may be used where the aircraft operator can demonstrate appropriate coverage.
- The GBNA infrastructure will not be maintained with the intent of supporting this capability.

(h) Approach with vertical guidance

- APV in New Zealand will be based on Baro-VNAV
- There is currently no SBAS capability in New Zealand. The deployment of vertical guidance based on SBAS for suitably equipped aircraft will be considered if that was to change.

15 End State 2023

The aim of this plan is that by 2023, New Zealand will be operating in a full PBN environment, the context of this is:

- Aircraft operating under IFR will be navigating using GNSS (GPS) as the primary source of navigation.
- Recovery of aircraft in the event of the loss of GPS navigation capability will be based upon a MON, provided by GBNA at strategically located airports.
- Contingency capability in the event of prolonged loss of GPS will be provided by a contingency GBNA network which provides connectivity between Auckland, Wellington and Christchurch. The MON is expected to meet this requirement and will, in addition, provide a contingency capability to most regional airports.
- Routes and instrument flight procedures will be connected and optimised based upon PBN capability.
- Where practicable, runway ends with PBN procedures with Baro-VNAV to increase safety.
- The ATM system will include functions that take full advantage of PBN, providing benefits to operators and users.
- Implementation of PBN will have been achieved through a collaborative approach with all stakeholders.
- Realisation of benefits, such as improved fuel efficiency, reduced impact on the environment, reduced aircraft direct operating costs, increased operator capability, improved safety in approach profiles, passenger value of time, greater connectivity and accessibility to airports and reduced infrastructure costs will be occurring.

16 Safety

CAA retains sole responsibility for aviation safety oversight of PBN deployment in New Zealand. CAA will utilise their current systems and procedures to identify risks associated with PBN deployment and to ensure that an acceptable level of safety is maintained.

Stakeholders have an individual responsibility for safety within the scope of their control. Close coordination will ensure that PBN deployment is achieved safely.

It has been noted previously that improvements in safety is a significant benefit of PBN deployment.

Appendix A

Assembly Resolution A37-11

PERFORMANCE BASED NAVIGATION GLOBAL GOALS

Note: Resolution A37-11 is a result of the 11th Air Navigation Conference recommendations on area navigation implementation and Resolution A33-16 that requested Council to develop a program to encourage states to implement approach procedures with vertical guidance. The main points of Resolution A37-11 are as follows:

{Preamble Removed}

The Assembly

1. Urges all states to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with ICAO PBN concept laid down in the Performance-based Navigation (PBN) Manual (DOC 9613);
2. Resolves that:
 - a) States complete a PBN implementation plan as a matter of urgency to achieve:
 - 1) Implementation of RNAV and RNP operations (where required) for en route and terminal areas according to established timelines and intermediate milestones;
 - 2) Implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS), including LNAV-only minima, 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% by 2010, 70% by 2014; and
 - 3) Implementation of straight-in LNAV-only procedures, as an exception to 2) above, for instrument runways at aerodromes where there is no local altimeter setting and where there are no aircraft suitably equipped for APV operations with a maximum certificated take-off mass of 5700 kg or more;
 - 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;
3. Urges that states 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 5700kg or more, according to established timelines and intermediate milestones;

4. *Instructs* the Council to provide a progress report on PBN implementation to the next ordinary session of the Assembly, as necessary;
 5. *Requests* the Planning and Implementation Regional Groups (PIRGs) to include in their work programme, the review of status of implementation of PBN by states according to the defined implementation plans and report annually to ICAO any deficiencies that may occur; and
3. *Declare* that this resolution supersedes Resolution A36-23.

Appendix B

Development of a regulatory framework to support PBN implementation Project Definition & Benefit Map – v0.7

