Namibia
Directorate of Civil Aviation
Ministry of Works and Transport

Strategy for the

Implementation of Performance Based Navigation (PBN)

in the Windhoek FIR Namibia

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Edition 1.0

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Change Summary

Edition Number	Brief Description of Change	Prepared by	Effective Date
1.0	• First Edition for the implementation of PBN in the Windhoek FIR Namibia.	PBN	15 January 2015

NOTE:

1. When amended, this document will be re-issued in full. Each page will indicate the edition number and the effective date. The edition number should be the same on each page.
2. When printed this document is uncontrolled. Check the DCA PBN Division – PBN partition for the current release edition.

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Executive Summary

Background

Namibia is a signatory to the Convention on International Civil Aviation; the Chicago Convention. The International Civil Aviation Organisation (ICAO) an entity of the United Nations (UN) administers the convention.

ICAO has recommended to member States the implementation of Performance Based Navigation (PBN). It is the framework for Area Navigation, and for Approach Procedures with Vertical Guidance (APV) for all instrument runways, either as primary approach or as backup for precision approaches by 2016. At the 2007 36th International Civil Aviation Organization (ICAO) General Assembly, States agreed.

The PBN concept links RNAV and RNP navigation specifications to airspace and procedures. Adoption of PBN ensures global harmonisation of the PBN Area Navigation specifications for existing forms of area navigation and the PBN Required Navigation Performance (RNP) add new navigation capability.

Area navigation is very well suited to the Windhoek Flight Information Region (FIR), which has a significant airspace volume, minimal radionavigation aids, and good surveillance capability above FL145. Area Navigation is the standard navigation capability for the majority of passenger carrying aircraft and is widely used in other types of aircraft. Using the Global Navigation Satellite System (GNSS) PBN RNP specifications include on board navigation performance monitoring and alerting which improves pilot situation awareness and reduces Air Traffic Control (ATC) navigation monitoring requirements. It allows for further improvements in operational safety and efficiency.

Namibia's main jet fleet are typically fully RNAV and RNP capable particularly for en-route operations. RNP approach capabilities vary. The remainder of the fleet have varying RNAV and RNP capabilities. It is therefore the intention to maintain the area navigation capability harmonised as PBN RNAV. Simultaneously, an RNP capability will be developed through the availability of RNP navigation specifications in all classes of airspace.

Namibia operates a small ground based radionavigation aid network, which provides aircraft with approach to land guidance when required. Of the 17 public and private aerodromes listed in the Namibian

Aeronautical Information Publication (AIP), 12 are listed as being capable of supporting Instrument Flight Rules (IFR) operations. Of these 12 aerodromes, three have published instruments approach procedures.

This equates to:

17% of all aerodromes providing an instrument approach procedure; or

25% of all IFR aerodromes providing an instrument approach procedure.

Only one aerodrome, Hosea Kutako International (FYWH), provides a vertically guided approach using Instrument Landing System (ILS) to one runway end. At the other two aerodromes, approaches are flown with lateral guidance only using VHF Omni directional Range (VOR) radionavigation aids.

Walvis Bay (FYWB) has an ILS installed however this radionavigation aid has never been commissioned. There are no approaches using Non Direction Beacon (NDB) as these have all been withdrawn.

These radionavigation aids use 75-year-old technology and are becoming increasingly expensive to install and maintain. APV procedures using GNSS and/or Barometric Vertical Navigation (Baro-VNAV) provide continuous lateral and vertical guidance without the need for ground based navigation aids.

APV approaches are also recognised internationally as being up to 8 times more safe than procedures using lateral guidance only. Lack of vertical guidance during approach to land is a major contributing factor to accidents involving Controlled Flight into Terrain (CFIT). Such accidents almost always result in 100% fatalities.

APV are an ICAO safety initiative directed at reducing the rate of high fatality CFIT accidents, which are typical in approach to land operations without vertical guidance. ICAO recognises Baro-VNAV and augmented GNSS as suitable to support vertical guidance.

Baro-VNAV is available in modern jet and regional aircraft and augmented GNSS is suitable for older and smaller aircraft. Namibia does not have a GNSS augmentation system such as Space Based Augmentation System (SBAS), or the European Geostationary Overlay Navigation Service (EGNOS).

Benefits

The introduction of PBN enables significant safety, efficiency and environmental benefits both now and into the future. Accurate lateral and vertical guidance for arrival and approach operations greatly enhance safety. Optimised lateral and vertical flight paths enhance efficiency and reduce fuel burn and emissions. Other benefits of PBN include:

Oceanic and Continental operations

Arrival and Approach operations utilising Continuous Descent Operations (CDO)

Reduced cost through adoption of global standards

Reduced reliance on ground based navigation aids through use of GNSS and PBN

Proposed Timeline and Key Stakeholders

The table below is indicative only and will be subject to normal project differences.

Time line	Activity	Stakeholders
December 2014 – September 2015	RNP APCH design, validation and deployment and associated requirements (e.g. RAIM) PBN Airspace and Air Routes Review, redesign as required Air Traffic Management Review ATC and pilot Education programmes Fleet Equipage Regulation Development and Implementation Safety Activities	ANSP Flight Procedures Designers Operators Airspace Designers Safety Regulator
December 2014 – December 2016	PBN Airspace Implementation specifically RNP10, RNAV 5, RNAV 1 (or RNP 1) Finalise PBN related Regulations	ANSP Regulator Safety Airspace Designers

Methodology

Namibia's transition to PBN is based upon:

- Maintaining the present area navigation capability while transitioning to using the ICAO PBN specifications.
- Introduction of limited APV capability through the use of Baro-VNAV.
- Utilise GNSS as the enabler for the implementation of PBN where possible

Namibia's PBN Implementation will encompass the AFI Regional Performance Based Navigation Implementation Plan.

This is a living document and will be amended and updated as required.

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1 About the Strategy

1.1 Background

ICAO, at the tenth Air Navigation Conference (ANC-10) in 1991 set direction that aviation worldwide should adopt satellite navigation as the means of navigation for all phases of flight. The initial deployment of GNSS had been slower than originally anticipated. However the combination of increasing State approvals and supply and development of new aircraft with integrated GNSS capability has resulted in increasing acceptance and use of satellite based navigation.

At the eleventh Air Navigation Conference (ANC-11) in 2003, the recommendation to adopt satellite navigation was re-affirmed. ANC-11 encouraged more rapid deployment of satellite navigation and introduced Performance Based Navigation (PBN) as the implementation framework.

The ICAO 36th Assembly in 2007 re-affirmed the direction to adopt satellite navigation and PBN. It also set direction for the adoption of APV as the primary instrument approach procedure or as a backup to precision approach procedures.

In October 2011, the ICAO 37th Assembly made the following resolution:

ICAO Assembly Resolution A37/11:
Recognising that not all States have developed a PBN Implementation Plan by the target date of 2009:

1. *Urges* all States to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with the 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:

   implementation of RNAV and RNP operations (where required) for en route and terminal areas according to established timelines and intermediate milestones;
   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 per cent by 2010, 70 per cent by 2014; and
   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 available 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 harmonised Standards and Recommended Practices

(SARPs), Procedures for Air Navigation Services (PANS) and guidance material including a global harmonised 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 5 700 kg or more, according to established timelines and intermediate milestones.

Targets for implementation were set as follows:

Operational Use	2010	2012	2016
PBN Oceanic	70%	⇒	100%
PBN En-route	70%	⇒	100%
PBN Terminal	30%	50%	100%
RNP Approach	30%	50%	100%

Figure 1. PBN Implementation Targets AFI PBN Implementation Plan

The intention of the ICAO recommendation to adopt PBN is to standardise and harmonise the deployment of area navigation, which is recognised as a necessary enabler for modern ATM applications. This will increase safety, operating efficiency and minimise environmental impact.
RNAV, RNP and PBN all share a common denominator, N, for Navigation. This forms part of and is integral to the CNS/ATM philosophy; Communication, Navigation, Surveillance / Air Traffic Management, and the standardisation and harmonisation of worldwide practices.

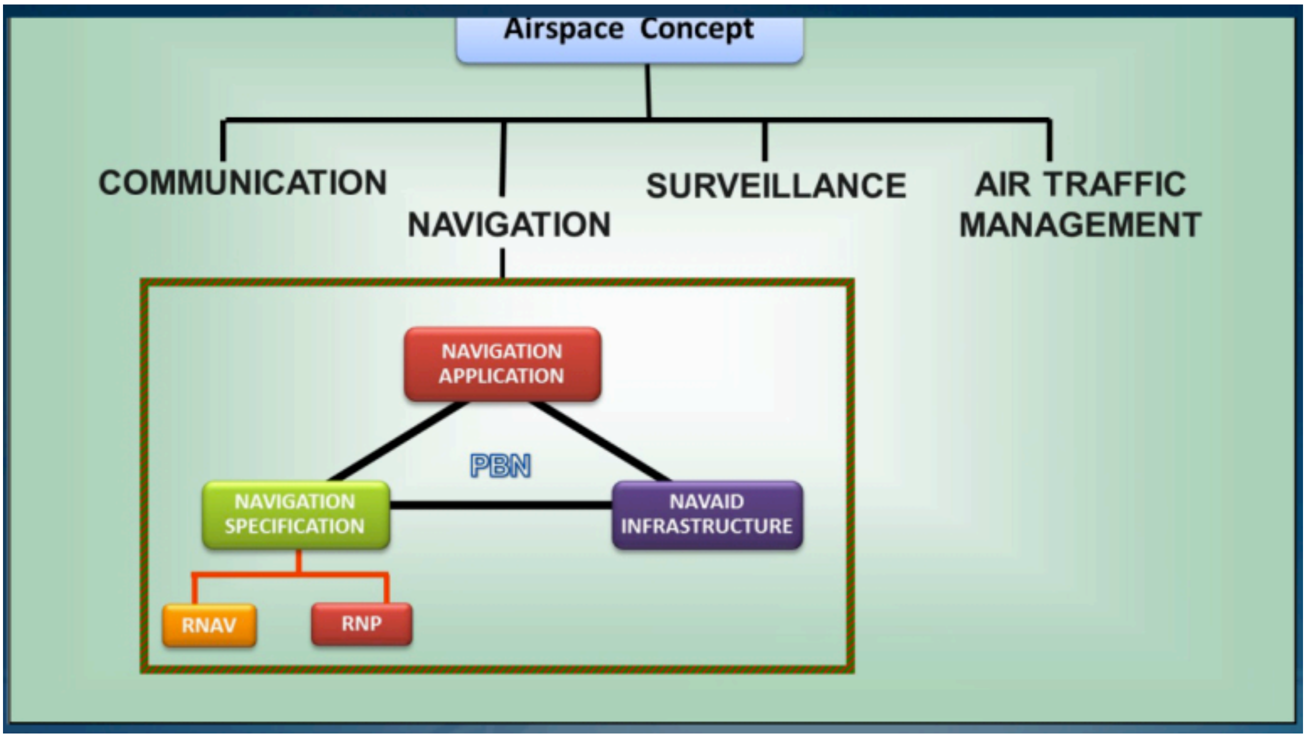

Figure 2.1:Where PBN fits with CNS/ATM

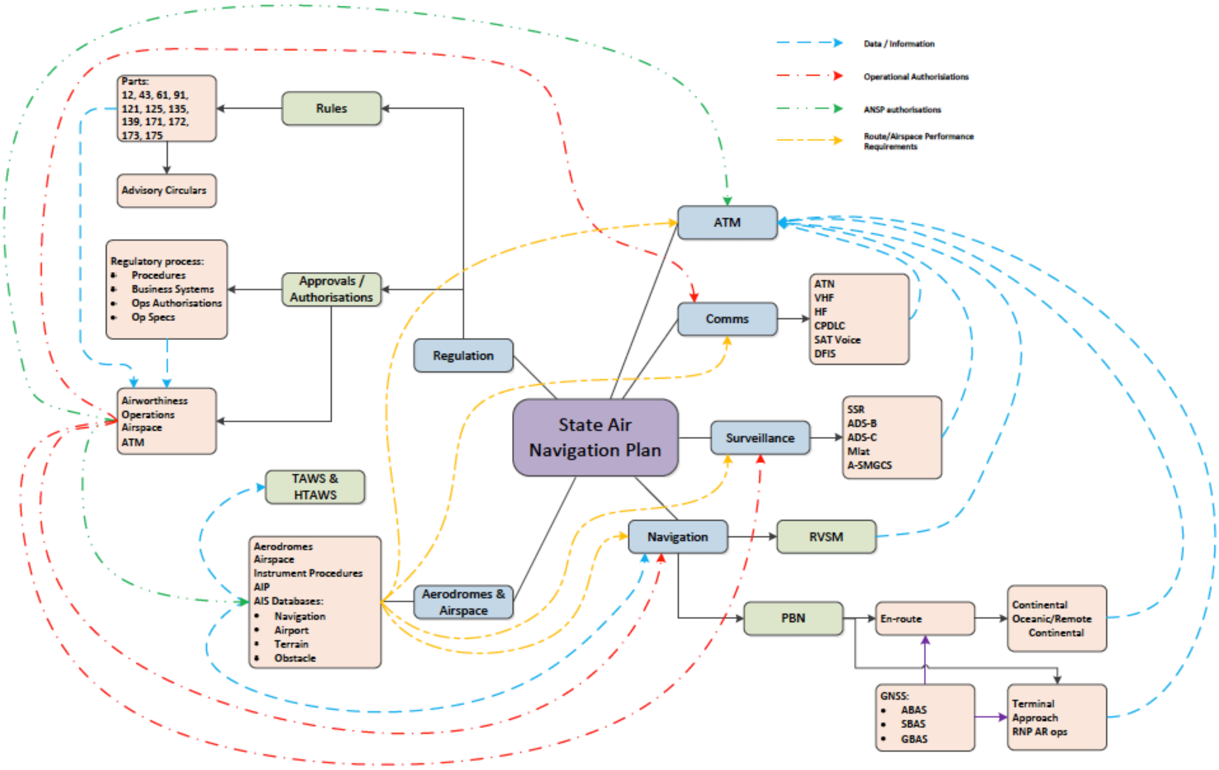

Figure 2.2: Where PBN fits in an organisation

The intention of the ICAO direction to adopt APV as the primary instrument approach procedure or as a backup to precision approach procedures is to significantly reduce the risk of CFIT, runway undershoot and overrun through the provision of continuous lateral and vertical guidance during instrument approach to the runway. As a result, Non Precision Approaches would be phased out resulting in the APV being the minimum world wide standard for an instrument approach to land procedure.

1.2 Objectives

The Namibian PBN Implementation Plan will aim to meet the following strategic objectives:

- provide a strategic transition from route based navigation using ground based navigation aids to area navigation using satellite navigation. This is based on the ICAO PBN concepts of RNAV and RNP navigation specifications which will apply to aircraft conducting instrument approaches, Standard Instrument Departures (SID), Standard Instrument Arrival (STAR) and fixed and flexible routes in oceanic and continental airspace, in accordance with ICAO resolution A37/11
- ensure the implementation of the CNS/ATM is based on clearly defined operational requirements
- avoid unnecessary imposition of multiple operational approvals for operators
- prevent commercial interests from supplanting ATM operational requirements
- prevent generating unnecessary costs for authorities, agencies or airspace users
- to assist the aviation community to plan and transition to the PBN RNAV and RNP concepts
- to assist the aviation community to forecast future equipage

2 Performance Based Navigation

2.1 Introduction

ICAO has set worldwide direction to transition to Performance Based Navigation and Approaches with Vertical Guidance. PBN RNAV and RNP specifications define navigation performance and other requirements for aircraft navigating along a route, in defined airspace or on an instrument approach.

Navigation performance requirements are defined in terms of accuracy, integrity, availability, and continuity for a particular operation in particular airspace. Navigation specifications also identify technology, systems and procedures, which are suitable to meet the performance requirement.

Area navigation is a method of navigation, which permits aircraft operation on any desired flight path. This allows more flexible and efficient aircraft operation compared to the traditional flying along fixed routes denoted by ground based radio navigation aids. Early area navigation systems required ATC navigation monitoring, typically by radar surveillance. The PBN RNAV specifications are applicable to these systems.

Modern area navigation avionics include performance monitoring and alerting. This allows for flight crew monitoring of navigation integrity rather than ATC. This is necessary with very high accuracy navigation (0.3 to 0.1 NM), as it is impractical for ATC to detect errors of this size and successfully intervene. Aircraft with RNP capability are also RNAV capable.

RNP standards are the more capable PBN specification and are recognised worldwide as the navigation standard that should be adopted in order to support improvements in safety, efficiency and environment:

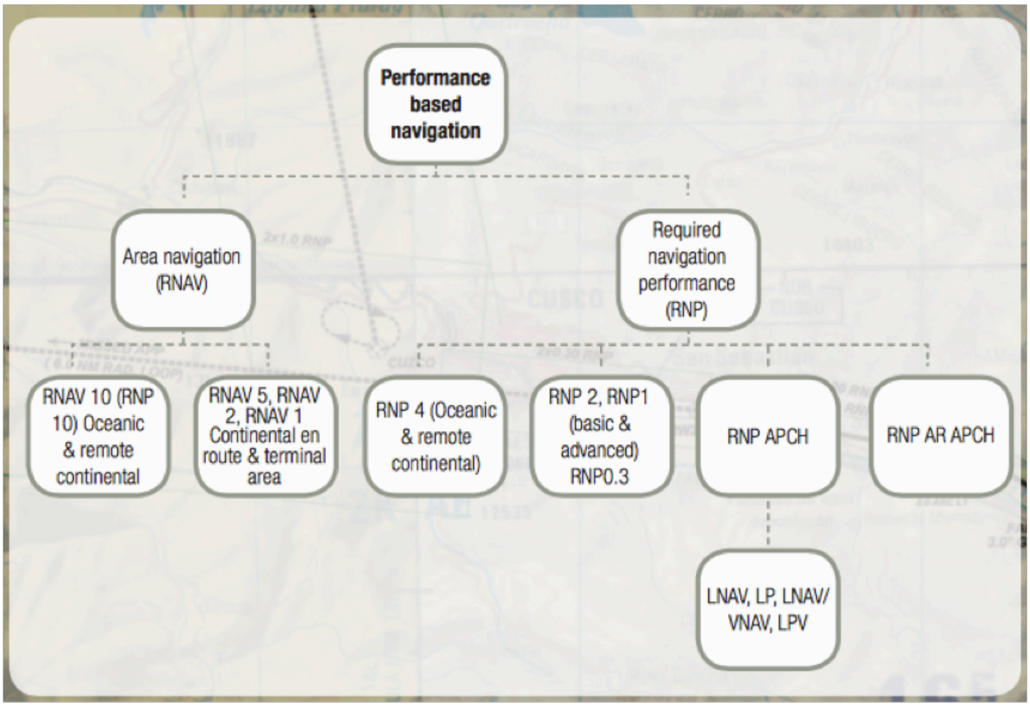

Figure 3: Performance Based Navigation Overview

2.2 Key Concepts

2.2.1 Area Navigation

Area Navigation (RNAV) Operations permit aircraft to fly on any desired flight path within the coverage of ground based navigation aids, and within the limits of the capability of the on board self- contained navigation systems.

RNAV was developed to provide more lateral freedom and thus more complete use of available airspace and efficient aircraft routing and operations. This method of navigation does not require direct tracking to or from any specific ground based radio navigation aid, and has three principal applications:

A route structure can be organised between any given departure and arrival point to reduce flight distance and traffic separation;
Aircraft can be flown into and out of terminal areas on pre-programmed arrival and departure paths to expedite traffic flow; and
Instrument approaches can be developed and certified at certain airports, without ground based navigation aids at that airport.

Navigation systems that provide RNAV capability include VOR/DME, DME/DME, LORAN C (phased out in February 2010), GPS, OMEGA (no longer in use) and self contained Inertial Navigation Systems (INS) or Inertial Reference Systems (IRS). RNAV can be supported by a variety of technologies such as multiple DME, INS updated by DME/DME or DME/VOR and GNSS.

The advent of the Flight Management System (FMS) as an onboard aircraft system allowed for the exploitation of RNAV procedures worldwide. The FMS also allowed for well defined and predetermined Vertical Navigation (VNAV) path operations giving greater certainty and efficiency to aircraft operations.

However, RNAV operations had no containment parameters to closely restrict operations from a lateral perspective, resulting in unnecessarily large separation standards and procedures for aircraft. The full benefit of RNAV could not be realised.

An RNAV specification is a navigation specification, which does not include requirements for on-board performance monitoring and alerting.

2.2.2 Required Navigation Performance (RNP)

Required Navigation Performance (RNP) Operations permit aircraft to fly on any desired flight path within the coverage of ground based radio navigation aids or by use of GNSS, within the limits of the capability of the onboard self-contained navigation systems, or a combination of these.

An RNP specification is a navigation specification, which includes requirements for on-board performance monitoring and alerting. RNP can be supported by a variety of technologies such as multiple DME, INS supported by DME/DME or DME/VOR and GNSS.

The advent of RNP allowed for more precise navigation tolerances. In the en-route phases of flight this saw the introduction of smaller separation standards making more efficient use of available airspace.

In the approach and departure phases of flight smaller navigation specifications meant more efficient use of terminal airspace and better access to challenging airports.

In order to harmonise aircraft equipage, operations and navigation specifications globally, PBN was born.

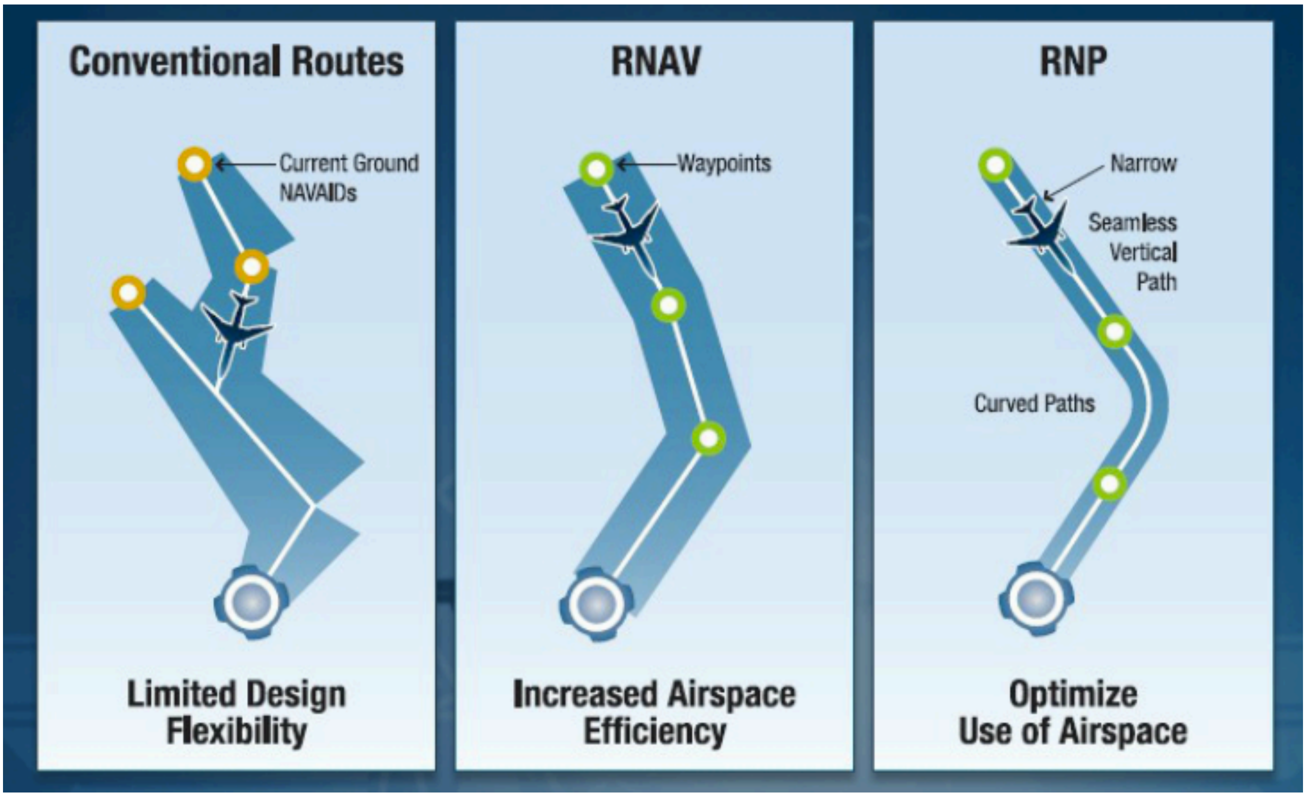

Figure 4: Development of navigation

2.2.3 Performance Based Navigation (PBN)

PBN is defined as area navigation based on performance requirements for aircraft operating along an ATS route, on an instrument approach procedure or in a designated airspace. PBN represents a fundamental shift from a sensor based navigation concept to a performance based navigation concept. Navigation specifications need no longer be met through prescribed equipment components, such as INS or VOR receiver, but rather through an aircraft's navigation systems ability to meet prescribed performance criteria.

The PBN concept recognised that advanced aircraft RNAV systems are achieving a predictable level of navigation performance accuracy, which, together with an appropriate level of functionality, allows a more efficient use of available airspace to be realised.

Under PBN, a navigation specification is either an RNAV specification or an RNP specification. Both RNAV and RNP must meet the same navigation performance requirements however an RNP specification includes a requirement for on-board performance monitoring and alerting while an RNAV specification does not.

2.3 Standard Instrument Departures and Standard Instrument Arrivals

2.3.1 Standard Instrument Departure (SID)

SIDs are designated Instrument Flight Rule (IFR) departures route linking an aerodrome or a specified runway of an aerodrome with a specified significant point, normally on a designated ATS route, at which the en-route phase of flight commences. Major aerodromes typically have a family of SIDs which link each runway end to the start of each major air routes.

2.3.2 Standard Instrument Arrival (STAR)

STARs are a designated IFR arrival route linking a significant point, normally on an ATS route, with a point from which a published instrument approach procedure can be commenced. Major aerodromes typically have a family of STARs which link major air routes to instrument approach procedures.

SIDs and STARs can be conducted under either RNAV or RNP navigation specifications.

2.4 Approach Procedures

Conventional approach procedures include ILS, VOR, and NDB. These procedures exclusively use ground based navigation aids as the basis of the procedure design. Under PBN there is no requirement for ground based navigation aids to support the procedure although they may be incorporated into the missed approach procedure if desired. PBN does not include RNAV approach specifications as integrity monitoring is required for approach operations. Consequently RNAV (GNSS) approaches have been reclassified as RNP APCH - LNAV. This is reflected in the performance specifications where only RNP APCH specifications include a lateral accuracy value for all segments of an instrument approach (initial, intermediate, final and missed).

Precision Approach (PA) procedures such as ILS, Microwave Landing System (MLS) and GNSS Landing System (GLS) are not included in the PBN Standards and hence are not addressed here. It should be noted that PBN/RNP Arrival/ Approach procedures can terminate in an ILS, MLS or GLS Procedure.

All PBN instrument approach to land procedures use the GNSS (either non- augmented or augmented signals) for lateral navigation (LNAV) guidance. Where vertical navigation (VNAV) guidance is provided either Baro-VNAV or augmented GNSS is used. There are two classes of RNP approach operations, RNP APCH and RNP AR APCH. The fundamental differences between them are:

- The RNP value of the final approach segment is fixed at 0.3nm for RNP APCH and may vary from 0.3nm to 0.1nm for RNP AR APCH
- RNP APCH may include vertical guidance; RNP AR APCH always includes vertical guidance
- RNP AR APCH operations requires specific crew training and operational approval

There are four types of RNP APCH procedures; they are:

RNP APCH:

LNAV: where lateral guidance is provided by the GNSS Signal In Space (SIS)

LNAV/VNAV: where lateral guidance is provided by the GNSS SIS and vertical guidance is provided by barometric vertical navigation (Baro-VNAV);

LP (Localiser Performance): where lateral guidance equivalent to a localiser approach is provided by augmented GNSS SIS; and

LPV (Localiser Performance with Vertical guidance): where lateral and vertical guidance is provided by augmented GNSS SIS.

An RNP AR APCH is flown using non-augmented GNSS SIS and barometric vertical navigation and is applicable to aircraft equipped with GNSS multi-sensor navigation systems and suitably capable Flight Management Systems. RNP AR APCH utilise LNAV/VNAV minima based upon the RNP accuracy value which is between 0.3 and 0.1NM for current operations.

The advent of approaches with vertical guidance has introduced a third classification of instrument approach procedure into ICAO vernacular - APV. The classifications of instrument approach to land procedures are therefore:

Non-Precision Approaches (NPA)

Approaches with Vertical guidance (APV)

Precision Approaches (PA).

These are illustrated in the table below:

Approach Classification	Approach Type
Non precision Approach (NPA)	NDB VOR DME (GPS) Arrival RNP APCH (0.3NM) LNAV (Currently termed RNAV(GNSS)) LP (augmented GNSS required)
Approach with Vertical Guidance (APV)	RNP APCH (0.3NM) LNAV/VNAV (Baro-VNAV) LPV (augmented GNSS required) RNP AR APCH (0.3NM and below) LNAV/VNAV (Baro-VNAV)
Precision Approach	ILS MLS GLS

Figure 5. Approach Types

2.5 Approaches with Vertical Guidance

ICAO defines an APV as "An instrument approach procedure which utilises lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations". ICAO recognises Baro-VNAV and augmented GNSS SIS as suitable technologies to support vertical guidance applications and has enabled APV operations through the development of PansOps procedures for both Baro-VNAV and augmented GNSS.

APV are:

RNP APCH - LNAV/VNAV

Baro-VNAV approach procedures that include system performance monitoring and alerting for lateral navigation errors in the GNSS SIS and must meet demonstrated system accuracy requirements for the vertical navigation source (altimeter)

RNP APCH - LPV

SBAS approach procedures that include system performance monitoring and alerting for lateral and vertical navigation errors in the GNSS SIS. LPV are a landing system design and can be considered as a GNSS enabled ILS

RNP AR APCH

Baro-VNAV approach procedures that include system performance monitoring and alerting for lateral and vertical error budget requirements for the vertical navigation source (altimeter)

2.6 PBN RNAV

Capabilities

PBN RNAV is the less capable of the two families of PBN navigation specifications. RNAV is insufficient to support many of the new and future Air Traffic Management (ATM) applications, eg. 3 dimensional, or 4 dimensional ATM concepts.

The PBN RNAV Navigation Specifications are:

RNAV 10: (known as RNP-10) intended for oceanic and remote continental operations
RNAV 5: intended for continental en route operations
RNAV 2: intended for terminal areas
RNAV 1: intended for terminal areas

The PBN RNAV Navigation Applications include:
RNAV SID: applied to terminal areas
RNAV STAR: applied to terminal areas

Note: In historical documentation RNAV 10 is referred to as RNP 10. RNP 10 is a member of the RNAV specification family. It is acknowledged that the cost of correcting documentation worldwide, to correct this anomaly, is excessive and not worth the effort.

2.7 PBN RNP

Capabilities

PBN RNP is the more capable of the two families of PBN navigation specifications. The on board navigation performance monitoring and alerting is a necessary enabler for many new ATM applications envisaged in strategic plans. Full RNP capability is available to the latest generation of aircraft families such as A320, A330, B737-NG and B787. This capability may be available to other late generation aircraft via modification processes.

The PBN RNP Navigation Specifications are:

RNP 4: intended for oceanic operations
RNP 2: intended for continental en route operations
Basic RNP 1: intended for terminal area operations

The PBN RNP Navigation Applications are:

RNP APCH	RNP AR APCH
LNAV	LNAV/VNAV
LNAV/VNAV	
LP	
LPV	

2.8 Current Status

Area navigation, particularly GNSS enabled area navigation, is well suited to the Namibian environment, which has the following characteristics:

Good surveillance coverage above FL145
Limited ground based radionavigation aids

Airspace	Navigation Specifications	AFI Near Term (2008-2012)	AFI Mid Term (2013-2016)	Namibia Current Status
En-route Oceanic	RNAV 10 / RNP 4	70% by 2010	100% by 2016	0%
En-route Remote Continental	RNAV 10 / RNP 4	N/A	N/A	N/A
En-route Continental	RNAV 5 / RNAV 2	70%	100% by 2016	0%
TMA Arrival/Departure	RNAV 1 / Basic RNP 1	30% by 2010 50% by 2012	60% by 2014 100% by 2016	0%
Approach	RNP APCH (Baro-VNAV) or RNP AR APCH if required	30% by 2010 50% by 2012	70% by 2014 100% by 2016	0%

Figure 6: PBN Targets and Namibian Status

2.9 Challenges

Safety Challenges

Safety challenges revolve largely around the safe operation of the ATM system during the transition to PBN operations. Gaps might occur within the CNS/ATM system. PBN addresses only the navigation aspect of the system and advances in navigation may out pace advances in communication and/or surveillance. Safety challenges possibly could include:

Integration into the ATM system including software enhance to support PBN
Safety monitoring of ATM system
Mixed fleet/system operations
Maintenance of a Target Level of Safety (TLS)
Continued evolution of PBN navigation specifications and their deployment in the ATM system
Development of supporting rule set and regulations
Education and training of stakeholders
Approach naming and charting conventions
Data base integrity and control
Viability of RNP APCH at terrain challenged aerodromes (Hosea Kutako and Eros)
GNSS system performance and availability of RAIM prediction service

ICAO has designed PBN such that it can be supported by terrestrial radio navigation aids or self contained aircraft navigation systems (inertial and/or GNSS), however Namibia's small existing network of ground based radio navigation aids is insufficient to support PBN navigation specifications.

PBN implementation in Namibia will be supported by self contained aircraft navigations systems which are GNSS based.

Namibia will maintain a small network of ground based radio navigation aids to provide an alternative means of navigation for terminal operations and Non-Precision Approach (NPA) using conventional navigation procedures.

A RAIM prediction service will be required to support PBN.

A weather service system will be required to support APV Baro-VNAV operations.

Approximately 22 APV (Baro-VNAV) procedures will need to be designed, validated and implemented.

3 Implementation

3.1 Targets - AFI Mid Term (2013-2016)

The AFI PBN Implementation Plan Near Term (2008-2012) targets cannot been met. Therefore it is appropriate to deal with and concentrate fully on successful implementation of the AFI Mid Term (2013-1016) targets. A Summary Table appears below:

Airspace	Navigation Specifications	AFI Mid Term (2013-2016)
En-route Oceanic	RNAV 10 / RNP 4 (where required)	100% by 2016
En-route Remote Continental	RNAV 10 / RNP 4 (where required)	N/A
En-route Continental	RNAV 5 / RNAV 2 (where required)	100% by 2016
TMA Arrival/Departure	RNAV 1 / Basic RNP 1	60% by 2014 100% by 2016
Approach	RNP APCH (Baro-VNAV) or RNP AR APCH where required	70% by 2014 100% by 2016

Figure 7: AFI PBN Mid Term Targets

In order to achieve this a coordinated and concentrated effort will be required over several disciplines and areas including:

Safety
Airspace
Operators
Airworthiness
Flight Operations
Pilot Licensing (PEL)
Regulatory / Legal (LEG)
Flight Procedures Design
Air Navigation Service Provider (ANSP)

Implementation strategies will run concurrently to achieve the desired outcomes.

3.2 Process for Implementation

3.2.1 Determine Requirements

Develop an Airspace Concept
Decide on required objectives
Develop airspace and user requirements
Note current baseline and estimate benefits to be had

3.2.2 Navigation Specifications for Implementation

Driven from AFI PBN Regional Plan for En-route and Terminal
En-route requirements for RNAV 5
Terminal requirements for either RNAV 1 or RNP 1
RNP APCH LNAV/VNAV
Develop national standards

3.2.3 Planning and Implementation

Develop PBN Safety Plan
Validate Airspace Concept
Commence procedure design
Ground and flight validation of procedures
Decide on implementation
ATC system integration and amendment as necessary
ATC and pilot training material
Define operational implementation date (rolling implementation for aerodromes)
Post Implementation Review

3.3 Priorities for Implementation

3.3.1 December 2014 – September 2015

- RPN APCH LNAV/VNAV
    - APV Baro-VNAV criteria
    - Backup at ILS equipped aerodromes
    - Primary approach at non-ILS aerodromes
    - Provides instrument approaches to runway ends not previously serviced
- Airspace Review
    - Eros airspace review
    - National Review
    - Intermediate SID/STAR implementation pending deployment of RNP APCH at Hosea Kutako and Eros airports

- ATM review for above:
  - Procedures
  - Eurocat X system for capability recognition
- Fleet equipage
  - Determines navigation specifications
- Regulation implementation
  - Part 61 pilot licensing
- Operators
  - Fleet approvals
  - Pilot certification
- Provision of RAIM prediction service

3.3.2 December 2014 – December 2016

- PBN oceanic/en-route/terminal
  - RNAV10 or RNP 4 for oceanic airspace
  - RNAV 5 for continental en-route airspace
  - RNAV 1 /RNP 1 for terminal navigation applications
- Airspace
  - National Review
  - Harmonisation with neighbours
  - Area QNH possible implementation
- Regulation
  - Finalise regulations for full PBN implementation

3.4 Collaborative Decision Making

ToR7: Apply the concepts of Collaborative Decision Making (CDM) as envisaged in ICAO guidelines

3.4.1 ICAO CDM guidelines.

ICAO Doc 9854 Global Air Traffic Management Operational Concept, Appendix 1 - 10 annunciates the basic guidelines for Collaborative Decision Making (CDM):

10. COLLABORATIVE DECISION MAKING

10.1 Collaborative decision making will allow all members of the ATM community, especially airspace users, to participate in the ATM decision making that affects them. The level of participation will reflect the level to which a decision will affect them.
Appendix I. The Concept — Explanations and Examples I-13

10.2 Collaborative decision making will apply to all layers of decisions, from longer-term planning activities through to real-time operations. It will apply across all concept components of the ATM system and is an essential element of the operational concept.

10.3 Collaborative decision making means achieving an acceptable solution that takes into account the needs of those involved. All participants will therefore require a spirit of cooperation. A balance is required because collaborative decision making is primarily invoked to resolve competing demands for an ATM resource and to organize a safe sharing of that resource among airspace users.

10.4 The time available for achieving a collaborative decision decreases from the strategic to the tactical stages. In the most tactical of situations, there may be no time to consider options; however, wherever such situations can be foreseen, collaborative decision making will have been previously used to determine agreed procedures for such cases. For example, rules for determining priorities for accessing an ATM resource will have been collaboratively agreed in advance. Therefore collaborative decision making can be applied both actively and, through agreed procedures, passively.

10.5 Effective information management and sharing will enable each member of the ATM community to be aware, in a timely manner, of the needs, constraints and priorities of other members in relation to a decision-making issue.

10.6 Collaborative decision making can occur among airspace users directly, without any involvement of an ATM service provider.

It will be these guidelines which form the basis of all decision making process in order to gain a productive and efficient outcome for all airspace users.

Essential is the coordination between Air Navigation Services of the Directorate of Civil Aviation and those adjacent to Namibia. Adjacent ANSP's include the Air Traffic and Navigation Service Provider (ATNS South Africa), The Civil Aviation Authority of Botswana (CAA Botswana), and the Direcção Nacional de Aviação Civil, Angola This is imperative to ensure harmonisation with and the application of the AFI PBN Implementation

Plan. ATNS appears to be the lead country in this region for PBN Implementation. Initiatives will be drawn from their experience.
Regional planning groups will be consulted and attended in order to ensure harmonisation of PBN in line with the AFI Regional PBN Implementation Plan. Regional groups include:

- AFI Planning and Implementation Regional Group (APIRG)
- Southern Africa Development Community (SADAC)

3.4.2 National PBN Implementation Consultative Forum (NPICF)

ToR5: Coordinate the establishment of a National PBN Implementation Consultative Forum (NPI-CF)
ToR6: Ensure that the NPI-CF is involved at appropriate and relevant stages of PBN related planning, design and validations.

The National PBN Implementation – Consultative Forum (NPI-CF) will be established, comprising representatives from all stakeholders involved with the implementation and continuation of Performance Based Navigation (PBN) in the Windhoek FIR. It is envisaged this group will meet monthly at the outset then as required.

It is appropriate that the Director, Directorate of Civil Aviation, is the Sponsor for the NPICF.

Stakeholders comprise the following agencies:

- Director DCA as Sponsor
- The Directorate of Civil Aviation
    - Flight Operations
    - Aerodromes
    - Air Navigation Services
    - Airworthiness
    - Legal
    - Regulatory
    - Licensing
- Local and foreign air operators using the airspace including Air Namibia, Government Air Transport Services (GATS), West Air and other operators.
- Pilots
- Air Traffic Controllers
- Airspace and flight procedures planners and designers
- National Airspace Committee
- Civil aviation regulator
- Military aviation
- Airports planning (including the Namibian Airports Corporation)
- Operational expertise representatives
- AOPA

3.4.3 Working Group NPICF sub group

From the NPICF a working group of 6 members (flexible) shall be established to undertake research and planning on issues related to PBN Implementation. This working group shall report to the NPICF at the meetings on progress made, or on request from the Sponsor.

The table below indicates those users involved in the NPI-CF at this stage. Members will be added as required throughout the process.

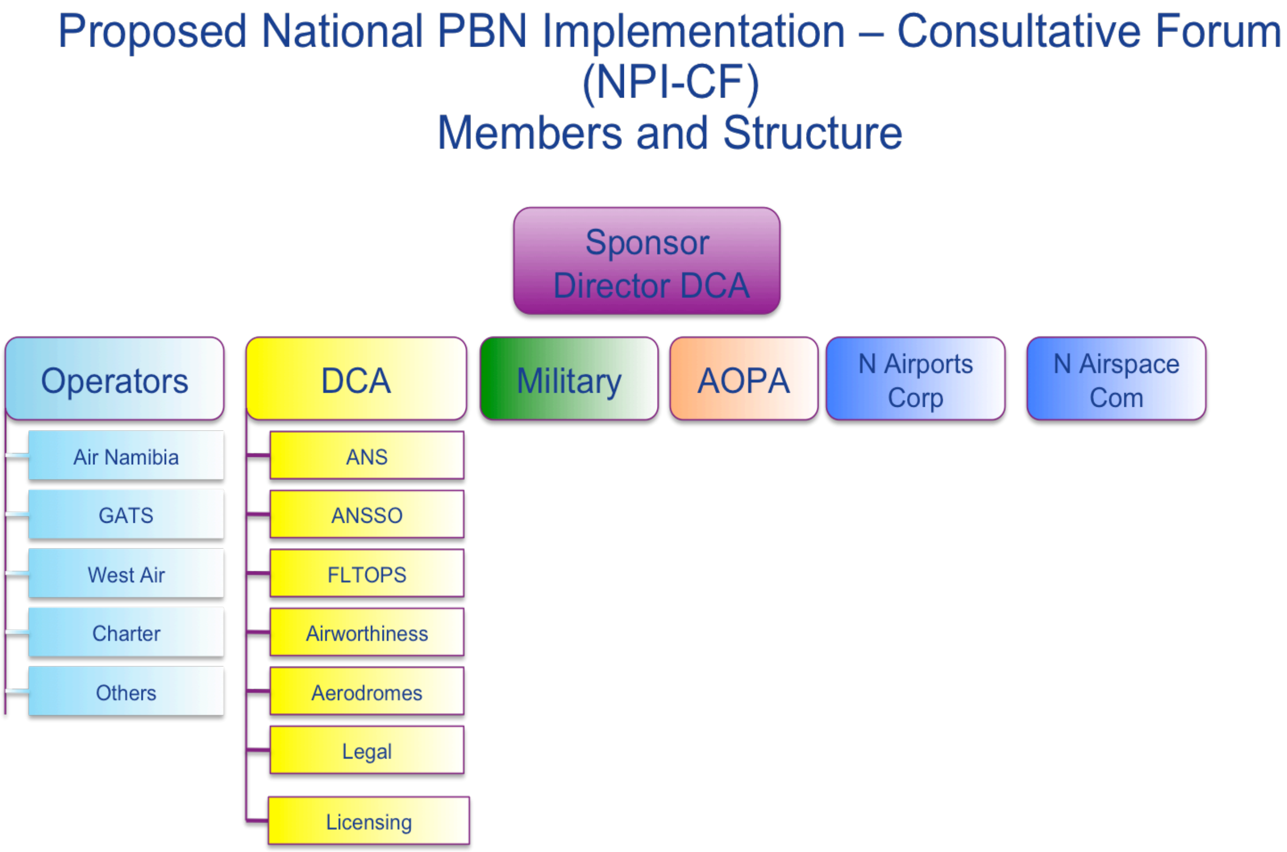

Figure 8.1: proposed NPICF structure

Figure 8.2: Working Groups

4 Regulatory / Legal (LEG)

ToR3: In coordination with the DCA counterparts and Air Law Expert, draft input for the development and promulgation of national civil aviation regulations relating to PBN implementation.

4.1 Overview

The basis of the current legislative framework for civil aviation in Namibia is the Civil Aviation Act of 1962 (Act no. 74 of 1962) , which in turn was amended by Acts of Parliament promulgated in 1991 and 1998. This legislation is supported by the Civil Aviation Regulations, generally termed the NAMCARs. The core set of NAMCARs was gazetted in 2001. Various Technical Standards have been issued and published in the Gazette on the basis of the NAMCARs by the Director.

It is expected that a new Civil Aviation Act will be enacted early 2015, establishing the Namibian Civil Aviation Authority (NCAA).

Supporting the new Civil Aviation Act, a set of Civil Aviation Regulations (NAM-CARs) will be developed by the ANSSO section for consultation, approval and promulgation. It is expected that this supporting legislation and associated standards will be in place by early 2015.

The Regulations relevant to PBN Implementation will comprise:

- NAM-CAR Part 61 Flight Crew Licensing (Revised)
- NAM-CAR Part 71 Airspace Management (ASM) – NEW (revised and moved from part 172)
- NAM-CAR Part 91 General Operating and Flight Rules
- NAM-CAR Part 121 Air Transport Operations – large aeroplanes
- NAM-CAR Part 127 Air Transport Operations - Helicopters
- NAM-CAR Part 135 Air Transport Operations – small aeroplanes
- NAM-CAR Part 172 Air Traffic Services (ATS) - REVISED
- NAM-CAR Part 173 Instrument Flight Procedure Design Services (PDS) - NEW
- NAM-CAR Part 174 Aviation Meteorological Services (MET) - REVISED
- NAM-CAR Part 177 ICAO Charts – REVISED or INCORPORATED WITH PART 175

Underpinning the regulations, a set of Civil Aviation Technical Standards (NAM-CATS) will also be developed (for new CARs) or amended (for existing CARs) against each of the CARs.

Operational Directives and Advisory Pamphlets are also used for operator guidance.

4.2 Current Status

Presently there are no PBN regulations attached to NAM-CARS 91, 121, 127 and 135 and no associated NAM-CATS. Technical standards are released through Operation Directive (OD) No 5 and Advisory Pamphlets (AP) 121 through 126.

The opportunity exists to develop a single point Regulation either through existing NAM-CAR Part 91 with references to NAM-CAR Part 91 in relevant sections of NAM-CARS 121, 127 and 135, or by way of a new Regulation covering PBN. This would then allow for the OD and AP's to be incorporated in the Regulations.

4.2.1 NAM-CAR Part 61

- Under review for PBN inclusion. To be added as a schedule to new CAA Act
- Currently there are no NAM-CATS associated with Part 61.

4.2.2 NAM-CAR Part 71

Under existing regulation NAM-CAR Part 172, the Director is responsible for Namibian airspace, with the Chief Air Traffic Controller being responsible for the management and use of the airspace. There is no regulation governing Air Routes. Under draft NAM-CAR Part 71 the Director of the proposed Namibian Civil Aviation Authority (NCAA) will be responsible for Airspace and Air Routes.

NAM-CAR Part 11, Subpart 5, 11.05.1 gives rise to the National Airspace Committee (NAC) instituted by the Director DCA. 11.05.2 directs the NAC to meet at least once every three months. The Director must consult with and get agreement from the NAC for any proposed airspace change. The new NAM-CAR Part 71 will delete reference to the NAC giving full authority to the Director.

4.2.3 NAM-CAR 172, 173, 174, 177

These are currently underdevelopment and review.

5 Air Traffic Management (ATM) System

ToR8: Evaluate the current ATM system, focusing on route structure, separation standards, equipage, maintenance, operations and procedures to identify any weaknesses.

5.1 Air Navigation Services

Air Navigation Services (ANS) are currently provided in Namibian territorial airspace, and international oceanic airspace administered by Namibia, by the ANS Division of the Directorate of Civil Aviation. ANS is provided across a range of functions as shown in Figure 2.1.

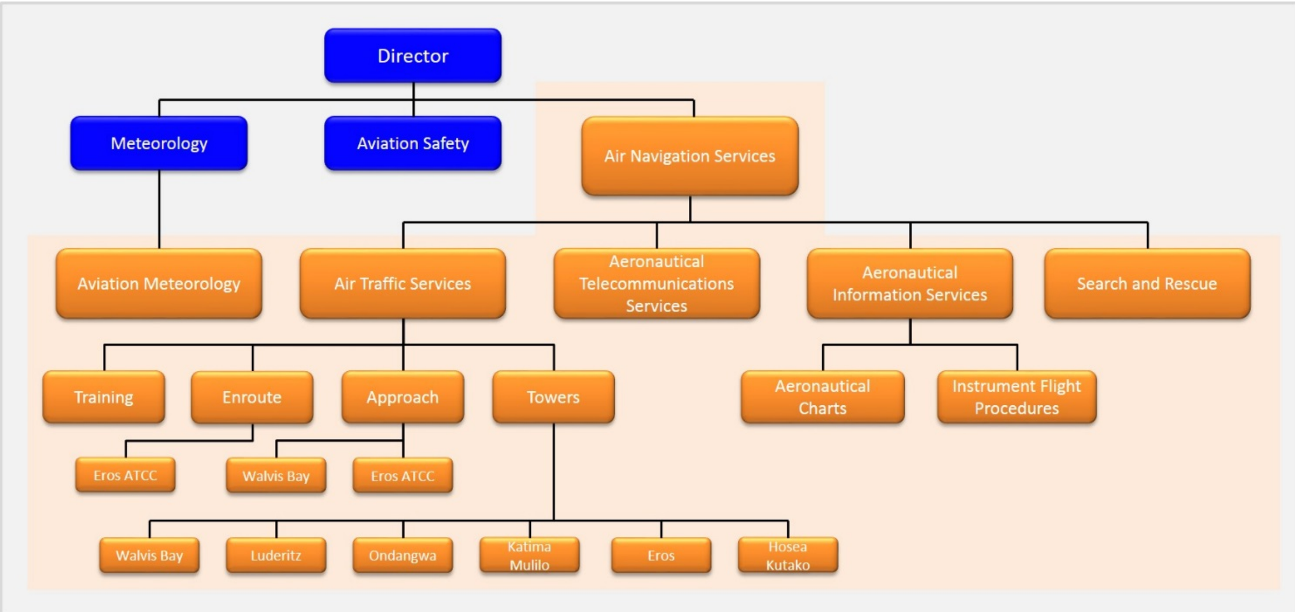

Figure 10: ANS Structure

5.2 Air Traffic Services

Air Traffic Services (ATS) are provided within the majority of the airspace of the territory of Namibia, and oceanic airspace extending west of the Namibian coastline to 10 degrees east. ATS in a portion of Namibia's assigned oceanic airspace are provided by South Africa. ATS in the upper airspace in the southern part of Namibia are also provided by South Africa. ATS in the upper airspace above the eastern Kavango and Zambezi regions are provided by Botswana.

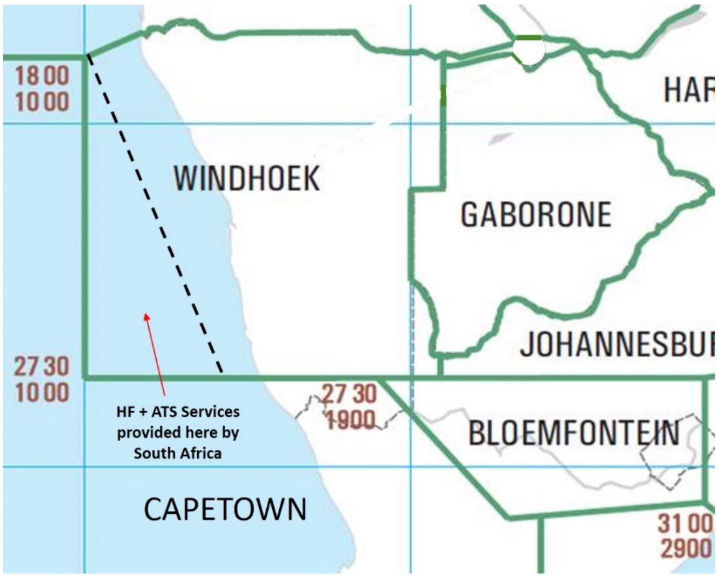

Figure 11: Windhoek Flight Information Region (FIR)

5.2.1 Air Traffic Control facilities

There is one major Air Traffic Control Centre (ATCC) for Namibia located at Eros Airport, Windhoek. This facility provides enroute Air Traffic Control (ATC) services in Namibian controlled airspace above FL145, Flight Information Services (FIS) for the whole of Namibia, and approach control (APP) services to Hosea Kutako International Airport and Eros Airport. Approach control services for Walvis Bay airport are currently provided from the Walvis Bay control tower.

An Air Traffic Control training facility is co-located with the ATCC. Training is conducted in the same room as live operations. There are facilities set aside for a new training area on the ground floor of the same building, however the move to these facilities has been delayed

There are 6 staffed Air Traffic Control towers in Namibia – Hosea Kutako, Eros, Walvis Bay, Lüderitz, Ondangwa, and Katima Mulilo. There are plans to staff two further towers at Keetmanshoop and Swakopmund.

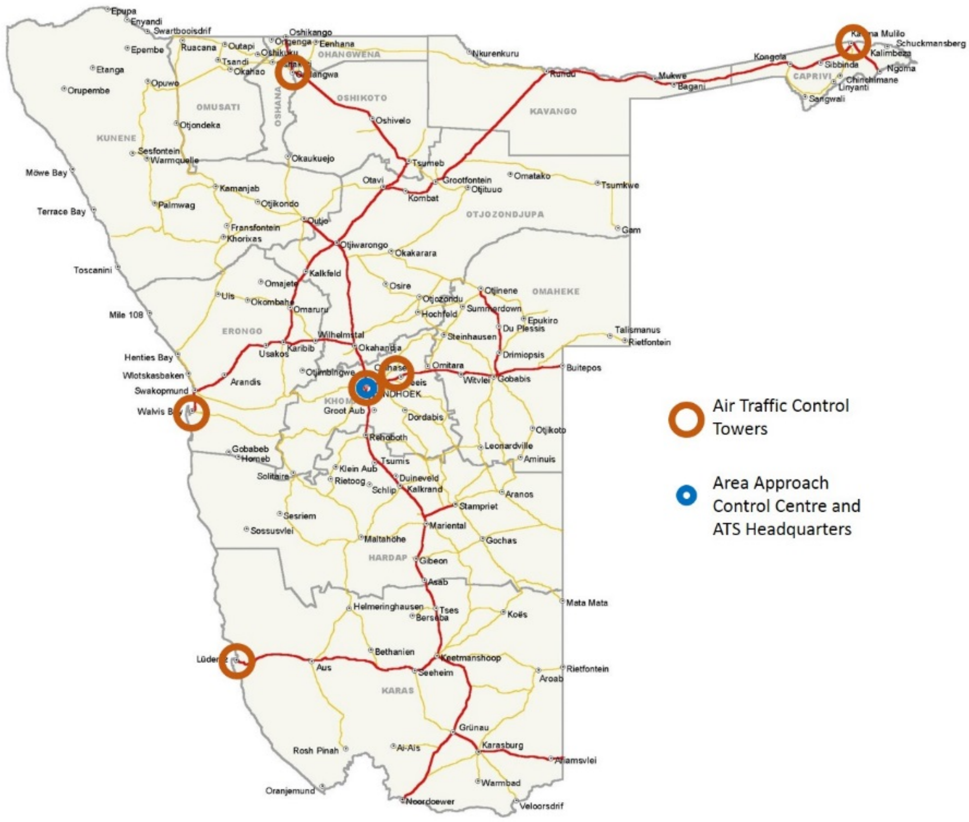

Figure 12: ATS Facilities Namibia

5.3 Communications, Navigation and Surveillance (CNS)

5.3.1 CNS Facilities

There is a network of 54 WAM stations and associated control facilities installed or planned for installation across Namibia.

Airspace above Flight Level 145 is subject to surveillance using the Wide Area Multi-lateration (WAM) system, comprising a network of antenna distributed across Namibia. The system interacts with both SSR transponders (Modes A, C and S), and Automatic Dependent Surveillance - Broadcast (ADS-B). There is also a single Monopulse Secondary Surveillance Radar (MSSR) located at Hosea Kutako International Airport. Mandatory transponder carriage requirements above FL145 ensure full surveillance coverage.

Hosea Kutako International Airport at Windhoek is serviced by both a primary terminal area surveillance radar (nominal 60NM coverage at altitude) supported by a Monopulse Secondary Surveillance Radar (MSSR) (nominal 250NM coverage at altitude).

There is a significant network of VHF radio outlets, navigation stations located across Namibia as detailed in Appendix A.

The primary CNS monitoring and engineering base is co-located with the Area Approach Control Centre at Eros Airport. There is one remote CNS maintenance facility located at Hose Kutako airport.

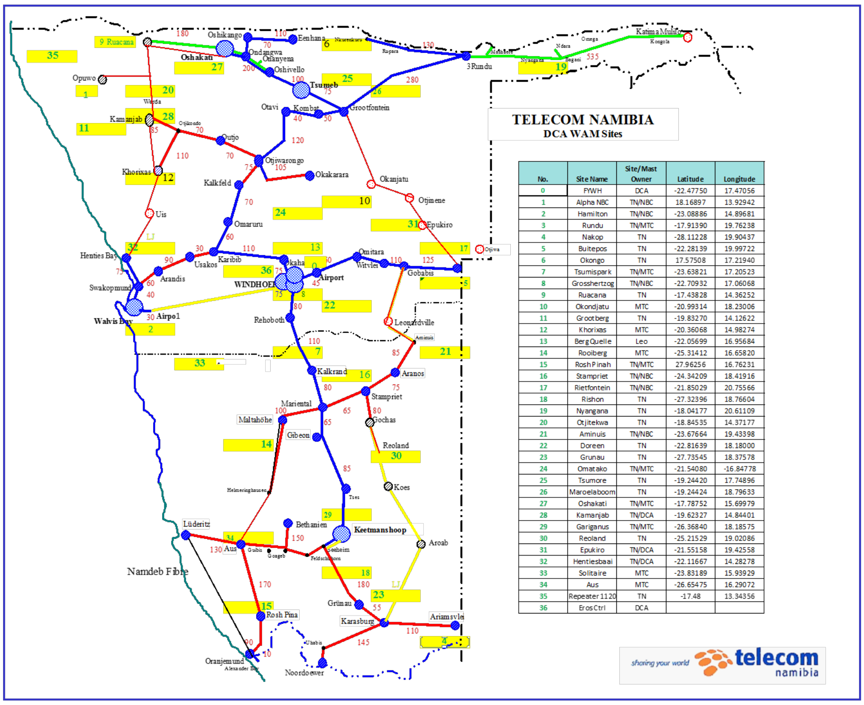

Figure 13: WAM Network Namibia

5.3.2 MET facilities

Meteorological data requirements for the use of APV's are local temperature and pressure readings being available from the site at which the approach is being conducted (ICAO DOC 9613 PBN Manual, Vol II Att A-2, 3.5 Service Provider Assumptions), and states *"These data must be from measurement equipment at the airport where the approach is to take place."*. If these data are not available the approach reverts to an LNAV only approach, thus diminishing the level of protection afforded to aircraft and passengers alike.

The Air Navigation Services (ANS) section of the DCA, in conjunction with a software provider, are in the process of developing an interface to connect the current Automatic Weather Stations to the Namibian Auxiliary Information Display (NAID) system with a new software upgrade to be released in December 2014. This will allow retransmission of real time data from these locations to the Air Traffic Services centre at Eros, for transmission to aircraft, when ATC services are not available on site.

Once the data is received at the local airport it will be routed to the main server at Eros Airport and will be made available from there to aircraft operating at these airports.

Airports currently being prepared are Katima Mulilo, Ondangwa, Keetmanshoop and Lüderitz. Walvis Bay is already connected to the system.

Information from the Deputy Director, Aviation, Administration and Navigation, indicates the project should be completed by March 2015.

5.4 Aeronautical Information Services

The Namibian AIP is published in 3 parts, is managed by AIS, and published under contract by ATNS South Africa. Similarly, aeronautical charts are published by ATNS South Africa. Both are amended on a 6 month cycle due to low amendment rate. Currently Namibia does not publish the full range of ICAO aeronautical charts but has trained staff with the capability to do so, subject to availability of appropriate equipment.

6 Airspace and Air Routes

ToR8: Evaluate the current ATM system, focusing on route structure, separation standards, equipage, maintenance, operations and procedures to identify any weaknesses.

ToR10: Undertake a gap analysis of existing and optimum airspace and ATM performance.

ToR14: Lead the process of airspace design pertaining to all terminal airspace in Namibia, with priority given to international airports, airports used by aircraft with MTOW exceeding 5700KG, high usage airports and other airports that may be prioritised based on ICAO guidance and national policies.

ToR15 Lead a team of PBN Implementation professionals including airspace designers and flight procedures designers.

6.1 Current Status

Airspace above Flight Level 145 is designated as Controlled Airspace Class A. Except where Class C airspace is established in the vicinity of the controlled aerodromes, the airspace below FL145 is uncontrolled (Class G). Control area steps (Class C) are used to connect aerodrome control zones (CTR) with overlying en-route controlled airspace at Hosea Kutako and Walvis Bay, and Eros. Terminal airspace around Luderitz, Ondangwa, and Katima Mulilo is designated as ATZ with Class C services provided. The airspace between the top of the ATZ and the overlying en-route controlled airspace is uncontrolled Class G airspace. A Flight Information Service (FIS) is provided in Class G airspace.

Uncontrolled airspace designated as TIBA (Traffic Information and Broadcast Area) extends from ground level to 1500FT above ground level.

6.2 Concept

Airspace review and concept will be according to AFI PBN Implementation plan. Review of Airspace will be conducted to determine priorities and appropriateness for new airspace design to cater for PBN and legacy operations. Stakeholders involved with this process include:

- Regulator
- Airport Operators
- Air Traffic Services
- Aeronautical Information
- Airspace Users (operators)
- Avionics providers where available
- Airports (AGA)

The revised airspace concept will need to provide better efficiency for users (fuel savings for operators and more efficient procedures for ATS). In addition, it will need to cater for increased capacity without the need for change in the medium to long term.

Improved access to aerodromes in all weather conditions is a priority given the current situation with very restricted access because of lack of IFPs.

A major benefit of the revised airspace will be the ability to reduce incidents by repeatable and predictable procedures for aircraft and the air traffic service provider.

Environment will also benefit with reduced emissions and to a degree, noise reductions.

6.2.1 Considerations/Priorities

NEAR TERM (December 2014 - September 2015)

- Eros Tower Airspace review and redesign including:
  - Immediate removal of ATZ from the Eros Zone airspace description
  - Reclassification to Class D Control Zone
  - Redesign of Eros Control Zone to accommodate RNP APCH and RNP 1 SIDS and STARS
  - Extending Eurocat use to Eros Tower – surveillance – with appropriate procedures
  - VFR entry/exit points
  - Reposition and review of General Flying Area (GFA) if appropriate
  - Implementation of RNP APCH
  - Implementation of RNAV1 or RNP1 SIDs and STARs for traffic segregation at Eros, and from Hosea Kutako airspace and traffic
- Windhoek Terminal Area (TMA) redesign including:
  - Vertical realignment with Eros Tower airspace
  - Review and redevelopment of the minimum terrain vectoring chart
  - Review and possible redesign of inbound/outbound routes to Hosea Kutako International Airport for improved traffic segregation
  - Implementation of RNAV1 or RNP1 SIDs and STARs at Hosea Kutako for traffic segregation with Eros.
- Walvis Bay TMA review including:
  - ATM Procedures following implementation of surveillance approach procedures
  - Review and redesign of airspace to cater for RNP APCH
  - Implementation of RNP APCH procedures either pre or post surveillance implementation
  - Development of minimum terrain vectoring chart
- Hosea Kutako Control Zone
  - Redesign to cater for RNP APCH
  - Implement RNP APCH
- RNP APCH implemented at Ondangwa airport – safety issue with night operations and no instrument approach.

LONGER TERM (January 2015 – December 2016)

- Review of National Airspace and redesign as appropriate
- Review and consolidation of continental air-routes and align with AFI PBN Implementation plan

- Consideration of routes in relation to SID and STAR design for Eros, Hosea Kutako and possibly Walvis Bay
- Review of Oceanic airspace and align with AFI PBN Implementation plan
- Review of remaining Tower airspace and continuity with upper level airspace
- Progressive rollout of RNP APCH to remaining 8 airports on a priority basis determined by ATM and operators

7 Instrument Flight Procedures Design

ToR15 Lead a team of PBN Implementation professionals including airspace designers and flight procedures designers.

ToR18: Assist in the implementation of PBN flight procedures

7.1 Capability

Regulations for Instrument Flight Procedure (IFP) design are currently not available in Namibia. This includes procedures validation and flight validation.

A local company, Spacewise Namibia, had designed several PBN RNP APCH LNAV/VNAV procedures in July 2011. The company was approved under a previous approval regime, however that approval was revoked in 2013. Currently the company has no design approvals either in Namibia or elsewhere. The designs therefore cannot be accepted for use.

There are no approved instrument flight procedures design and validation capabilities in country currently.

Existing non-PBN procedures in Namibia have no provenance and it has not been possible to determine which organisation designed the procedures. Current instrument procedures are not compliant with PANS-OPS requirements for maintenance.

Procedures will be developed to allow NCAA ANS Safety Oversight section to review all procedures, and have them approved by the Director, NCAA. This is not likely to be in place until inspectorate staff are trained and competent.

As part of a mentoring and up-skilling programme an ANS Safety Oversight inspector will be afforded a fellowship arrangement for PANS-OPS training followed by on the job training. The programme includes:

- 6 weeks PANS-OPS training course at Air Navigation Institute (ANI) Gunten Switzerland
- On the job training with the ATNS design section for 10 months

It is envisaged that after the initial training and during the on the job skilling process, the inspector will be able to redesign the current non PBN Instrument Flight Procedures (IFP) to bring those procedures up to date.

Further training and experience should enable the inspector to become familiar with PBN approaches and departures with the view to reviewing both PBN and non PBN IFPs into the future. This arrangement is being developed by ANS Safety Oversight.

A need also exists for instrument flight procedures flight validation capability. There is currently no capability in Namibia. Reliance is placed on outsourcing of this activity. Some flight validation can be achieved with the

use of flight simulators. To alleviate the flight validation requirement it is proposed that an experienced pilot working in Licensing section (PEL) be trained on a PBN Validation Pilot training course. This would give the DCA in house capability for some time and beyond with timely succession planning.
Timing is an issue with one course available in August 2015. Earlier training is being sourced through the ICAO COSCAP office in Gaborone, Botswana. Details of this will not be available until late January 2015. This training will be developed in conjunction with the ICAO PEL expert and incorporated into the PEL experts Training Plan. Associated documents are incorporated for reference at Appendix 2.

7.2 Implementation Strategy

The availability of instrument approach procedures at airports where non currently exist is a safety priority for several airports.

Given the lack of capability for design several options have been discussed in conjunction with the ICAO Safety Oversight Expert and the Deputy Director DCA. Not all are viable but will be examined for transparency:

OPTION 1: In house: Not viable

There is no capability. The ANS Safety Oversight Expert has developed a training programme for one inspector as discussed at Page 35, 7.1. Following training he will be able to review existing procedures however this will be of at least 1 year duration. There is also no associated infrastructure available for design, validation and charting. This is costly and time consuming.

OPTION 2: In country: Not viable

There is no Part 173 certified company able to design, validate and produce the procedures in a timeframe relevant to the urgency for deployment. Spacewise has been discussed previously (see Page 35 at 7.1). It is unknown whether this company has Part 173 approval from a Regulator which is acceptable to the Director.

OPTION 3: ICAO experts: Possible

The issue arises whereby there would also be a need for in-country ICAO experts to have access to required infrastructure (hardware and software) which would need to be supplied by ICAO as well. There would be a requirement for 2 designers for checking and validation of work (as Chief Designer and Designer). One possible solution could be ICAO designers on a fly-in basis as needed who would then have access to the requisite infrastructure out of country. They would return for flight validation and deployment. The designers must be certified for PBN IFP.

OPTION 4: Outsource to external Part 173 certified organisation: Probable

This is probably the most efficient solution given the priority for PBN approaches. Several organisations can be evaluated and a decision made according to timeliness, qualifications, experience and costing.

7.3 Other Considerations

Other considerations for PBN design include:

- Provision of RAIM prediction service. This can be provided by a third party provider or done in house. The in house capability is limited given the infrastructure and manpower required. A third party provider seems the likely solution in the short term.
- Initial viability study for RNP APCH and RNP 1 SIDS and STARS deployment at Hosea Kutako and Eros aerodromes given the terrain issues surrounding these two aerodromes. It would be proper to conduct the study rather than deploy procedures which might possibly be rendered unflyable due to terrain and satellite disposition. The study will be completed by 31st March 2015.

8 Flight Operations

ToR9: Assist in the assessment, establishment and documentation of data on equipage of aircraft using the Windhoek FIR domestic and foreign known fleets, as well as aircraft projected to operate within the FIR in the time frame 2016 – 2020

ToR19: Provide necessary support to the regulatory authorities in the operational approval processes of aircraft and operators

8.1 Aircraft equipage

A database has been developed and established to hold data for aircraft operating in Namibian airspace. This will be updated as required. Operators will be contacted progressively for the information.

Data will be used to confirm/amend PBN decisions accordingly.

8.2 Operator Approvals

Assistance will be rendered when requested from the Flight Operations section of DCA. This will be an ongoing process for the duration of the project.

Of priority currently is the re-certification of the national carrier, Air Namibia. This airline currently has Operational Approvals for PBN Operational Specification of RNAV5 and RNP1. The next step for the airline is RNP APCH certification, necessary for PBN approach operations.

Regulations relevant to PBN APCH approvals for operators are being developed in conjunction with an ICAO short mission expert. It is expected this expert will return April 2015 for this purpose.

9 Safety

ToR16: Lead the Safety Assessment of process prior to validation of procedures or airspace changes with the view of facilitating that airspace improvements result in safe operations.

9.1 Background

Each of the processes involved with the PBN implementation will be managed under the Performance Based Navigation Implementation Safety Plan for Namibia.

This document will be separate from this Strategy document.

10 PBN Acronym List

ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependant Surveillance – Broadcast
ADS-C	Automatic Dependant Surveillance – Contract
AMASS	Airport Movement Area Safety System
ANC	Air Navigation Conference
APV	Approach with Vertical Guidance
ASDS	Airport Surface Detection System
ASMGCS	Advanced Surface Movement Guidance and Control Systems
ATC	Air Traffic Control
ATS	Air Traffic Services
Baro-VNAV	Barometric Vertical Navigation
CCO	Continuous Climb Operations
CDM	Collaborative Decision Making
CDO	Continuous Descent Operations
CFIT	Controlled Flight into Terrain
CNS/ATM	Communication Navigation and Surveillance/Air Traffic Management
DARPS	Dynamic Aircraft Route Planning System
DME	Distance Measuring Equipment
EGNOS	European Geostationary Overlay Navigation Service
FIR	Flight Information Region
FMGS	Flight Management Guidance System
FMS	Flight Management System
GA	General Aviation
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HUD	Head Up Display
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INS	Inertial Navigation System
LORAN	LOng RAnge Navigation
LNAV	Lateral Navigation
LP	Localiser Performance
LPV	Localiser Performance with Vertical Guidance
MLS	Microwave Landing System
NDB	Non Directional Beacon
NPA	Non Precision Approach
PA	Precision Approach
PANS-OPS	Procedures for Air Navigation Services - Aircraft Operations
PBN	Performance Based Navigation
PIRG	Planning and Implementation Regional Group
RAIM	Receiver Autonomous Integrity Monitoring
RNAV	Area Navigation
RNP	Required Navigation Performance
RNP APCH	RNP Approach
RNP AR APCH	RNP Authorisation Required Approach
SBAS	Space Based Augmentation System
SID	Standard Instrument Departure
SIS	Signal in Space
STAR	Standard Instrument Arrival
TMA	Terminal Area
UPR/T	User Preferred Route/Trajectory
VHF	Very High Frequency
VOR	VHF Omnidirectional Radio Range
VNAV	Vertical Navigation
VSD	Vertical Situation Display
WAAS	Wide Area Augmentation System

APPENDIX 1 Communications and Navigation Aid Infrastructure

STATION	CATEGORY	TYPE	QUANTITY	COMMENTS
Windhoek Eros	VCCS ACC	Page CD-30	2	
(Area Control Centre and Control Tower)	VCCS TWR	Page CD-30	2	
	VRS	Formation AIR	2	
	AFTN TERMINAL	Copperchase	4	
	STRIP PRINTER	IER	4	
	MET DISPLAY	Almos	1	
	UTC TIME DISPLAY	Page	8	
	NAID TERMINAL	SAAB	8	
	SURVEILLANCE TERMINAL	EuroCat-X	14	
	UPS	Galaxy 6000	2	
	ATIS	Almos	1	
	AFTN SWITCH	Copperchase	2	
	VSAT ATS/DS	SADC ATNS	1	
Hosea Kutako	VCCS TWR	Page CD-30	2	
(Control Tower)	VRS	Nice Mirra II	2	
	AFTN TERMINAL	Copperchase	1	
	STRIP PRINTER	IER	1	
	MET DISPLAY	Almos + MetCap	2	
	UTC TIME DISPLAY	Page	3	
	NAID TERMINAL	SAAB	1	
	SURVEILLANCE TERMINAL	EuroCat-X	2	
	UPS	Galaxy 300	2	
	ATIS	Almos	1	
Walvis Bay	VCCS TWR	Page CD-30	2	
(Control Tower)	VRS	Nice Mirra II	2	
	AFTN TERMINAL	Copperchase	1	
	STRIP PRINTER	IER	1	
	MET DISPLAY	Almos + MetCap	2	
	UTC TIME DISPLAY	Page	2	
	NAID TERMINAL	SAAB	1	
	SURVEILLANCE TERMINAL	EuroCat-X	2	
	UPS	Galaxy 300	1	
	ATIS	Almos	1	
Lüderitz	VCCS TWR	Page CD-30	2	
(Control Tower)	VRS	Nice Mirra II	2	
	AFTN TERMINAL	Copperchase	1	
	STRIP PRINTER	IER	1	
	MET DISPLAY	Almos + MetCap	2	
	UTC TIME DISPLAY	Page	2	
	NAID TERMINAL	SAAB	1	
	UPS	Galaxy 300	1	
	ATIS	Almos	1	
Keetmanshoop	VCCS TWR	Jotron VoIP	2	(pending new installation)
(Control Tower)	VRS	Ricochet	2	
	AFTN TERMINAL	Copperchase	1	
	STRIP PRINTER	IER	1	
	MET DISPLAY	NMS MetCap	1	
	UTC TIME DISPLAY	Jotron	2	
	NAID TERMINAL	SAAB	1	
	UPS	Galaxy 300	1	
Ondangwa	VCCS TWR	Jotron VoIP	2	(pending new installation)
(Control Tower)	VRS	Ricochet	2	
	AFTN TERMINAL	Copperchase	1	
	STRIP PRINTER	IER	1	
	MET DISPLAY	NMS MetCap	1	
	UTC TIME DISPLAY	Jotron	2	

	NAID TERMINAL	SAAB	1	
	UPS	Galaxy 300	1	
Swakopmund	VCCS TWR	Jotron VoIP	2	(pending new installation)
(Control Tower)	VRS	Ricochet	2	
	AFTN TERMINAL	Copperchase	1	
	STRIP PRINTER	IER	1	
	MET DISPLAY	NMS MetCap	1	
	UTC TIME DISPLAY	Jotron	2	
	NAID TERMINAL	SAAB	1	
	UPS	Galaxy 300	1	
Katima Mulilo	VCCS TWR	Jotron VoIP	2	(pending new installation)
(Control Tower)	VRS	Ricochet	2	
	AFTN TERMINAL	Copperchase	1	
	STRIP PRINTER	IER	1	
	MET DISPLAY	NMS MetCap	1	
	UTC TIME DISPLAY	Jotron	2	
	NAID TERMINAL	SAAB	1	
	UPS	Galaxy 300	1	

NOTES

VCCS *Voice Communications Control System*

VRS *Voice Recording System*

AFTN *Aeronautical Fixed Telecommunications Network*

NAID *Namibia ATC Information Display*

UPS *Uninterruptible Power Supply*

ATIS *Automatic Terminal Information System*

VSAT *Very Small Aperture Terminal (SADC satellite communication system for Direct Speech and AFTN data)*

ATS RADIO EQUIPMENT IN USE BY DCA

STATION	CATEGORY	TYPE	CO-ORDINATES	FREQUENCY	POWER	EMMISSION	IDENT	RANGE	QUANTITY
Hosea Kutako	Communications	ATC VHF Tx and Rx	S 22° 29' 02" E 17° 28' 15"	118.1 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF Tx and Rx		120.5 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF Tx and Rx		124.7 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF Tx and Rx		129.6 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF Tx and Rx		123.8 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF Tx and Rx		121.5 MHz	50 W	6K00A3E	-	80 NM	2
		VHF Tx ATIS		126.2 MHz	50 W	6K00A3E	-	80 NM	2
		VHF Tx VOLMET		126.8 MHz	50 W	6K00A3E	-	80 NM	2
		Mobile VHF		118.1 MHz	7 W	6K00A3E	-	5 NM	4
		ATC HF Tx and Rx	S 22° 29' 02" E 17° 28' 15"	5493 kHz	1000 W	6K00A3J	-	global	1
		ATC HF Tx and Rx		6559 kHz	1000 W	6K00A3J	-	global	1
		ATC HF Tx and Rx		8903 kHz	1000 W	6K00A3J	-	global	1
		ATC HF Tx and Rx		13294 kHz	1000 W	6K00A3J	-	global	1
	Navigation Aids	VOR	S 22° 28' 27" E 17° 28' 17"	114.5 MHz	50 W	20K9A9W	WHV	150 NM	1
		DME	S 22° 28' 27" E 17° 28' 17"	1179 MHz	1000 W	3MOOM1D	WHV	150 NM	1
		ILS	S 22° 29' 25" E 17° 26' 51"	110.3 MHz	25 W	2K10A2A	WD	20 NM	1
	Surveillance	Primary Radar	S 22° 29' 02" E 17° 28' 15"	2.75 / 2.85 GHz	16 kW	-	-	60 NM	1
		Secondary Radar	S 22° 29' 02" E 17° 28' 15"	1.03 / 1.09 GHz	2.5 kW	-	-	250 NM	1
		WAM sites	(see attached)	1.03 / 1.09 GHz	1.4 kW	-	-	90 NM	36
Windhoek Eros	Communications	ATC VHF Tx and Rx	S 22° 37' 00" E 17° 05' 07"	118.7 MHz	50 W	6K00A3E	-	50 NM	2
		ATC VHF Tx and Rx	S 22° 37' 00" E 17° 05' 07"	121.5 MHz	50 W	6K00A3E	-	50 NM	2
		VHF Tx ATIS	S 22° 37' 00" E 17° 05' 07"	126.4 MHz	50 W	6K00A3E	-	80 NM	2
		Handheld VHF		118.7 MHz	0.5 W	6K00A3E	-	5 NM	1
		Mobile VHF		118.7 MHz	7 W	6K00A3E	-	5 NM	1
Walvis Bay	Communications	ATC VHF Tx and Rx		122.5 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF Tx and Rx		121.5 MHz	50 W	6K00A3E	-	80 NM	2
		VHF Tx ATIS		127.0 MHz	50 W	6K00A3E	-	80 NM	2

Walvis Bay	Navigation Aids	VOR	S 22° 58' 54" E 14° 38' 45"	113.6 MHz	50 W	20K9A9W	WBV	120 NM	1
		DME	S 22° 58' 54" E 14° 38' 45"	1170 MHz	1000 W	3MOOM1D	WBV	120 NM	1
		ILS	S 22° 58' 54" E 14° 38' 45"	109.3 MHz	25 W	2K10A2A	WD	20 NM	1
Lüderitz	Communications	ATC VHF Tx and Rx		118.6 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF Tx and Rx		121.5 MHz	50 W	6K00A3E	-	80 NM	2
		VHF Tx ATIS		126.6 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 26° 38' 49" E 15° 11' 53"	124.7 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 26° 38' 49" E 15° 11' 53"	123.8 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 26° 38' 49" E 15° 11' 53"	121.5 MHz	50 W	6K00A3E	-	80 NM	2
Keetmanshoop	Communications	ATC VHF Tx and Rx		118.3 MHz	25 W	6K00A3E	-	50 NM	2
		ATC VHF relay	S 26° 34' 23" E 18° 08' 10"	124.7 MHz	50 W	6K00A3E	-	80 NM	1
		ATC VHF relay	S 26° 34' 23" E 18° 08' 10"	123.8 MHz	50 W	6K00A3E	-	80 NM	1
	Navigation Aids	VOR	S 26° 32' 14" E 18° 06' 52"	112.9 MHz	100 W	20K9A9W	KTV	200 NM	1
		DME	S 26° 32' 14" E 18° 06' 52"	1163 MHz	1000 W	3MOOM1D	KTV	200 NM	1
Ondangwa	Communications	ATC VHF Tx and Rx	S 17° 47' 08" E 15° 53' 24"	125.6 MHz	10 W	6K00A3E	-	30 NM	2
	Navigation Aids	VOR	S 17° 52' 36" E 15° 56' 57"	116.3 MHz	50 W	20K9A9W	OAV	120 NM	1
		DME	S 17° 52' 36" E 15° 56' 57"	1197 MHz	1000 W	3MOOM1D	OAV	120 NM	1
Grootfontein	Navigation Aids	VOR	S 19° 36' 10" E 18° 07' 17"	115.7 MHZ	50 W	20K9A9W	GFV	120 NM	1
		DME	S 19° 36' 10" E 18° 07' 17"	1191 MHz	1000 W	3MOOM1D	GFV	120 NM	1
Swakopmund	Communications	ATC VHF Tx and Rx		126.3 MHz	10 W	6K00A3E	-	30 NM	2
		ATC VHF relay	S 22° 38' 56" E 14° 32' 45"	124.7 MHz	50 W	6K00A3E	-	80 NM	1
Katima Mulilo	Communications	ATC VHF Tx and Rx	S 17° 38' 04" E 24° 11' 37"	125.6 MHz	50 W	6K00A3E	-	80 NM	2
Devundu	Communications	ATC VHF relay	S 18° 06' 43" E 21° 39' 22"	125.6 MHz	50 W	6K00A3E	-	100 NM	2
Oshakati	Communications	ATC VHF relay	S 17° 46' 21" E 15° 40' 06"	124.7 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 17° 46' 21" E 15° 40' 06"	129.6 MHz	50 W	6K00A3E	-	80 NM	2

Maroelaboom	Communications	ATC VHF relay	S 19° 17' 02" E 18° 53' 14"	124.7 MHz	50 W	6K00A3E	-	80 NM	1
		ATC VHF relay	S 19° 17' 02" E 18° 53' 14"	129.6 MHz	50 W	6K00A3E	-	80 NM	2
		VHF VOLMET Tx	S 19° 17' 02" E 18° 53' 14"	126.8 MHz	50 W	6K00A3E	-	80 NM	2
Outjo	Communications	ATC VHF relay	S 20° 03' 28" E 16° 04' 59"	124.7 MHz	50 W	6K00A3E	-	80 NM	1
		ATC VHF relay	S 20° 03' 28" E 16° 04' 59"	129.6 MHz	50 W	6K00A3E	-	80 NM	2
		VHF VOLMET Tx	S 20° 03' 28" E 16° 04' 59"	126.8 MHz	50 W	6K00A3E	-	80 NM	2
Omaere	Communications	ATC VHF relay	S 22° 33' 07" E 19° 28' 45"	124.7 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 22° 33' 07" E 19° 28' 45"	129.6 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 22° 33' 07" E 19° 28' 45"	123.8 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 22° 33' 07" E 19° 28' 45"	121.5 MHz	50 W	6K00A3E	-	80 NM	2
Stampriet	Communications	ATC VHF relay	S 24° 37' 52" E 17° 51' 43"	124.7 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 24° 37' 52" E 17° 51' 43"	123.8 MHz	50 W	6K00A3E	-	80 NM	1
		VHF VOLMET Tx	S 24° 37' 52" E 17° 51' 43"	126.8 MHz	50 W	6K00A3E	-	80 NM	2
Rehoboth	Communications	ATC VHF relay	S 23° 18' 05" E 17° 04' 07"	124.7 MHz	50 W	6K00A3E	-	80 NM	1
		ATC VHF relay	S 23° 18' 05" E 17° 04' 07"	123.8 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 23° 18' 05" E 17° 04' 07"	120.5 MHz	50 W	6K00A3E	-	80 NM	2
Opuwo	Communications	ATC VHF relay	S 18° 10' 07" E 13° 55' 50"	124.7 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 18° 10' 07" E 13° 55' 50"	129.6 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 18° 10' 07" E 13° 55' 50"	121.5 MHz	50 W	6K00A3E	-	80 NM	2
Rossing Mtn	Communications	ATC VHF relay	S 22° 31' 50" E 14° 49' 13"	124.7 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 22° 31' 50" E 14° 49' 13"	129.6 MHz	50 W	6K00A3E	-	80 NM	2
		ATC VHF relay	S 22° 31' 50" E 14° 49' 13"	123.8 MHz	50 W	6K00A3E	-	80 NM	2
		VHF VOLMET	S 22° 31' 50" E 14° 49' 13"	126.8 MHz	50 W	6K00A3E	-	80 NM	2

NOTES

ATC *Air Traffic Control*

Tx *Transmitter* Rx *Receiver*

VHF *Very High Frequency (radio communication system)*

VOR *Very high frequency Omni-directional Range (radio navigation beacon that provides bearing information to a pilot)*

WAM Wide Area Multilateration

DME *Distance Measuring Equipment (radio navigation beacon that provides a pilot with distance information)*

NDB *Non Directional Beacon (radio navigation beacon that provides a pilot with directional information)*

ILS *Instrument Landing System (radio landing aid that provides approach path information to a pilot)*

Appendix 2 Training

Flight Validation Pilot

Justification:

A need exists for Instrument Flight Procedures flight validation capability. There is currently no capability in Namibia. Reliance is placed on outsourcing of this activity. Some flight validation can be achieved with the use of flight simulators. To alleviate the flight validation requirement it is proposed that Mr Alwyn Biermann, an experienced pilot working in Licensing section (PEL), be trained on a Flight Validation Pilot training course. This would give the DCA in house capability for some time and beyond with timely succession planning. Timing is an issue with one course available in August 2015, the one detailed below Page 47. Earlier training is being sourced through the ICAO COSCAP office in Gaborone, Botswana, and the Beijing office of COSCAP. Details of this will not be available until late January 2015. The training plan could require amendment depending on available courses.

Requirements for attending the course are a current Commercial Licence and Instrument Rating. Both are held by the prospective participant.

Proposed Training Plan for Mr Alwyn Biermann August 17th to September 4th 2015

Courses	Training Objective	Qualification	Training Provider	Cost	Contact
Geodesy Module 17/8 – 18/8 2015	Module 1 of Flight Validation Course	Flight Validation Pilot	Air Navigation Institute Zug Switzerland (ANI)	CHF1100 USD1200 NAD14000	see below
ARINC 424 coding 19/8 – 21/8 2015	Module 2 of Flight Validation Course	Flight Validation Pilot	ANI	CHF1500 USD1600 NAD18000	
PansOps Procedure Module and CBT 24/8 – 4/9 2015	Module 3 of Flight Validation Course	Flight Validation Pilot	ANI	CHF4000 USD4200 NAD48000	
			Total Cost	CHF6600 USD7000 NAD80000	

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BIBLIOGRAPHY

AFI Regional Performance Based Navigation Implementation Plan, APIRG17, WP7, Appendix G

PBN Implementation Plan, Australia; Version 1 March 2010, Australian Government, Civil Aviation Safety Authority

Strategy for the Safety oversight of Air Navigation Services in the Republic of Namibia V2.0, Dumsa, A, Directorate of Civil Aviation, Namibia, 2014

PBN Implementation Plan – New Zeland, Civil Aviation Safety Authority of New Zealand, 16 December, 2009

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