Luftfartstilsynet
CIVIL AVIATION AUTHORITY - NORWAY

PBN IMPLEMENTATION PLAN NORWAY

Version 3.0 June 2013

All photos:
Colourbox.com

DOCUMENT HISTORY - TABLE OF CONTENTS

Edition	Date	Status	Author	Justification
Version 1.0	December 2009	Replaced	PBN Implementation Plan Working Group	First version
Version 1.1.	September 2011	Issued by NCAA	PBN Implementation Plan Working Group	Plan not updated Explanatory text revised based on comments from stakeholders
Version 2.0	September 2012	Issued by NCAA	PBN Implementation Plan Working Group	Plan updated per February 2012 Explanatory text revised accordingly
Version 3.0	June 2013	Issued by NCAA	PBN Implementation Plan Working Group	Plan updated per June 2013 Explanatory text revised accordingly

Document history

Table of Contents

EXECUTIVE SUMMARY 3
0. Introduction 4
0.1 The international background framework of PBN Implementation Plan Norway 4
0.2 Why is the PBN Implementation Plan Norway Needed? 5
0.3 Objectives of the PBN Implementation Plan Norway 5
0.4 The intent of the PBN Implementation Plan Norway 5
0.5 The scope of the PBN Implementation Plan Norway 5
0.6 Principles applied in development of the PBN Implementation Plan Norway 5
1. Strategic Issues and Trade-Offs 7
Approval of GNSS as primary means of navigation: 7
2. Benefits of RNAV and Global Harmonization 7
2.1 General 7
2.2 Benefits - Airspace users 8
2.3 Benefits – Airports and ANSP 8
3. Challenges 8
3.1 General 8
3.2 En-route Continental 8
3.3 Oceanic operations in Bodø OFIR/OCA 8
3.4 Terminal Areas 8
3.5 Instrument approach procedures 9
3.6 Helicopter operations 9
4 Current Status 10
4.1 Aircraft Capabilities 10
4.2 En-route Continental 10
4.3 Oceanic operations in Bodø OFIR/OCA 10
4.4 Terminal Areas 10
4.5 Approach operations 10
5 Implementation Roadmap (2013-2016) 11
5.1 Roadmap (2013-2016) - En-route Continental 11
5.2 Roadmap (2013-2016) 11
- Oceanic operations in Bodø OFIR/OCA 11
5.3 Roadmap (2013-2016) - Terminal Areas 11
5.4 Roadmap (2013-2016) - 11
Helicopter operations 11
5.5 Roadmap (2013 – 16) Instrument approach procedures 12
Helicopter operations 12
5.5.1 Airspace User's priorities 12
Summary 12
5.5.2 Current ANSP implementation plan 13
6 Long Term Implementation Strategies (2017+) 14
6.1 Strategies (2017+) - En-route Continental 14
6.3 Strategies (2017+) - Terminal Areas 14
6.4 Strategies (2017+) - Instrument approach procedures 14
7 Strategy for PBN Implementation and Progress Monitoring 15
7.1 PBN Project Group 15
7.2 PBN Implementation Plan Working Group 15
Abbreviations 17
Appendix A 18
Appendix B 22

Tables

Table 1.1 required PBN procedures and possible back-up for PBN applications and GNSS infrastructure 7
Table 4.1 Current status - Terminal Areas 10
Table 5.1 Roadmap (2013-16) - Terminal Areas 13

Figures

Figure 4.1 RNP APCH definitions 11

EXECUTIVE SUMMARY

In order to ensure a safe and efficient performance of the global Air Navigation System, ICAO have urged 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 PBN Manual (ICAO Doc 9613) [1] This being done by developing a Performance Based Navigation (PBN) Implementation Plan to ensure the implementation of RNAV and RNP operations (where required) for en-route and terminal areas, and implementation of instrument approach procedures with vertical guidance (APV) including LNAV only minima for all instrument runway ends either as primary approach or as a back-up for precision approaches by 2016.
This plan covers PBN implementation in all flight phases in Norway FIR and Bodø Oceanic.

0. Introduction

0.1 The international background framework of PBN Implementation Plan Norway

The Global ATM Operational Concept, endorsed by ICAO 11th Air Navigation Conference (AN-Conf/11) and published as ICAO Doc 9854, provides the framework for the development of all regional ATM concepts. AN-Conf/11 also endorsed a number of technical recommendations affecting navigation, including the harmonization of air navigation systems between regions, frequency planning, the transition to satellite based air navigation, curved RNAV procedures, and the use of multiple GNSS signals and the rapid implementation of approaches with vertical guidance.

The PBN Manual (ICAO Doc 9613) [1] was developed in direct response to the 11th Air Navigation Conference recommendation.

In September 2007, the ICAO 36th General Assembly issued Resolution 36-23 urging States to:

a) Complete PBN implementation plans by 2009,
b) Implement RNAV and RNP operations (where required) for en route and terminal areas and
c) Implement approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS) for all instrument runway ends, either as the primary approach or as a back-up for precision approaches, by 2016 (with 30 per cent by 2010 and 70 per cent by 2014).

In 2010 ICAO 37th General Assembly issued Resolution A37-11 superseding A36-23. Main additions to A37-11 compared to A36-23:

- Requirement to add LNAV minima to any approach chart procedure with vertical guidance.
- Allow states to publish LNAV only approach if there is no traffic equipped for operations with vertical guidance.
- The ICAO Resolution A37-11 has now been followed up by an amendment to the National Regulation BSL G 4 – 1, valid from 1. January 2012. The new §7a. No (2) impose the introduction of APV to all instrument Runway ends by the end of 2016.

The proposed amendment to ICAO EUR ANP (doc 7754) Volume I, basic ANP, part IV contains the PBN Implementation Roadmap for the ICAO European Region as approved on June 2010.

The PBN Implementation Roadmap for the ICAO European Region exists within the context of the EUR region operating environment. This includes the Navigation Application and Infrastructure Planning Strategy for the EUR.
Given the requirement for interoperability this Roadmap represents the parent source of the strategic regional planning context and strong links are forged with the sub-regional programs, e.g. SESAR, ESSIP.

0.2 Why is the PBN Implementation Plan Norway Needed?

A PBN implementation Plan is needed to facilitate an efficient, globally harmonized and coordinated transition from conventional navigation towards GNSS becoming the prime positioning source for RNAV and RNP applications in all phases of flight using Galileo/GPS/GLONASS, GBAS and SBAS.

The ICAO EUR Region is characterized by diverse air traffic volumes and densities, operational requirements and CNS/ATM capabilities, and thus different navigation applications may be applied by different homogeneous ATM areas, TMAs and airports. For this reason the States should make clear their own individual plans in order to assist operators in their planning for the transition to PBN, based on the European Roadmap and the PBN Manual (ICAO Doc 9613) [1].

The national plan will ensure coherent navigation planning by providing proper guidance and direction to the Norwegian air navigation service provider (Avinor), airports, airspace operators and users, regulating agency (NCAA), as well as foreign operators who operate or plan to operate in the state.

0.3 Objectives of the PBN Implementation Plan Norway

The Norwegian PBN implementation plan is targeted to meet the following strategic objectives:

a) Provide a high-level strategy for the evolution of the PBN applications to be implemented in the 2016 timeframe.

b) Provide a general description of the planned evolution of the PBN applications in the long term (beyond 2017).

c) Ensure that the implementation of PBN is based on clearly established operational requirements.

d) Avoid unnecessarily imposing the mandate for multiple equipment on board or multiple systems on the ground.

e) Avoid the need for multiple airworthiness and operational approvals for international operations to/from Norway or for operations across Norwegian regions.

f) Prepare for the development towards Advanced RNP.

0.4 The intent of the PBN Implementation Plan Norway

The Norwegian PBN implementation plan is a dynamic document that unveils the strategy to use performance based navigation in Norway. The strategy represents a collaborative Authority and industry initiative to move forward with performance based navigation.

The plan is intended to assist stakeholders of the aviation community to plan a gradual transition to PBN.

The goal of the plan is to provide a structure for the national PBN planning and cooperation between stakeholders, and to provide a roadmap for the PBN transition. Operators can use this roadmap to plan future equipage, capability and investments. Similarly, air navigation service providers can for instance determine requirements for future automation systems, and plan for the rationalisation of conventional instrument procedures and the ground based navigation infrastructure.

All stakeholders are strongly recommended to prioritize resources and to initiate the necessary actions to support the plan.

0.5 The scope of the PBN Implementation Plan Norway

The scope of the PBN Implementation Plan Norway is Norway FIR and Bodø Oceanic.

The plan describes the development of PBN applications. The concurrent decommissioning of ground based navigation infrastructure is not covered by the plan.

However a brief background on the development of GNSS infrastructure and backup systems is given in Chapter 1.

The plan only covers development of PBN applications that are covered by the ICAO Resolution A 37-11 and the PBN Implementation Roadmap for the ICAO European Region, i.e. applications in accordance with the navigation specifications in the PBN Manual (ICAO Doc 9613) [1]. Planned development of navigation applications other than these, is not covered in this plan.

The following Navigation applications are not covered by the plan:

- Conventional operations (i.e. non-RNAV operations based on ground-based navigational aids)
- GLS (SCAT-I) operations

These operations are implemented in addition to the PBN applications and do not exempt any airport or TMA from the PBN development.

In this plan an "Instrument runway end for APV" is defined as a runway end where an APV-procedure can be designed in accordance with current Pans-Ops criteria (ICAO Doc 8168 Vol II).

The design criteria for LPV allow +/- 5˚ offset from the extended runway centreline and a VPA up to 6.3˚.

The design criteria for LNAV/VNAV allow 0˚ offset, i.e. only final approach along the extended runway centreline, and a VPA limited to 3˚ - 3.5˚.

Continuous descend approach / continuous climb departure is enabled as a consequence of PBN implementation and will be covered during action planning and implementation at each location.

0.6 Principles applied in development of the PBN Implementation Plan Norway

Planning and implementation of PBN will be based on the following principles:

a) Continued application of conventional air navigation procedures during the transition period, to guarantee availability by users that are not RNAV- and/or RNP-certified. This implies the challenge of mixed operations, which must be solved at each location during the implementation planning phase.

b) Development of airspace concepts, if necessary applying airspace modelling tools as well as fast-time/real-time simulations, which identify the navigation applications that are compatible with the airspace concept.

c) Gradual reliance on GNSS that has as final goal its use as sole service, to the extent that this can be shown to be the most cost beneficial solution and is supported by a successful safety and security analysis. This will evolve concurrently with the improving quality of GNSS services in Europe. The planning of LPV is adjusted to the anticipated development of EGNOS SoL coverage and quality in relevant airspace.

d) Conduct of cost-benefit analyses to justify the implementation of the RNAV and/or RNP concepts in each particular airspace.

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

f) No conflict with the PBN Implementation Roadmap for the ICAO European Region.

g) Development of roadmaps in close consultation with airports and operators. This may involve priority to procedures with common interest among stakeholders, coordination with on-going airspace development activities, and emphasis put on achieving the highest possible implementation pace covering the highest possible traffic volume.

h) The present PANS-OPS criteria for Vertical Path Angle is maximum 3.5˚ (ICAO Doc 8168 Volume II), while the maximum glide path angle is 4.0˚ at some Norwegian airports because of surrounding terrain. Until PANS-OPS criteria for steeper angles are developed, LNAV/VNAV will only be implemented at runway ends with possibility for runway aligned final approach utilizing glide path 3.5˚ or below.

i) SID/STAR procedures at international airports and airports with ATC will be given priority. Efficient traffic handling and reduced track will be an important basis when developing the roadmaps.

j) RNP APCH procedures at international airports, and airports with ATC with runway ends without ILS, and at local airports coordinated with SCAT-1 implementation plan will be given priority.

k) Airports where the availability is dependent on conventional procedures based on non-redundant navaids will be will be given priority.

l) Airports where plans exist for reinvestments in old conventional navaids will be given priority.

m) Priority-setting in coordination with conventional navaids rationalization plans.

n) Environmental impact considerations; noise and emissions. PBN is considered to allow more efficient procedures and be a critical element taking into consideration emissions, and be an enabler for local noise interests and requirements. Valid for both noise and emission issues RNP may be used to optimize descend profiles, determine flight paths through tailored approach and departure procedures, and used as a tool to administer noise footprint.

Flight phase	NAV-application	NAV specification	NAV infrastructure	NAV Back-up infrastructure
En-route	ATS-routes	RNAV 5 (B-RNAV)	GNSS	VOR/DME (required) Radar
TMA	SID/STAR	RNAV 1 (P-RNAV)	GNSS	DME/DME (as required) Radar
APP	IAP	RNP APCH	GNSS	Conventional (ILS, VOR/ DME, NDB)

Table 1.1 required PBN procedures and possible back-up for PBN applications and GNSS infrastructure.

1. Strategic Issues and Trade-Offs

Performance Based Operations rely on the provision of adequate radio navigation aids, e.g. GNSS, and airborne avionics. All these elements have been standardised in support of each PBN Manual (ICAO Doc 9613) [1] application. In this chapter some issues relevant are highlighted.

Approval of GNSS as primary means of navigation:

GNSS (GPS and GLONASS) are not considered as components subject to conformity assessment and therefore no certification of GNSS according to the SES regulations are necessary. Standards and recommended practices in ICAO Annex 10 do ensure interoperability between components of GNSS. The challenging Norwegian terrain may at some airports limit the GNSS performance, but a combination of GNSS, DME/DME and INS will most probably give acceptable performance for all navigation applications.

GNSS signals are vulnerable to intentional, unintentional sources of interference and effects of ionosphere and solar activity. Until a more robust mitigation of GNSS vulnerabilities have been developed (ex: muliti-constellation/ multi-frequency GNSS) there is a requirement for retaining some conventional procedures and ground-based navigational aids.

The above table gives an overview of required PBN procedures and possible back-up for PBN applications and GNSS infrastructure.

DME/DME coverage:

DME/DME coverage in Norway is currently limited, primarily because of the challenging terrain. Complete DME/DME coverage is not cost-beneficial and implementation of DME/DME coverage at new locations will be based on a cost-benefit and safety analyses.

EGNOS Service Area limitation until 2015-16:

EGNOS services is currently limited to 70° North by design configuration. As a consequence current implementation of LPV procedures is only planned south of 70° North. The 12 northernmost Norwegian airports are affected by the service area limitation:
Hasvik, Hammerfest, Honningsvåg, Mehamn, Berlevåg, Båtsfjord, Vardø, Vadsø, Lakselv, Svea, Longyear and Ny Ålesund.

EGNOS MRD CCB (Mission Requirement Document Configuration Control Board) explores the possibility towards an extension of the current EGNOS V2 SoL Service Validity Area to 72°.

Through Avinors engagement and contributions to SESAR and to the European GNSS Evolution Programme, the target service areas of 2020+ versions of Galileo and EGNOS will cover Northern ECAC up to 80°N.

2. Benefits of RNAV and Global Harmonization

2.1 General

The following benefits are expected:

- Global standardization of navigation specifications.
- Safety improvement (gradual elimination of non-precision approaches will reduce the potential for CFIT)
- Capacity increase
- Flight efficiency (long term - by use of optimized aircraft trajectories, will permit airspace users to choose the most efficient trajectory as a mean of satisfying their particular requirements)
- Environment impact (noise and emissions).
- Airport access ability (improved airport regularity).
- Interoperability with other ICAO regions and within the ECAC Area.

2.2 Benefits - Airspace users

The operators point out the following achievable benefits through the use of P-RNAV SIDs/STARs:

- Optimized traffic-flow in the terminal phase of flight enabled by e.g. closed STAR via Initial Approach Fix (IAF) DCT to RNP APCH procedures or approach DCT IAF when appropriate by using the Terminal Altitude Approach (TAA) concept (Y/T-type approach).
- Reduction in flown track miles. (SID's included).
- Continuous climb and descent.
- Existing non-precision approaches replaced by RNP APCH -procedures.
- Airport availability (regularity).

Norwegian operators regard enhanced safety as the main benefit of PBN. They want to achieve this through simplification of procedures; with straight Final Approach Track and Missed Approach segments and, where there is no precision approach available, through RNAV based NPA with vertical guidance.

Further the Norwegian operators expect the following benefits from the PBN concept:

- Increased safety during approach and positioning towards final approach.
- Reduction in operational costs and environmental benefits.
- Simplified, strategic procedures will lead to increased safety and predictability.

2.3 Benefits – Airports and ANSP

PBN instrument procedures in all phases of flight facilitate the provision of correct data in the aircraft navigation databases thus eliminating the use of overlay procedures, often used today.

PBN instrument procedures will be implemented at all airports in Norway where ATC or AFIS is provided, thereby facilitating more efficient traffic handling and standardized flight procedures.

Airports with non-precision runway ends planning establishment of new ILS-installations will have the option to consider LPV and/or LNAV/VNAV thus considerably reducing investment costs

A-RNP will introduce a possibility for curved approaches. These carbon reducing curved approaches are expected also to meet special noise requirements in the vicinity of the airport. Based on type of population infrastructure RNP is suitable for tailoring approaches (as well as departures) meeting different requirements.

The Norwegian airport noise model NORTIM is well suited to analyse environmental consequences of implementing new RNP procedures both for landing and departing operations. For Oslo/Gardermoen, where taxiing operations are registered by our Noise and Track Monitoring System, air pollutions from LTO (Landing Take Off) cycles can be evaluated.

PBN instrument procedures facilitate the rationalisation of conventional navigation aids, resulting in reducing investment/operating costs for ANSP/Airports.

3. Challenges

3.1 General

In order to cope with forecasted increase in air traffic, the airspace capacity must be increased whilst at the same time keep the controller workload at an justifiable level. Because RNAV allows a more flexible route system, a more efficient airspace organisation can be established and thus contribute to fulfil the above requirements.
The current RNAV procedures that have been introduced for en route, terminal and approach use only part of the full navigation and functional capabilities of many RNAV-equipped aircraft, and provide only part of the potential benefits. RNAV operating procedures need to be drawn up, and routes making use of the advanced navigation performance of modern aircraft should be established so that more benefits can be provided from the RNAV procedures. Aircraft that do not meet the requirements for the new RNAV procedures are expected to continue flying, so there will be a period during which aircraft that meet the new requirements must coexist with aircraft that do not (mixed operations).
Confronted with a mix of equipped and non-equipped aircraft, there will be a need to figure out how to move to a “best equipped, best served” policy.

3.2 En-route Continental

Airspace design enroute must be based on a strategic ATS-route system along main traffic flows enabling optimum connections to the SID/STAR systems, coordinated connections to neighbouring states, flexible use of airspace and fulfilling the capacity demand. This might necessitate segregated ATS-routes with a lateral distance down to 7-8 NM. This could possibly be done with RNAV 1 routes. This challenge will also be an issue in the North European Functional Airspace Project (NEFAB) where a Free Route Airspace Concept is planned implemented in November 2015.

3.3 Oceanic operations in Bodø OFIR/ OCA

Bodø OCA is a part of the NAT-region. Expected increase in traffic and aircraft equipment necessitate the development of a PBN Roadmap for this area. The PBN implementation for Bodø OCA/OFIR will be driven by on-going plans and developments in the NAT Region.

3.4 Terminal Areas

Airspace design of TMAs must be based upon a strategic SID/STAR system enabling continuous climb departures and continuous descend approaches and which serve the declared airport capacity.
The requirement of SID/STARs at all airports necessitate cost/benefit analyses to decide upon supporting navigation infrastructure (DME/DME and/or GNSS).

3.5 Instrument approach procedures

Norway has a total of 107 runway ends including 79 instrument runway ends (para 0.5 refers) and 12 runway ends which are instrument runway end candidates but have to be further analysed in order to clarify whether implementation of APV procedures are possible.
Appendix B shows a list of all runway ends with a preliminary overview of APV applicability, which gives an estimation of the total number of LPV and LNAV/VNAV instrument runway ends according to the definition of “Instrument runway end for APV” in chapter 0.5.

3.6 Helicopter operations

At some airports along the western coast of Norway helicopter operations to/from the oil rigs in the North Sea is a challenge in the traffic regulation system (mixed operations helicopter/fixed wing).
Further the development within helicopters related to noise is quite the opposite as for fixed-wing. The introduction of S-92 for off-shore operations increases noise exposure. In the future we might anticipate that this also will be relevant for land-based type of operations. S-92 is one of several candidates for SAR operations (330 squadron). Today we already see that S-92 at several Norwegian airports, in particular Stavanger/Sola (ENZV) and Bergen/Flesland (ENBR), will trigger the demand for new noise abatement procedures for both approach and departure. Evaluation of noise regulations will most likely be on the agenda in near future. The introduction of RNAV 1, RNP 1, A-RNP and RNP 0.3 for helicopter operations is foreseen to mitigate these challenges.

CURRENT STATUS

TMA	ATC airports	SID	STAR	Infrastructure (RNAV)
Oslo	ENGM	P-RNAV	P-RNAV	GNSS or DME/DME
Farris	ENTO ENRY	P-RNAV P-RNAV	P-RNAV P-RNAV	GNSS or DME/DME
Kjevik	ENCN	P-RNAV	P-RNAV	GNSS
Sola	ENZV ENHD	Conventional Conventional	P-RNAV P-RNAV	GNSS GNSS
Flesland	ENBR ENSO	Conventional P-RNAV	P-RNAV P-RNAV	GNSS GNSS
Vigra	ENAL	Conventional	P-RNAV	GNSS
Kvernberget	ENKB	Conventional	P-RNAV Conventional	GNSS
Ørland	ENOL	Conventional	None	
Vaernes	ENVA	P-RNAV	P-RNAV	GNSS
Røros	ENRO	None	None	-
Bodø	ENBO	P-RNAV	P-RNAV	GNSS
Evenes	ENEV	Conventional	Conventional	
Bardufoss	ENDU	Conventional	Conventional	
Andøya	ENAN	None	Conventional	
Tromsø	ENTC	P-RNAV	P-RNAV	GNSS
Alta	ENAT	Conventional	Conventional	
Banak	ENNA	Conventional	Conventional	
Kirkenes	ENKR	None	None	-

Table 4.1 Current status - Terminal Areas

4 Current Status

4.1 Aircraft Capabilities
Today, the majority of the Norwegian commercial airplane fleet are RNP capable with a certified performance of RNP 0.3 nm or better.

4.2 En-route Continental
ATS-routes are based upon RNAV 5 specification (B-RNAV) .

4.3 Oceanic operations in Bodø OFIR/OCA
Flights operating in Bodø OFIR have to be certified according to Minimum Navigation Performance System (MNPS) specifications. Procedures stated in ICAO Doc 7030/4 - North Atlantic (NAT) Regional Supplementary Procedures apply. The PBN implementation for Bodø OCA/OFIR will be driven by on-going plans and developments in the NAT Region.

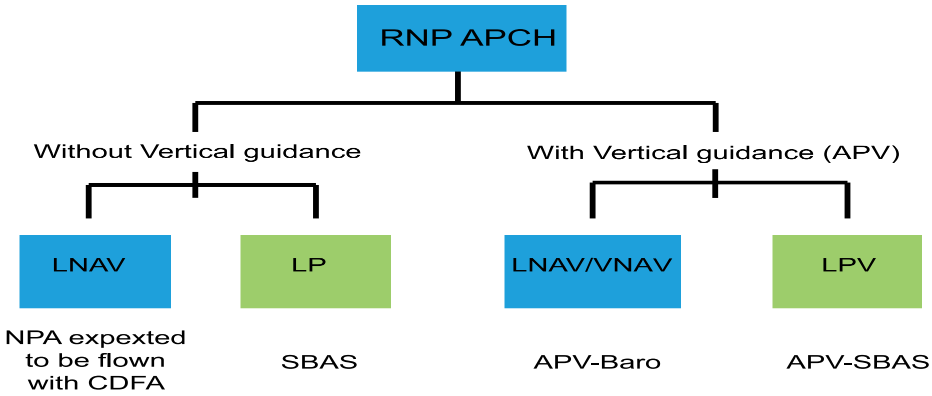

Figure 4.1 RNP APCH definitions

4.4 Terminal Areas

There is an on-going process of implementing RNAV 1 (P-RNAV) SID and STAR at all Norwegian airports supported either by GNSS or by GNSS and DME/DME. Analyses of traffic, available conventional procedures, aircraft certification, terrain challenges, cost/benefit and safety may lead to, or necessitate, areas with GNSS sole service. In addition conventional SID and STAR may be retained at some airports in order to support aircraft with no GPS.
Table 4.1 shows the status of implemented P-RNAV SID/ STAR at ATC airports underlying the TMAs together with supporting navigation infrastructure as of AIRAC 30 MAY 2013.

In addition Norway is implementing P-RNAV SID and STAR at local airports with AFIS. Helicopter RNAV 1 STAR are implemented to both Runway ends at Bergen/ Flesland.

4.5 Approach operations

The PBN Manual (ICAO Doc 9613) [1] classes the PBN approaches as RNP APCH and RNP AR APCH operations. As shown in Figure 1, RNP APCH operations include LNAV, LP, LNAV/VNAV and LPV.

Appendix B summarize current status for RNP APCH and RNP AR APCH (effective 30 MAY 2013).

IMPLEMENTATION ROADMAP (2013-2016)

5 Implementation Roadmap (2013-2016)

The intent of this chapter is to give an overview of the planned PBN implementation for all flight phases.
The following PBN implementation strategy is the basis for the roadmap shown in the following subsections.

Phase 1 P-RNAV STAR with T-bar or Y-bar connections to the final approach track
Phase 2 RNP APCH - LNAV procedures connected to the P-RNAV STAR
Phase3 RNP APCH - APV (LNAV/VNAV and/or LPV procedures as relevant)

At airports with low TFC/complexity, Phase 2 and Phase 3 may be implemented before Phase 1 based upon use of the Terminal Arrival Altitude (TAA) concept.

5.1 Roadmap (2013-2016) - En-route Continental

ATS-routes in Norway will be based upon continued use of RNAV 5 (B-RNAV) supported as necessary by radar monitoring service. RNP 1 routes will be considered at the end of the period.

5.2 Roadmap (2013-2016)

- Oceanic operations in Bodø OFIR/OCA

Bodø OCA is a part of the NAT-region. The PBN implementation for Bodø OCA/OFIR will be driven by on-going plans and developments in the NAT Region. Pending approval from the NAT SPG, a change in ICAO doc 7030 will allow all RNP 10 and/or RNP4 approved/certified aircraft to be issued with an MNPS operational approval without further examination.
The NAT PBN plan states that from 2015, aircraft will no longer be certified according to MNPS certifications. New MNPS approvals will be based on RNP10 and/or RNP4.
Further, redefine the NAT airspace such that the NAT MNPS airspace will be replaced with the NAT PBN airspace. The NAT PBN airspace will be defined in such a way that MNPS, RNAV10 and RNP4 aircraft are deemed to satisfy the prescribed NAT PBN airspace operation requirements. Bodø OCA is not a part of the PBN (MNPS) airspace today, but will be PBN airspace from 2015.

5.3 Roadmap (2013-2016) - Terminal Areas

RNAV 1 (P-RNAV) SID and STAR will be implemented at all Norwegian airports supported by GNSS and/or DME/DME as supporting infrastructure. Analyses of traffic, available conventional procedures, aircraft certification, terrain challenges, cost/benefit analyses and safety may however lead to, or necessitate, areas with GNSS sole service. A small number of conventional SID and STAR may be retained in order to support non P-RNAV aircraft.
At local airports (AFIS) with low traffic/complexity and where RNAV(GNSS) – LNAV procedures are implemented implementation of a RNAV STAR system based upon the Terminal Area Altitude (TAA) concept and RNAV SID based upon Omnidirectional Departure (Omni SID) will be considered
Table 5.1 shows planned implementation of P-RNAV SIDs and STARs as of AIRAC 30 MAY 2013.

**** In addition a DME/DME infrastructure is planned operational 2014***
***** At AFIS airports with low TFC/complexity STARs connected to RNAV (GNSS) procedures will solely be based upon the Terminal Arrival Altitude Concept (TAA) and SIDs will be based upon solely Omni-directional deparures.***

TMA	ATC airports (AFIS)	P-RNAV SID	P-RNAV STAR	Infrastructure (RNAV)	Year
Stavanger	ENZV ENHD	P-RNAV P-RNAV	Implemented Implemented	GNSS* GNSS*	
Flesland	ENBR	P-RNAV	Implemented	GNSS*	2014
Røros	ENRO	P-RNAV	P-RNAV	GNSS	2014
Kirkenes	ENKR	P-RNAV	P-RNAV	GNSS	2014
Evenes	ENEV	P-RNAV	P-RNAV	GNSS	2014
Vigra	ENAL	P:RNAV	Implemented	GNSS	2014
Kvernberget	ENKB	P-RNAV	Implemented	GNSS	2014
Ørland	ENOL	P-RNAV	P-RNAV	GNSS	2014
Bardufoss	ENDU	P-RNAV	P-RNAV	GNSS	2015
Andøya	ENAN	P-RNAV	P-RNAV	GNSS	2015
Alta	ENAT	P-RNAV	P-RNAV	GNSS	2015
Banak	ENNA	P-RNAV	P-RNAV	GNSS	2015
Lofoten	(AFIS airports)	**	**	GNSS	2014
Hammerfest	(AFIS airports)	**	**	GNSS	2015
Helgeland	(AFIS airports)	**	**	GNSS	2014/15

Table 5.1 Roadmap (2013-16) - Terminal Areas

5.4 Roadmap (2013-2016) -
Helicopter operations

A major revision of the airspace organisation in Stavanger AoR and southern part of Bodø AoR (south of Helgeland TMA) is planned effective on AIRAC 13 NOV 2014.
A part of this revision is to revise/implement helicopter RNAV 1 SID and STAR at Stavanger/Sola (ENZV), Bergen/Flesland (ENBR), Florø (ENFL) and Kristiansund/Kvernberget (ENKB)
Further helicopter RNAV 1 SID/STAR is planned implemented at Brønnøysund (ENBN) and Hammerfest (ENHF) in the period 2014/2015.
RNP 0.3 applications will be considered implemented when they are operational ready

5.5 Roadmap (2013 – 16) Instrument approach procedures

Implementation of LNAV to all runway ends and APV procedures to all instrument runway ends is planned to be fulfilled in this period .
An important criterion for selection is the type of airspace users operating at the airport including type and navigation capability of the aircraft. Generally mainline airlines with Boeing and Airbus aircraft express a need for LNAV/VNAV at the larger airports with ATC. Regional airlines, ambulance operators and helicopter operators at local airports with AFIS express a need for LPV.
Terrain constraints and other characteristics of the aerodrome and the environment may limit the possibilities for implementing a specific APV procedure. In general, LPV is more flexible and LNAV/VNAV more stringent.

AIRSPACE USER'S PRIORITIES

This reinforces the general preference for LNAV/VNAV at airports with ATC, and for LPV at local airports with AFIS. The introduction of curved segments in the new navigation specification Advanced RNP (A-RNP), as well as any future development of curved LPV procedures, may potentially enable APV at airports where APV is not feasible today. Curved segments with vertical guidance are currently only possible using RNP AR where a sophisticated modern FMS and autopilot and a stringent approval process is required.

New instrument flight procedure design criteria for A-RNP have been developed and will be published in ICAO Doc 8168 (PANS OPS) in the 2013/2014 timeframe. These criteria are less stringent than the RNP AR criteria, will require less stringent operator approval process and will thus open up the use of RF legs to a much wider population of airspace users.

Based upon requests from some airspace users, RNP AR procedures are initially planned at Alta (ENAT) RWY 29, Evenes (ENEV) RWY 35. Tromsø (ENTC) RWY 19, Haugesund/Karmøy (ENHD) RWY14 and all instrument runway ends at Oslo/Gardermoen . Further implementation of curved RNAV approaches (RNAP AR or A-RNP) will be evaluated during this period.

Helicopter operations

In order to implement more effective helicopter instrument approach procedures and thus increase capacity in mixed operations environment and also mitigate environmental issues, helicopter instrument approach procedures (SID/STAR/APCH) based on the navigation specifications , Advanced RNP and RNP 0.3 will be implemented in this period

In the following subsections the airspace user priorities based on inputs to a survey conducted autumn 2011 is first presented in chapter 5.5.1, followed by a presentation in chapter 5.5.2 and Appendix A, of the ANPS's (Avinor) current plan for implementation of RNP APCH and RNP AR APCH.

5.5.1 Airspace User's priorities

PBN demand survey carried out in autumn 2011

In connection with the revision of PBN Implementation Plan Norway, the CAA conducted a stakeholder demand survey among owners and users of the country's airports as part of the substrate for the rollover of the PBN implementation plan.

Stakeholders divided into groups:

Operators, divided into 4 groups, A, B, C and D
ANSP (Avinor), E
Airport owners, divided into 2 groups F and G
The Armed Forces, H
CAA, I

Group A. SAS and NAS
Mainly wants procedures based on APV Baro, RNP APCH (EASA AMC 20-27) and RNP AR APCH (EASA AMC 20-26). IATA shares this vision. SAS and NAS have set up priority order.

Group B. WIF and Lufttransport (LTP)
Local airports priority 1, wants procedures based on SBAS (EASA AMC 20-28), at regional and main airports APV Baro, RNP APCH (EASA AMC 20-27). WIF and LTP operate at most Norwegian airports but did not set up priority order.

Group C. Helicopter operators CHC and Bristow
Want RNP SID and RNP APCH to selected airports.

Group D. Requests from other carriers
Want procedures based both on APV Baro, RNP APCH (EASA AMC 20-27) and SBAS (EASA AMC 20-28)

Group E. Avinor ANSP
Ref Roadmap:Terminal Areas, Instrument approach procedures

Group F. Major airports
Wants mainly procedures based on APV Baro, RNP APCH and some SBAS procedures.

Group G. Local regional airports (short field)
Mainly wants procedures based on SBAS

Group H. The Armed Forces
The armed forces do not want at this time to come up with specific wishes

Group H. The Civil Aviation Authority
Ref PBN Implementation Plan Norway and BSL G

Summary

The two largest fixed wing operators and IATA want RNP APCH based on APV Baro, and the two main short field operators want RNP APCH based on SBAS, but also APV Baro for regional and main airports. Helicopter operators want suitable RNP procedures. These 3 groups represents the vast majority of the users.

Based on input from all stakeholders, the Working Group has drawn up a list of procedural steps at Norwegian airports. Priority tools: ICAO Convention 37-11, aviation safety, vulnerability and Avinor on-going and planned space projects.

In terms of implementation and capacity, APV procedures according to ICAO resolution 37-11 and BSL G will be priority 1.

5.5.2 Current ANSP implementation plan

The ANSP (Avinor) has, based upon principles stated in chapter 0.6, challenges mentioned in chapter 3.5, analysis made for each runway end, coordination with on-going airspace projects and input from airspace users, developed an implementation plan for the period 2013-16. The plan is shown in Appendix A.

The implementation plan does not in this version explicit mention helicopter instrument approach procedures, but such procedures will be developed and implemented based on evolving requests. A coordinated input from Bristow, Blueway and CHC Helicopter Service.concerning RNP operations at Stavanger/Sola (ENZV), Bergen/Flesland (ENBR), Florö (ENFL) and Kristiansund/Kvernberget (ENKB) will also be taken into account.

6 Long Term Implementation Strategies (2017+)

6.1 Strategies (2017+) - En-route Continental

ATS-routes in Norway is expected to be based upon RNAV 1 /RNP 1 (GNSS) and extended use of Free Route Airspace with the aim to provide selectable user preferred routes in Norway CTA.

6.2 Strategies (2017+) - Oceanic operations in Bodø OFIR/OCA

Bodø OCA is part of the NAT-region. Expected increase in traffic and evolution of aircraft equipment necessitate the development of a PBN roadmap for this area. The PBN implementation for Bodø OCA/OFIR will be driven by on-going plans and developments in the NAT Region. The NAT PBN plan states that from 2020, all aircraft operating in the NAT PBN airspace shall have an operational approval based on the RNAV10 (RNP10) or RNP4 navigation specification requirements. Aircraft having MNPS approvals will not be allowed anymore.

6.3 Strategies (2017+) - Terminal Areas

Advanced RNP-1 applications are expected to be implemented in selected terminal areas.
This will entail increased decommissioning of VOR/DME and the remaining NDBs will be completely withdrawn.

6.4 Strategies (2017+) - Instrument approach procedures

APV is established at all instrument runway ends.
Decommissioning of conventional procedures need to be preceded by commissioning of PBN back-up procedures for missed approaches and diversions.
Advanced applications as 4-D and curved paths will evolve and applications come mature for implementations.
As of today GBAS is expected to be the only solution to meet future demands in all-weather navigational performance (CAT II/III), and also be an enabler for reduced environmental impact. However the technology is under development and international standards are not in place. Combined with the fact that only a limited number of airlines have the necessary equipment on order, a full benefit of such an investment has to be further assessed. GBAS is not expected to be implemented until 2016+.
In Oslo, Gardermoen GBAS is in a short term assumed to be the valid tool for these procedures, but will be dependent on the development of both GBAS and SBAS solutions in the future. Development within ICAO and the navigation strategy in Europe, USA and globally must therefore closely be monitored. It is considered to be important to aim for global standards and avoid regional/ local solutions for the few.
Even if Gardermoen today only is equipped with ILS CAT II/III minima for 2 out of 4 RWYs the PBN plan do not take into consideration alternative procedures at this stage. GLS as required tool is expected to provide CAT II/III minima in 2018-19 and ILS is therefore the only solution to secure high capacity in the near future. ILS is therefore anticipated in the foreseeable future to remain as precision approach and landing application at those airports equipped with ILS.

7 Strategy for PBN Implementation and Progress Monitoring

7.1 PBN Project Group

A national PBN Group consisting of members from the NCAA shall:

- Monitor and ensure that commitments described in the PBN Implementation Plan Norway are carried out according to established timeframes and intermediate milestones.
- Ensure harmonised reporting of the PBN implementation progress to Eurocontrol, EC (LSSIP) and ICAO.

7.2 PBN Implementation Plan Working Group

A national PBN Implementation Plan Working Group consisting of members from Avinor and NCAA shall:

- Be responsible for revising the PBN implementation Plan Norway in accordance with any applicable revisions to ICAO DOC 9613, relevant EASA documentation or and national strategic priorities.

Stakeholders will be invited to contribute and take part in review of the plan and in prioritizing PBN applications.

ABBREVIATIONS

AFIS	Aerodrome flight information service
AIP	Aeronautical information publication
ANC	Air navigation conference
ANSP	Air navigation service provider
APCH	Approach procedure
APV	RNP APCH procedure with vertical guidance (i.e. LPV and LNAV/VNAV)
ATC	Air traffic control
ATM	Air traffic management
ATS	Air traffic service(s)
B-RNAV	Basic RNAV
Baro-VNAV	Barometric VNAV
CBA	Cost benefit analysis
CCD	Continuous climb departure
CDA	Continuous descent approach
CDM	Collaborative Decision Making
CDFA	Continuous descent final approach
CFIT	Controlled flight into terrain
CNS	Communications, Navigation, Surveillance
CTA	Control area
CTR	Control zone
DME	Distance measuring equipment
EASA	European Aviation Safety Agency
ECAC	European Civil Aviation Conference
EGNOS	European geostationary navigation overlay service
ESSIP	European Single Sky ImPlementation
ESSP	European Satellite Services Provider
eTOD	Electronic terrain and obstacle data
EUROCAE	European Organisation for Civil Aviation Equipment
FIR	Flight Information Region
FL	Flight Level
FMS	Flight management system
FOSA	Flight operational safety assessment
GBAS	Ground-based augmentation system
GLONASS	Global Navigation Satellite System
GLS	GNSS landing system
GNSS	Global navigation satellite system
GPS	Global positioning system
IAP	Instrument approach procedure(s)
ICAO	International Civil Aviation Organization
IFP	Instrument Flight Procedure
IFR	Instrument flight rules
ILS	Instrument landing system
INS	Inertial navigation system
IRU	Inertial reference unit
LNAV	RNP APCH procedure with lateral navigation only; no vertical guidance (i.e. RNP APCH based on GPS; GPS NPA)
LNAV/VNAV	RNP APCH procedure with lateral and vertical navigation (i.e. RNP APCH to LNAV/VNAV minima based on baro-aided GPS)
LPV	RNP APCH procedure with localizer performance with vertical guidance (i.e. RNP APCH based on APV SBAS)
LSSIP	Local Single Sky ImPlementation
LTO	Landing Take Off cycle. From 3000 ft. and block-on – from push back to 3000 ft.
LVP	Low Visibility Procedures
MNPS	Minimum Navigation Performance System
MSA	Minimum Sector Altitude
NAT	North Atlantic
NCAA	Norwegian Civil Aviation Authority
NM	Nautical Mile
NPA	Non precision approach
OCA	Oceanic Control Area
OFIR	Oceanic flight information region
PANS	Procedures for air navigation services
PBN	Performance-based navigation
P-RNAV	Precision RNAV
QA	Quality Assurance
RAIM	Receiver autonomous integrity monitoring
RF	Radius to fix
RNAV	Area navigation
RNP	Required navigation performance
RNP APCH	RNP APPROACH (i.e. PBN specification)
RNP AR	Required navigation performance - authorization required
SARPS	Standards and recommended practices
SBAS	Satellite-based augmentation system
SCAT-I	Special category 1
SES	Single European Sky
SESAR	Single European Sky ATM Research
SID	Standard instrument departure
SoL	Safety of Life
STAR	Standard instrument arrival
TAA	Terminal Arrival Altitude
TMA	Terminal Area
VEB	Vertical Error Budget
VHF	Very high frequency
VNAV	Vertical navigation
VOR	VHF omnidirectional radio range
VPA	Vertical Path Angle
WGS84	World Geodetic System 1984

Luftfartstilsynet
CIVIL AVIATION AUTHORITY - NORWAY

PBN Plan Ver 3.0 Appendix A

Airports with ATC:

ICAO code	Airport name	IFR RWY	LNAV	LNAV/VNAV	LPV	RNP AR	Notes:
ENAL	Ålesund, Vigra	7	Implemented	Planned 2014	Planned 2014		
		25	Planned 2014	Planned 2014	Planned 2014		
ENAN	Andøya, Andenes	3	Not planned	Analysis required	Analysis required		No published procedure to RWY 03
		21	Planned 2015/16	Planned 2015/16	Planned 2015/16		
		14	Implemented	Planned 2015/16	Planned 2015/16		
		32	Implemented	Planned 2015/16	Planned 2015/16		
ENAT	Alta	11	Planned 2015/16	VPA issue	EGNOS issue		
		29	Planned 2015/16	VPA issue	EGNOS issue	Planned	
ENBO	Bodø	7	Planned 2015/16	Planned 2015/16	Planned 2015/16		
		25	Planned 2015/16	Analysis required	Analysis required		Offset issue
ENBR	Bergen, Flesland	17	Implemented	Planned 2014	Planned 2014		
		35	Implemented	Planned 2014	Planned 2014		
ENCN	Kristiansand, Kjevik	4	Implemented	Planned 2015/16	Planned 2015/16		
		22	Implemented	Planned 2015/16	Planned 2015/16		
ENDU	Bardufoss	10	Planned 2015/16	Planned 2015/16	Planned 2015/16		
		28	Planned 2015/16	Analysis required	Planned 2015/16		VPA issue
ENEV	Harstad/Narvik, Evenes	17	Planned 2014	Analysis required	Planned 2014		
		35	Planned 2014	Offset issue	Offset issue	Planned	APV not possible due to offset angle
ENGM	Oslo, Gardermoen	01R	Implemented	Planned 2014	Planned 2014	Planned	
		01L	Implemented	Planned 2014	Planned 2014	Planned	
		19R	Implemented	Planned 2014	Planned 2014	Planned	
		19L	Implemented	Planned 2014	Planned 2014	Planned	
ENHD	Haugesund, Karmøy	14	Implemented	Planned 2015/16	Planned 2015/16	Planned	
		32	Implemented	Planned 2015/16	Planned 2015/16		
ENKB	Kristiansund, Kvernberget	7	Planned 2014	Planned 2014	Planned 2014		
		25	Planned 2014	Offset issue	Planned 2014		LNAV/VNAV not possible due offset angle
ENKR	Kirkenes, Høybuktmoen	6	Planned 2014	Analysis required	Planned 2015/16		
		24	Planned 2014	Planned 2015/16	Planned 2015/16		
ENNA	Lakselv, Banak	17	Planned 2015/16	Planned 2015/16	EGNOS issue		
		35	Planned 2015/16	Planned 2015/16	EGNOS issue		
ENOL	Ørlandet	15	Planned 2015/16	Planned 2015/16	Planned 2015/16		
		33	Planned 2015/16	Planned 2015/16	Planned 2015/16		
ENRO	Røros	14	Planned 2014	Not possible	Not possible		APV not possible due to terrain
		32	Planned 2014	Analysis required	Analysis required		
ENRY	Moss, Rygge	12	Planned 2015/16	Planned 2015/16	Planned 2015/16		
		30	Planned 2015/16	Planned 2015/16	Planned 2015/16		

ENTC	Tromsø, Langnes	1	Implemented	VPA issue	Analysis required	Planned	EGNOS issues to be clarified (2014)
		19	Implemented	VPA issue	Analysis required	Planned	EGNOS issues to be clarified (2014)
ENTO	Sandefjord, Torp	18	Planned 2015/16	Planned 2015/16	Planned 2015/16		
		36	Planned 2015/16	Planned 2015/16	Planned 2015/16		
ENVA	Trondheim, Værnes	9	Implemented	Planned 2014	Planned 2014		
		27	Implemented	Planned 2014	Planned 2014		
ENZV	Stavanger, Sola	18	Implemented	Planned 2014	Planned 2014		
		36	Implemented	Planned 2014	Planned 2014		
		11	Planned 2014	Planned 2014	Planned 2014		
		29	Planned 2014	VPA issue	Planned 2014		

Airports with AFIS:

ICAO code	Airport name	IFR RWY	LNAV	LNAV/VNAV	LPV	RNP AR	Notes:
ENBL	Førde, Bringeland	7	Planned 2013	VPA issue	Planned 2014		
		25	Planned 2013	VPA issue	Planned 2014		
ENBN	Brønnøysund	4	Planned 2013	VPA issue	Planned 2014		
		22	Planned 2013	Analysis required	Analysis required		No published procedure to RWY 22
ENBS	Båtsfjord	3	Planned 2013	VPA issue	EGNOS issue		
		21	Planned 2013	Planned 2015/16	EGNOS issue		
ENBV	Berlevåg	6	Planned 2013	Planned 2015/16	EGNOS issue		No published procedure to RWY 06
		24	Planned 2013	Planned 2015/16	EGNOS issue		
ENFG	Fagernes	15	Planned 2015/16	Offset issue	Offset issue		APV not possible due to offset angle
		33	Planned 2015/16	Planned 2015/16	Planned 2015/16		
ENFL	Florø	7	Planned 2014	Planned 2014	Planned 2014		
		25	Planned 2014	Analysis required	Analysis required		
ENHF	Hammerfest	5	Implemented	Planned 2015/16	EGNOS issue		
		23	Planned 2013	Planned 2015/16	EGNOS issue		
ENHK	Hasvik	11	Planned 2013	Planned 2015/16	EGNOS issue		
		29	Planned 2013	Planned 2015/16	EGNOS issue		
ENHV	Honningsvåg, Valan	8	Analysis required	Offset issue	EGNOS/offset issue		LNAV/VNAV and LPV not possible due offset angle
		26	Analysis required	Offset issue	EGNOS/offset issue		LNAV/VNAV and LPV not possible due offset angle
ENLK	Leknes	3	Planned 2015/16	Offset issue	Offset issue		APV not possible due to offset angle
		21	Implemented	VPA issue	Planned 2015/16		
ENMH	Mehamn	17	Implemented	Planned 2015/16	EGNOS issue		
		35	Implemented	VPA issue	EGNOS issue		
ENML	Molde, Årø	7	Planned 2014	Planned 2014	Planned 2014		
		25	Planned 2014	Analysis required	Planned 2014		
ENMS	Mosjøen, Kjærstad	16	Planned 2015/16	Offset issue	Offset issue		APV not possible due to offset angle
		34	Planned 2015/16	Offset issue	Planned 2015/16		LNAV/VNAV not possible due offset angle
ENNK	Narvik	1	Planned 2015/16	Offset issue	Offset issue		APV not possible due to offset angle
		19	Planned 2015/16	VPA issue	Planned 2015/16		
ENNM	Namsos	7	Implemented	Planned 2014	Planned 2014		
		25	Implemented	Planned 2014	Planned 2014		
ENNO	Notodden, Tjuven	12	Implemented	VPA issue	Planned 2015/16		LNAV/VNAV not possible due to VPA
		30	Planned 2015/16	Offset issue	Offset issue		APV not possible due to offset angle
ENOV	Ørsta-Volda	6	Planned 2014	Offset/VPA issue	Offset/VPA issue		Only circling procedures available
		24	Planned 2014	Offset/VPA issue	Offset/VPA issue		Only circling procedures available
ENRA	Mo i Rana, Røssvoll	14	Planned 2015/16	Offset issue	Offset issue		APV not possible due to offset angle
		32	Planned 2015/16	Offset issue	Offset issue		APV not possible due to offset angle

ENRM	Rørvik, Ryum	4	Implemented	Planned 2015/16	Planned 2015/16		
		22	Implemented	Planned 2015/16	Planned 2015/16		
ENRS	Røst	3	Implemented	Planned 2015/16	Planned 2013		
		21	Implemented	Planned 2015/16	Planned 2013		
ENSB	Svalbard, Longyearbyen	10	Planned 2014	Planned 2014	EGNOS issue		
		28	Planned 2014	Offset issue	EGNOS issue	Planned	APV not possible due to offset angle
ENSD	Sandane	9	Planned 2014	Offset issue	Offset issue		APV not possible due to offset angle
		27	Planned 2014	VPA issue	Analysis required		
ENSG	Sogndal, Haukåsen	6	Planned 2014	VPA issue	Planned 2014		
		24	Planned 2014	VPA issue	Planned 2014		
ENSH	Svolvær, Helle	1	Planned 2013	Planned 2015/16	Planned 2015/16		
		19	Planned 2015/16	Offset/VPA issue	Offset/VPA issue		APV not possible due to terrain
ENSK	Skagen, Stokmarknes	9	Planned 2014	Planned 2014	Planned 2014		
		27	Planned 2014	Offset issue	Offset issue		APV not possible due to offset angle
ENSN	Skien, Geiteryggen	1	Implemented	Planned 2015/16	Planned 2015/16		
		19	Implemented	Planned 2015/16	Planned 2015/16		
ENSO	Stord, Sørstokken	15	Implemented	Planned 2015/16	Planned 2015/16		
		33	Implemented	Planned 2015/16	Planned 2015/16		
ENSR	Sørkjosen	15	Planned 2015/16	Offset issue	Offset issue		APV not possible due to offset angle
		33	Planned 2015/16	Offset issue	Offset issue		APV not possible due to offset angle
ENSS	Vardø, Svartnes	15	Implemented	Planned 2015/16	EGNOS issue		
		33	Implemented	Planned 2015/16	EGNOS issue		
ENST	Sandnessjøen, Stokka	3	Implemented	Planned 2014	Planned 2014		
		21	Implemented	Planned 2014	Planned 2014		
ENVD	Vadsø	8	Implemented	Planned 2015/16	EGNOS issue		
		26	Implemented	Planned 2015/16	EGNOS issue		

An Assessment of Norwegian AIP airport Runway ends, suitable for implementing of APV procedures

The purpose of this assessment has been to elaborate what kind of APV-procedures are possible to implement and where - at Norwegian AIP Airports. National regulation BSL G 4-1 requirements and the Norwegian PBN implementation plan has been reference documents in the assessment process.

APV in this context means LNAV/VNAV (baro-VNAV) or LPV based on EGNOS (SBAS). These two applications will appear on the Approach charts as LNAV/VNAV or LPV lines of minima. SCAT-I and RNP AR are not covered by BSL G 4-1 but are (and will become) appropriate approach procedures at some airports. Procedures based on SCAT-I and RNP AR was omitted for this purpose (although they may be mentioned in the notes for the individual airports).

During the development of version 2 of the Norwegian PBN implementation plan, a questionnaire was sent to all airports and aircraft operators asking which APV application was preferred. The feedback from these was compiled with Avinors on-going and planned airspace projects, and the result is shown in the existing Norwegian PBN Plan chapter 5.

The purpose of this analysis was to conduct an assessment of the individual airports and the type of APV procedure that can and should be established on the basis of existing design criteria and system constraints (signal coverage).

The Analysis

The Analysis consists of an assessment of the individual Airport in the Norwegian AIP, and an evaluation to determine how many instrument runway ends meets the requirements for the establishment of APV procedures and the type of APV procedures that are best suited for the particular runway. The timeframe for when the current applications will be implemented at each Airport, appears in the Norwegian PBN implementation plan.

At Runway ends where both LNAV/VNAV and LPV can be established, the airport operator should be given the option in regards to whether or not it is deemed beneficial to implement both APV applications.

It is recommended that there should be a process raising awareness about what is feasible at a given Airport. Operator capabilities and equipage must also be considered. Simultaneous implementation of both LNAV/VNAV and LPV, where possible, does not greatly impact the cost of implementation.

Instrument Runway Ends

Currently there is no ICAO definition of the term Instrument Runway End. The team doing the assessment has therefore based their work on the current design criteria (ICAO DOC 8168 VOL II) for current APV applications. This means that if one cannot design an APV procedure to a Runway-end, the Runway cannot be regarded as an instrument runway end in this context.

For some Runways which have conventional non-precision instrument approach procedures (for example LOC, VOR and NDB), these can be up to 30˚ offset for category A and B aircraft.

A practical consequence means that some Airports have instrument runway ends that cannot meet the criteria for APV procedures, and therefore will not be a basis of calculation against the required target figures for APV procedure implementation in Norway.

Some conventional procedures that are currently offset due to navigational aid restrictions might be candidates for APV procedure implementation. Further analysis of these runway ends is required to assess whether it is possible to implement APV procedures.

At present the criteria for LPV is +/- 5˚ offset from the extended Runway centreline and with a Vertical Path Angle (VPA) up to 6.3˚.

For LNAV/VNAV 0˚ offset applies, - only final approach along the extended Runway centreline and with a VPA limited to 3˚ - 3.5˚.

Criteria for LNAV/VNAV (Baro-VNAV) will be significantly changed from November 2014. At the time of AIRAC March 7 2013, there will be no LNAV/VNAV published in the Norwegian AIP. Avinor PANS-OPS has therefore recommended delaying implementation of Baro-VNAV procedures until the new criteria are released from ICAO.
The PBN implementation working group supports this recommendation.

LPV limitations

The Team accomplished the assessment under the assumption that the use of EGNOS (SBAS) north of 70˚ is not advisable. This point of view was made based on the monthly reports from the ESSP and actual coverage Charts. Web site: http://www.essp-sas.eu/home

Due to the topography of northern Norway there may be possible issues related to mask angles. In this area there will be a need for further investigation and clarification. However there are on-going efforts to improve the EGNOS coverage up to 72˚ N. Among the local Airports located north of 70˚ N SCAT-I procedures will be implemented to 14 instrument runway ends by the end of 2013. There is a total of 8 Airports north of 70˚ N, and 7 of these will therefore receive SCAT-I procedures.

LNAV/VNAV versus LPV

APV based on LNAV/VNAV has a limitation on the Vertical Path Angle (VPA) of 3.5˚ according to Pans-Ops criteria. This means that where EGNOS signals are available, LPV may be a better solution where LNAV/VNAV possibilities are limited by topography.

LNAV procedures that are off-set by more than 5˚ are indicated with an Asterix in the Table below, because they do not meet the criteria for APV.

Some runway ends that in this context do not fall under the concept of APV, may have RNP AR procedures implemented as an alternative to APV. Such operations are currently being considered at, but not limited to; Alta, Tromsø, Evenes and Svalbard.

PBN Plan Ver 3.0 Appendix B

Instrument Runway End Analysis

ICAO code	Airport name	IFR RWY	Straight-in	VPA (°)	LNAV	LNAV/VNAV	LPV	APV Instr RWY End	RWY Ends	Notes:
ENAL	Ålesund, Vigra	7	Yes	3.4°	Implemented	Possible	Possible	1	1	
		25	Yes	3.0°	Possible	Possible	Possible	1	1	
ENAN	Andøya, Andenes	3	No	-	Possible	Analysis required	Analysis required			No published procedure to RWY 03
		21	Yes	3.0	Possible	Possible	Possible	1	1	
		14	Yes	3.0	Implemented	Possible	Possible	1	1	
		32	Yes	3.0	Implemented	Possible	Possible	1	1	
ENAT	Alta	11	Yes	3.7	Possible	VPA issue	EGNOS issue		1	
		29	No	-	Possible*	VPA issue	EGNOS issue		1	
ENBL	Førde, Bringeland	7	Yes	3.9	Possible	VPA issue	Possible	1	1	
		25	Yes	4.1	Possible	VPA issue	Possible	1	1	
ENBN	Brønnøysund	4	Yes	3.7	Possible	VPA issue	Possible	1	1	
		22	No	-	Possible*	Analysis required	Analysis required		1	No published procedure to RWY 22
ENBO	Bodø	7	Yes	3.0	Possible	Possible	Possible	1	1	
		25	Yes	3.5	Possible	Analysis required	Analysis required		1	ILS procedure offset by 10°
ENBR	Bergen, Flesland	17	Yes	3.1	Implemented	Possible	Possible	1	1	
		35	Yes	3.0	Implemented	Possible	Possible	1	1	
ENBS	Båtsfjord	3	No	4.0	Possible	VPA issue	EGNOS issue		1	
		21	Yes	3.3	Possible	Possible	EGNOS issue	1	1	
ENBV	Berlevåg	6	No	-	Possible	Possible	EGNOS issue	1	1	No published procedure to RWY 06
		24	Yes	3.5	Possible	Possible	EGNOS issue	1	1	
ENCN	Kristiansand, Kjevik	4	Yes	3.5	Implemented	Possible	Possible	1	1	
		22	Yes	3.5	Implemented	Possible	Possible	1	1	
ENDU	Bardufoss	10	Yes	3.0	Possible	Possible	Possible	1	1	
		28	Yes	3.8	Possible	Analysis required	Possible	1	1	VPA issue
ENEV	Harstad/Narvik, Evenes	17	Yes	3.8	Possible	Analysis required	Possible	1	1	
		35	NO	-	Possible*	Offset issue	Offset issue		1	
ENFG	Fagernes	15	NO	3.3	Possible*	Offset issue	Offset issue		1	
		33	Yes	3.4	Possible	Possible	Possible	1	1	
ENFL	Florø	7	Yes	3.5	Possible	Possible	Possible	1	1	
		25	NO	3.3	Possible*	Analysis required	Analysis required		1	
ENGM	Oslo, Gardermoen	01R	Yes	3.0	Implemented	Possible	Possible	1	1	
		01L	Yes	3.0	Implemented	Possible	Possible	1	1	
		19R	Yes	3.0	Implemented	Possible	Possible	1	1	
		19L	Yes	3.0	Implemented	Possible	Possible	1	1	
ENHD	Haugesund, Karmøy	14	Yes	3.0	Implemented	Possible	Possible	1	1	
		32	Yes	3.0	Implemented	Possible	Possible	1	1	
ENHF	Hammerfest	5	Yes	3.5	Implemented	Possible	EGNOS issue	1	1	
		23	Yes	3.5	Possible	Possible	EGNOS issue	1	1	
ENHK	Hasvik	11	Yes	3.0	Possible	Possible	EGNOS issue	1	1	
		29	Yes	3.4	Possible	Possible	EGNOS issue	1	1	
ENHV	Honningsvåg, Valan	8	No	-	Analysis required	Offset issue	EGNOS/offset issue		1	Offset issue
		26	No	-	Analysis required	Offset issue	EGNOS/offset issue		1	Offset issue
ENKB	Kristiansund, Kvernberget	7	Yes	3.0	Possible	Possible	Possible	1	1	
		25	No	3.5	Possible*	Offset issue	Possible	1	1	

ENKR	Kirkenes, Høybuktmoen	6	No	3.5	Possible	Analysis required	Possible	1	1	
		24	Yes	3.4	Possible	Possible	Possible	1	1	
ENLK	Leknes	3	No	-	Possible*	Offset issue	Offset issue		1	
		21	Yes	3.9	Implemented	VPA issue	Possible	1	1	
ENMH	Mehamn	17	Yes	3.9	Implemented	Possible	EGNOS issue	1	1	
		35	Yes	3.9	Implemented	VPA issue	EGNOS issue		1	
ENML	Molde, Årø	7	Yes	3.1	Possible	Possible	Possible	1	1	
		25	Yes	3.5	Possible	Analysis required	Possible	1	1	
ENMS	Mosjøen, Kjærstad	16	No	-	Possible*	Offset issue	Offset issue		1	
		34	Yes	3.5	Possible	Offset issue	Possible	1	1	
ENNA	Lakselv, Banak	17	Yes	3.1	Possible	Possible	EGNOS issue	1	1	
		35	Yes	3.5	Possible	Possible	EGNOS issue	1	1	
ENNK	Narvik	1	No	-	Possible*	Offset issue	Offset issue		1	
		19	Yes	4.1	Possible	VPA issue	Possible	1	1	
ENNM	Namsos	7	Yes	3.5	Implemented	Possible	Possible	1	1	
		25	Yes	3.5	Implemented	Possible	Possible	1	1	
ENNO	Notodden, Tjuven	12	Yes	4.5	Implemented	VPA issue	Possible	1	1	
		30	No	-	Possible*	Offset issue	Offset issue		1	
ENOL	Ørlandet	15	Yes	3.0	Possible	Possible	Possible	1	1	
		33	Yes	3.3	Possible	Possible	Possible	1	1	
ENOV	Ørsta-Volda	6	No	-	Possible*	Offset/VPA issue	Offset/VPA issue		1	
		24	No	-	Possible*	Offset/VPA issue	Offset/VPA issue		1	
ENRA	Mo i Rana, Røssvoll	14	No	-	Possible*	Offset issue	Offset issue		1	
		32	No	-	Possible*	Offset issue	Offset issue		1	
ENRM	Rørvik, Ryum	4	Yes	3.9	Implemented	Possible	Possible	1	1	
		22	Yes	3.9	Implemented	Possible	Possible	1	1	
ENRO	Røros	14	No	-	Possible	Terrain issue	Terrain issue		1	
		32	Yes	3.3	Possible	Analysis required	Analysis required		1	
ENRS	Røst	3	Yes	3.9	Implemented	Possible	Possible	1	1	
		21	Yes	3.9	Implemented	Possible	Possible	1	1	
ENRY	Moss, Rygge	12	Yes	3.0	Possible	Possible	Possible	1	1	
		30	Yes	3.0	Possible	Possible	Possible	1	1	
ENSB	Svalbard, Longyearbyen	10	Yes	3.0	Possible	Possible	EGNOS issue	1	1	
		28	No	-	Possible*	Offset issue	EGNOS/offset issue	1	1	
ENSD	Sandane	9	No	-	Possible*	Offset issue	Offset issue		1	
		27	Yes	5.4	Possible	VPA issue	Analysis required	1	1	
ENSG	Sogndal, Haukåsen	6	Yes	4.3	Possible	VPA issue	Possible	1	1	
		24	Yes	4.0	Possible	VPA issue	Possible	1	1	
ENSH	Svolvær, Helle	1	Yes	3.6	Possible	Possible	Possible	1	1	
		19	No	-	Possible*	Offset/VPA issue	Offset/VPA issue		1	
ENSK	Skagen, Stokmarknes	9	Yes	3.2	Possible*	Possible	Possible	1	1	
		27	No	-	Possible*	Offset issue	Offset issue		1	
ENSN	Skien, Geiteryggen	1	Yes	3.5	Implemented	Possible	Possible	1	1	
		19	Yes	3.5	Implemented	Possible	Possible	1	1	
ENSO	Stord, Sørstokken	15	Yes	3.0	Implemented	Possible	Possible	1	1	
		33	Yes	3.6	Implemented	Possible	Possible	1	1	

ENSR	Sørkjosen	15	No	-	Possible*	Offset issue	Offset issue		1
		33	No	-	Possible*	Offset issue	Offset issue		1
ENSS	Vardø, Svartnes	15	Yes	3.5	Implemented	Possible	EGNOS issue	1	1
		33	Yes	3.5	Implemented	Possible	EGNOS issue	1	1
ENST	Sandnessjøen, Stokka	3	Yes	3.9	Implemented	Possible	Possible	1	1
		21	Yes	3.9	Implemented	Possible	Possible	1	1
ENTC	Tromsø, Langnes	1	Yes	4.0	Implemented	VPA issue	Analysis required		1
		19	Yes	4.0	Implemented	VPA issue	Analysis required		1
ENTO	Sandefjord, Torp	18	Yes	3.0	Possible	Possible	Possible	1	1
		36	Yes	3.0	Possible	Possible	Possible	1	1
ENVA	Trondheim, Værnes	9	Yes	3.1	Implemented	Possible	Possible	1	1
		27	Yes	3.4	Implemented	Possible	Possible	1	1
ENVD	Vadsø	8	Yes	3.5	Implemented	Possible	EGNOS issue	1	1
		26	Yes	3.5	Implemented	Possible	EGNOS issue	1	1
ENZV	Stavanger, Sola	18	Yes	3.0	Implemented	Possible	Possible	1	1
		36	Yes	3.0	Implemented	Possible	Possible	1	1
		11	Yes	3.0	Possible	Possible	Possible	1	1
		29	Yes	3.7	Possible	VPA issue	Possible	1	1
								79	107
								73,8	

*** Possible with an offset angle of more than**

12 RWY ends possible APV candidates, further analasys are required