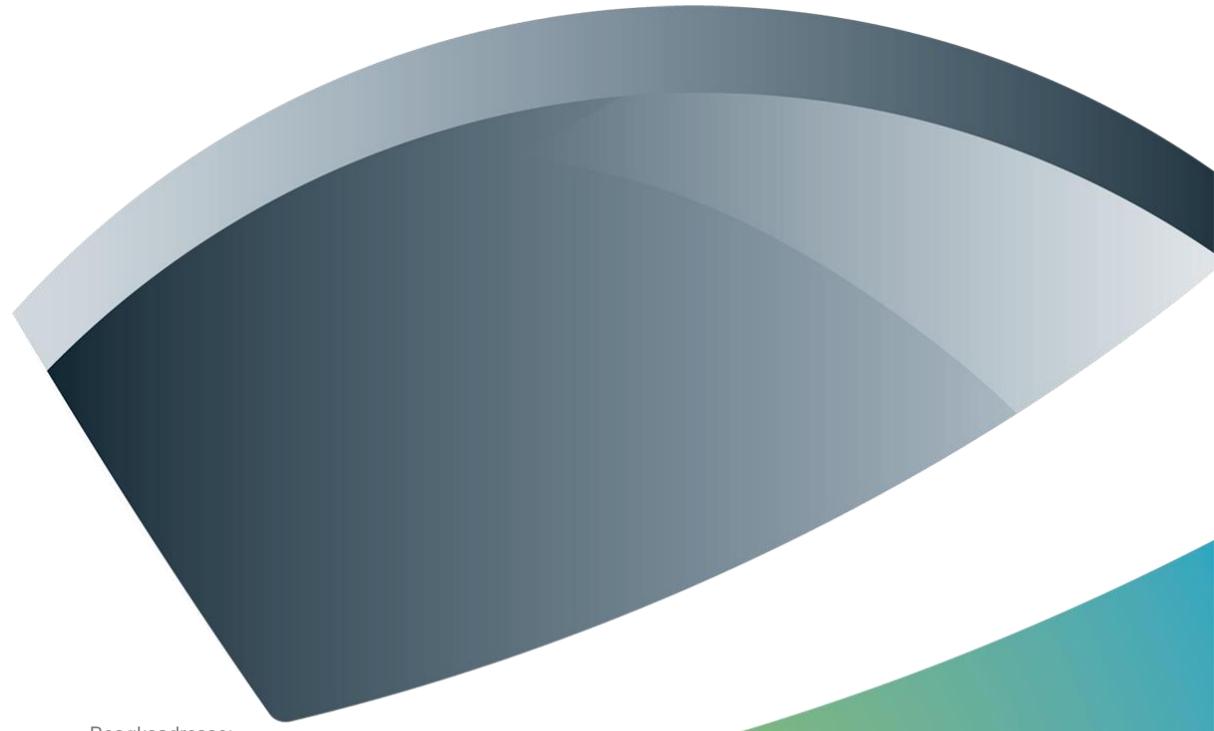




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# PBN Introduction and Norwegian Perspectives

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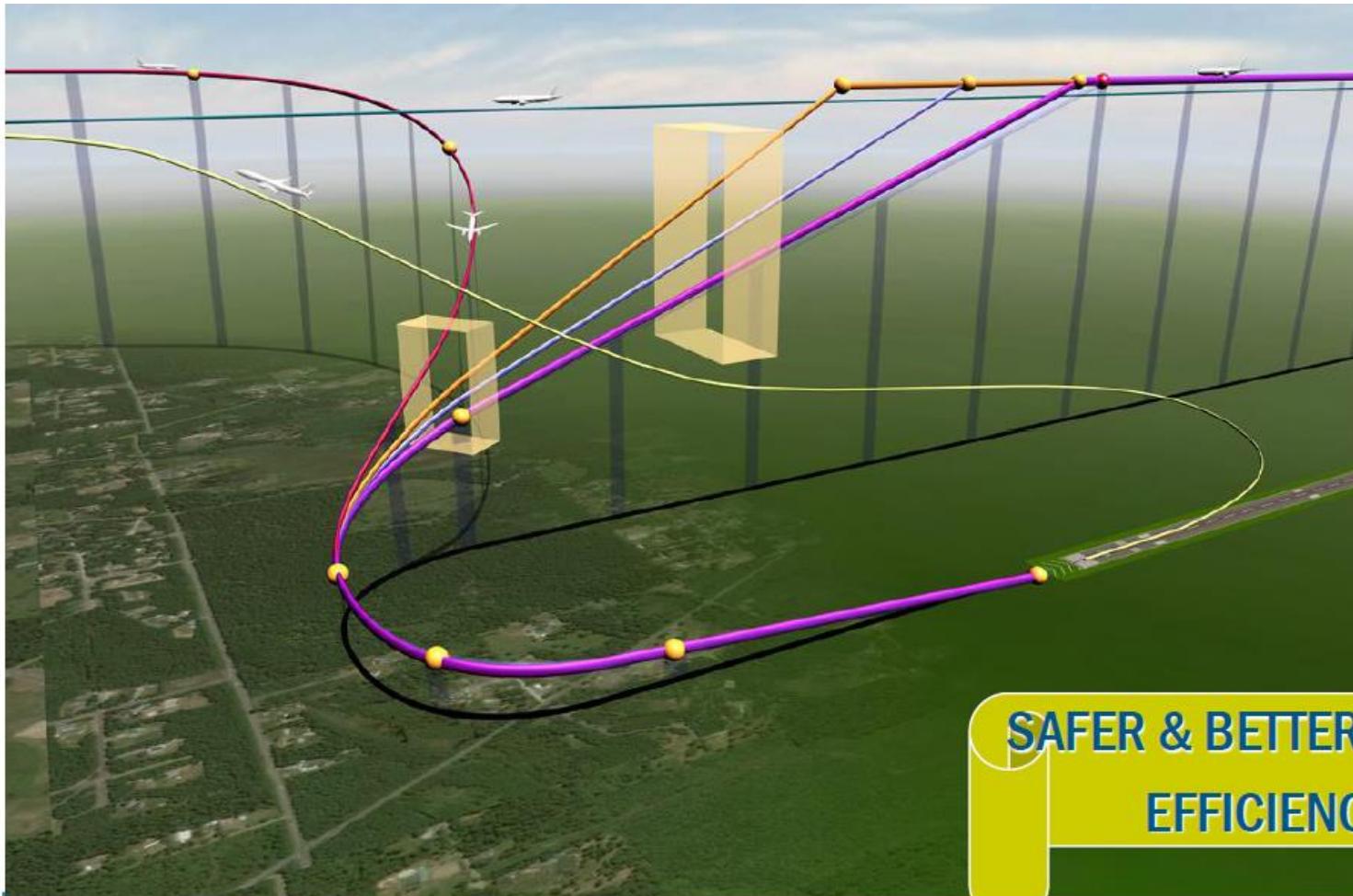
## PBN Areas

- The PBN Applications, Concept and Specifications
- The term – «Performance» and Pans-Ops
- ICAO and European drivers and rulemaking
- PBN Implementation Plan Norway
- PBN and Charting
- Achievements in Norway and ongoing Projects



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## What is PBN?



**SAFER & BETTER FLIGHT  
EFFICIENCY**

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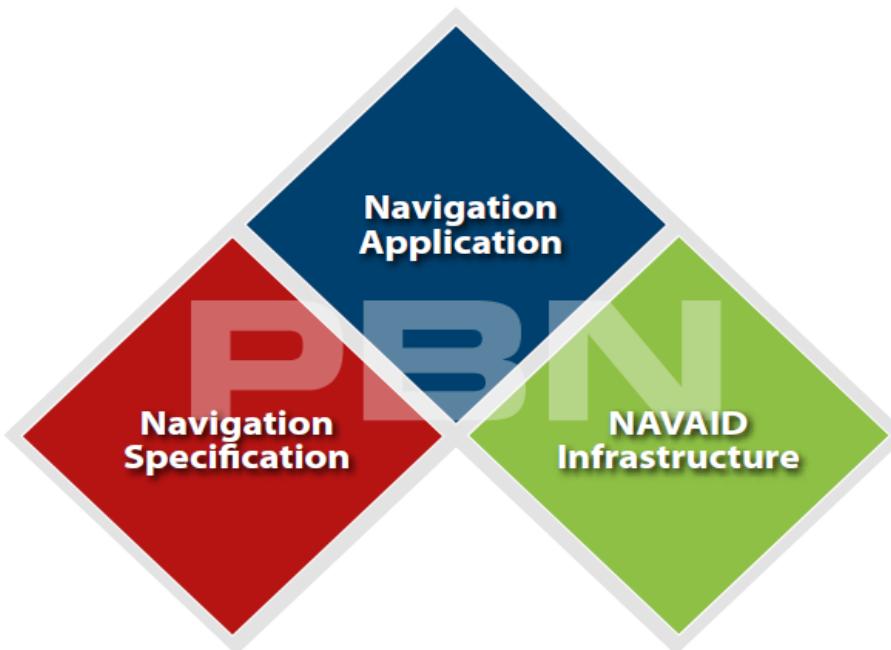
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# The PBN Application

The **Navigation Application** is achieved by the use of a **NAVAID Infrastructure** and associated **Navigation Specification**





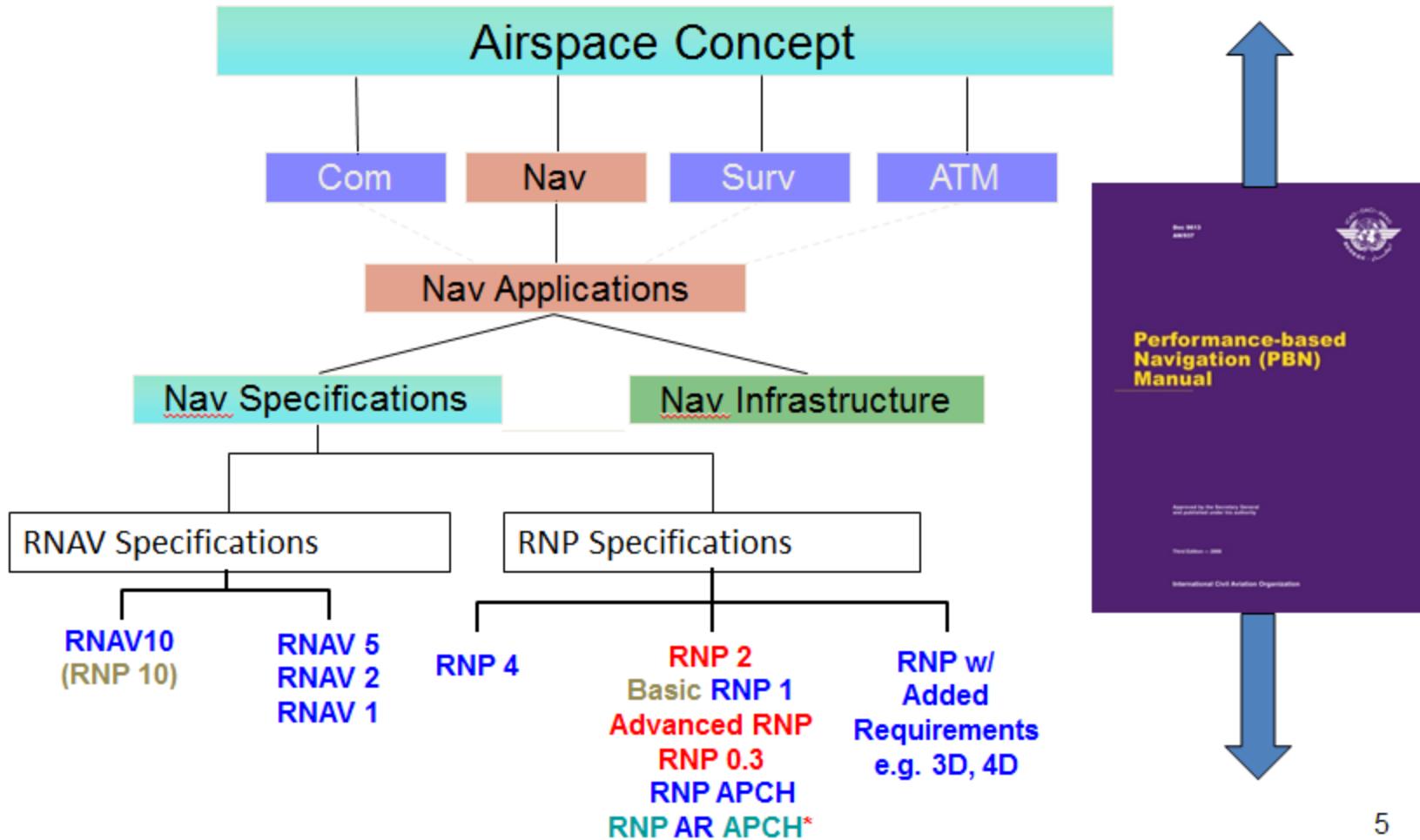
## Navigation Application

- The **NAVAID Infrastructure** refers to ground- and space-based navigation aids (except the Non Directional Beacon (NDB), which is excluded from use in PBN) – but includes the FMS(?)
- The **Navigation Specification** is a technical and operational specification that identifies the navigation performance and functionality required of the RNAV system. It also identifies how the navigation equipment is expected to operate in the NAVAID Infrastructure to meet the operational needs identified in the Airspace Concept. There are two kinds of navigation specification: **RNAV** and **RNP**.

The important difference between the two is that an RNP specification requires on-board performance monitoring and alerting



# ICAO PBN Concept - Review

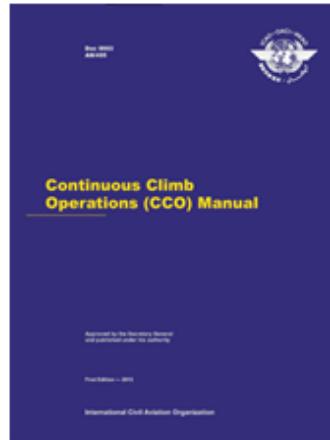




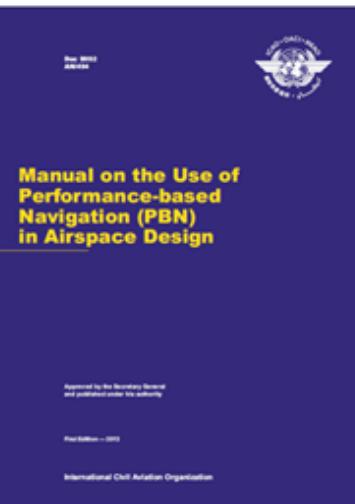
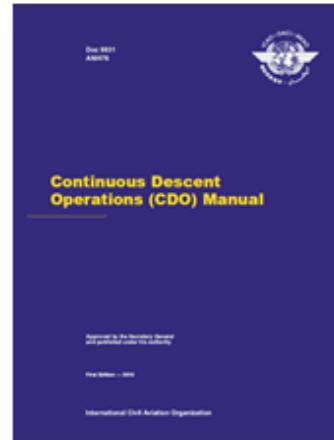
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# ICAO Guidance

**Doc 9993**



**Doc 9931**



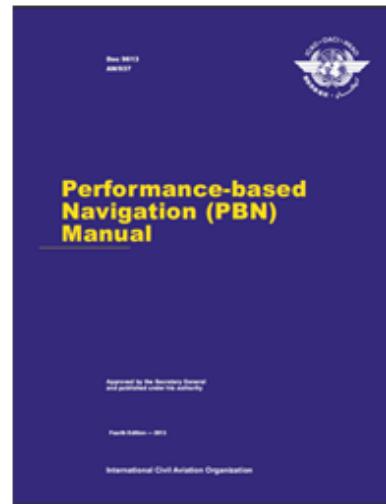
**Doc 9992**

Luftfartstilsynet

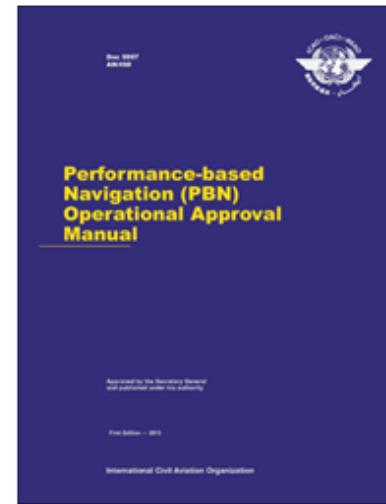
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**Doc 9613**



**Doc 9997**



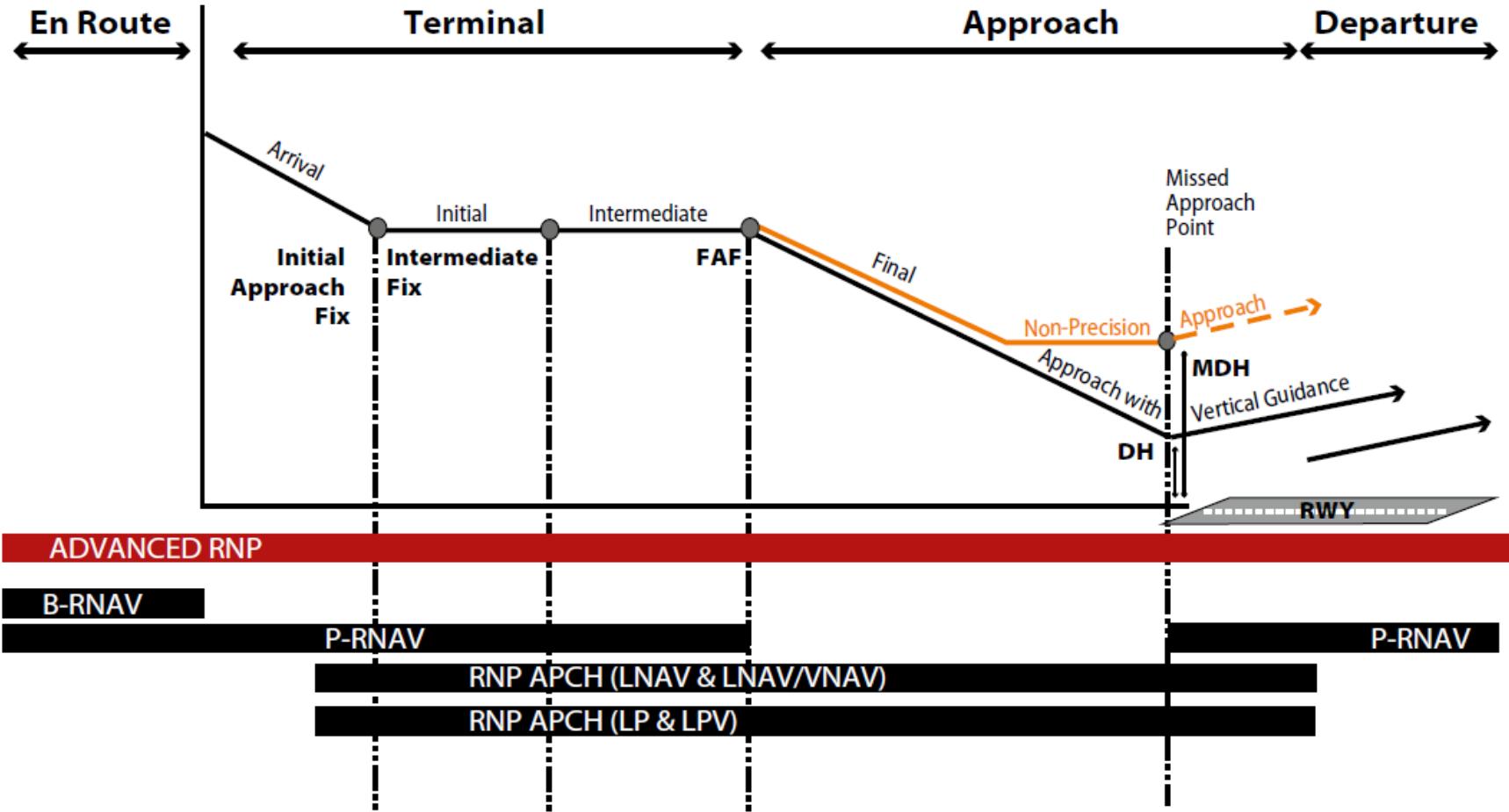
# NAV Specifications and Flight Phases

Navigation Specification	Flight Phase								Additional Functionalities (Required or Optional)			
	En Route Oceanic Remote	En Route Continental	ARR	Approach				DEP	RF	FRT	TOAC	Baro VNAV
				Initial	Intermed	Final	Missed					
RNAV 10 (RNP 10)	10											
RNAV 5		5	5									
RNAV 2		2	2							2		
RNAV 1		1	1	1	1			1	1			0
RNP4	4									0		
RNP2	2	2								0		
RNP1			1	1	1			1	1	0		0
Advanced RNP	2	2 or 1	1	1	1	0.3	1	1	R	0	0	0
RNP APCH				1	1	0.3	1		O			0
RNP AR APCH				1-0.1	1-0.1	0.3-0.1	1-0.1		Specific requirements for RF & VNAV			
RNP 0.3		0.3	0.3	0.3	0.3	-	0.3	0.3	O			0



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# PBN Approaches & Segments



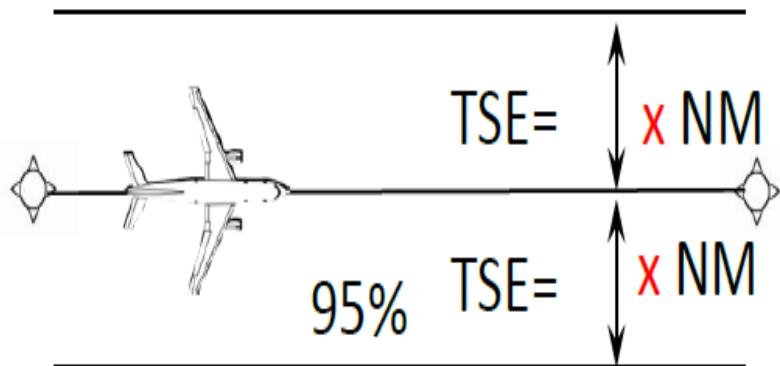


## The PBN Concept Performance & TSE – The Performance requirement

The TSE is the Total System error  
For RNAVx or RNPx

TSE is made of :

- Navigation System Error (NSE)
- Path Definition Error (PDE)
- Flight Technical Error (FTE)



The performance of the navigation system are defined by :

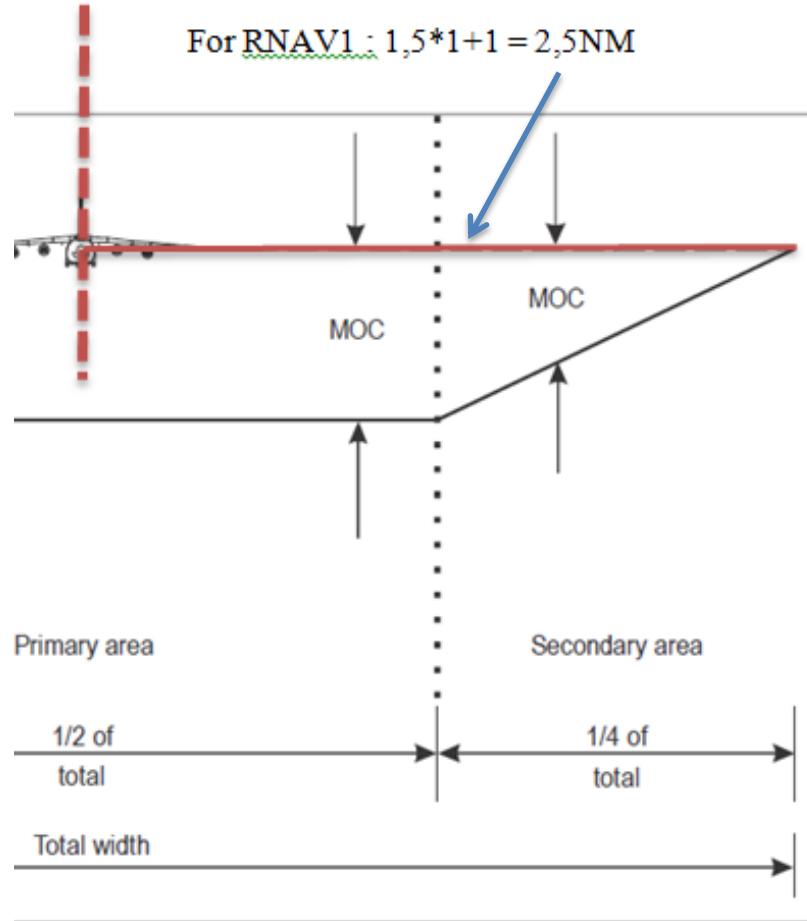
- **Accuracy:** the difference between the estimated position and the actual position
- **Integrity:** a measure of the trust that can be placed in the correctness of the information supplied by the total system. It includes the ability of a system to provide timely and valid warnings to the user when the system must not be used for the intended operation.
- **Continuity:** the capability of the system to perform its function without unscheduled interruptions during the intended operation.



# Pans-Ops Protection Areas

Area Semi with ;  $\frac{1}{2} A/W = 1.5 * XTT + BV$

For RNAV1 ;  $1.5 * 1 + 1 = 2.5 \text{ NM}$





## Main Drivers in Europe – SES Goals

At the launch of the SESAR Definition Phase, **the Commission stated its vision and set highlevel goals for the SES to be met by 2020 and beyond**. It should:

- “enable a **3-fold increase in capacity** which will also reduce delays both on the ground and in the air;
- improve **safety by a factor of 10**;
- enable a **10 % reduction** in the effects flights have on the environment, and;
- provide ATM services to the airspace users at **a cost of at least 50% less**.”

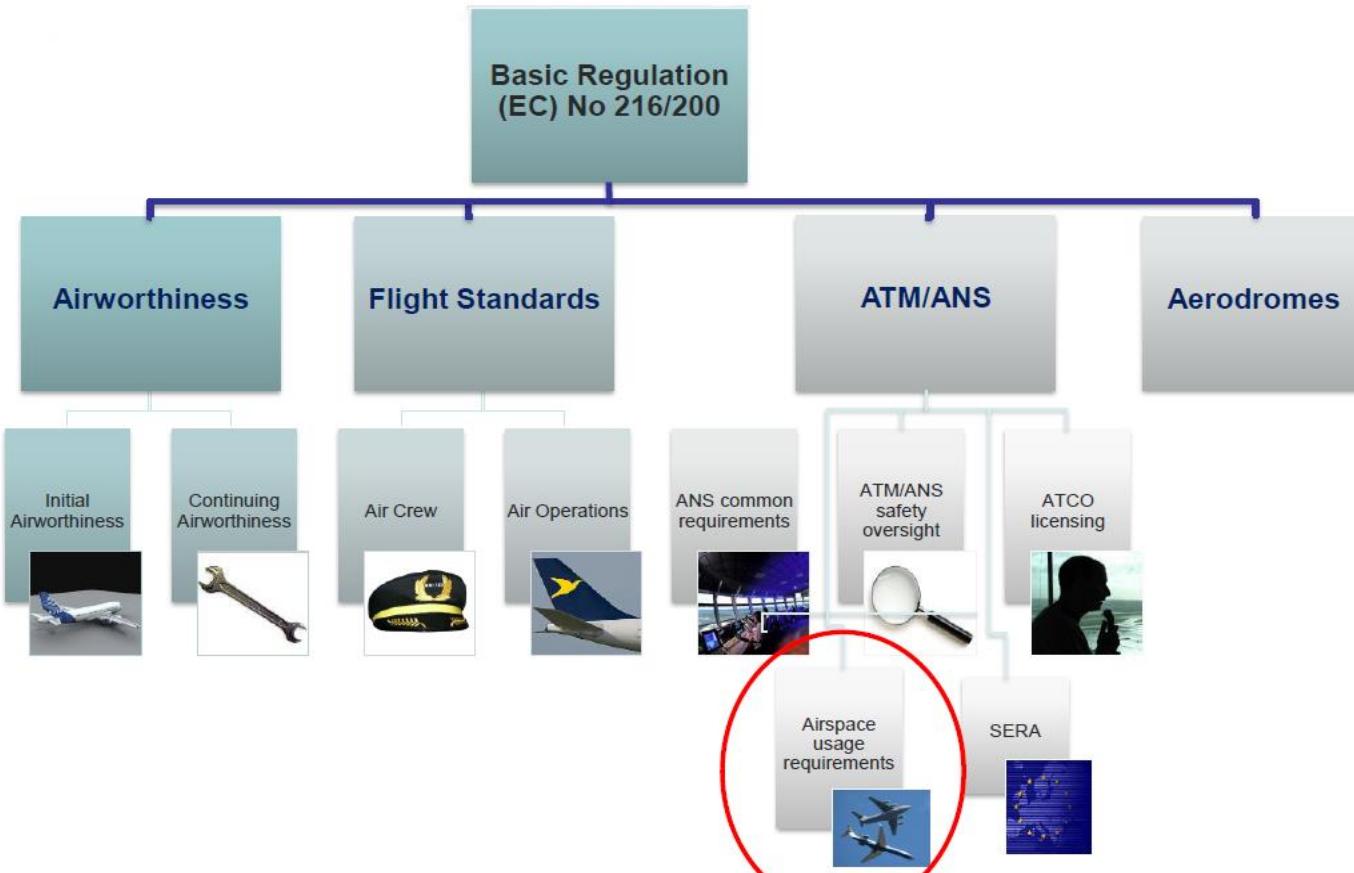


## EASA RMT on PBN

- NPA was distributed early 2015 – closed for comments april 2015
- PBN IR will be a part of EU No 1332/2011 AUR, with a Subpart – PBN
- Currently awaiting CRD from EASA (number of comments!)
- Opinion expected Q3 – Q4 2016



# PBN IR & EASA Framework



# Pilot Common Project EU 716/2014 BSL G 1-2a

## The purpose:

The Pilot Common Project identifies a first set of ATM functionalities to be deployed in timely, coordinated and synchronised way so as to achieve the essential operational changes stemming from the European ATM Master Plan.

**Valid for 25 High Density Airports in Eur – in Norway at Oslo Gardermoen,  
from 1. jan 2024**



**RNP 1 SIDs, STARs Plus Radius  
to Fix (RF)**

**2024**



**RNP APCH to LNAV/VNAV or  
LPV minima**



# ICAO PBN Resolution in Norway - BSL G 4-1

## § 7a. Inn og - utflyggingsprosedyrer

(2) Flyplasser skal, innen 31. desember 2016, ha en APV-prosedyre til hver rullebane som har en instrumentinnflyggingsprosedyre. APV-prosedyren skal være basert på Baro-VNAV eller GNSS med støttefunksjon SBAS. Dersom det grunnet terremessige forhold ikke er mulig å etablere en APV-prosedyre skal det etableres en LNAV-prosedyre.

# The Norwegian PBN Implementation Plan Ver 3.0 is valid

- The Plan describes National guidelines for implementing PBN
- This version has a the Time frame for the rest of the ICAO A37-11 resolution period – end 2016
- It covers PBN in different Flight phases
- NAV Applications and Specifications
- NAV infrastructure and back-up infrastructure
- Long Term implementation Strategies (2017+)
- Instrument RWY End Analysis for all N-AIP Airports
- (defining target numbers for PBN goals)
- New version 4.0 are almost completed. – A simplified version with a Policy-part and a dynamic Roadmap



## The Scope of the PBN Implementation plan Norway

- Norway FIR & Bodø Oceanic
- The concurrent decommissioning of ground based nav infrastructure is NOT covered
- Only covers PBN Apps covered by ICAO A 37-11, ICAO EUR PBN Impl Roadmap and Doc 9613
  - Nav applications other than these is not covered
  - hence – conventional ops and SCAT-I are outside the scope
- 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 ICAO Pans Ops criteria



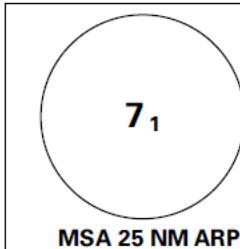
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# PBN and Charting

AIP NORGE/NORWAY

AD 2 ENTC 4 - 15

## STANDARD ARRIVAL CHART INSTRUMENT (P-RNAV STAR based on GNSS)



ATIS:	126.125
APP:	123.750
TWR:	118.300 (122.100)
VDF:	123.750

ALT AND ELEV ARE IN FT  
DIST IN NM

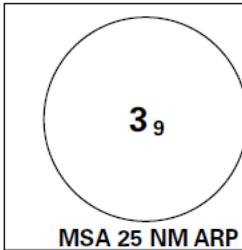
**TROMSØ/LANGNES**  
**RWY 19**  
NORWAY

AMIMO 1M, AMIMO 6Y, AMIMO 6Z, BAREG 1M, GILGU 1M, IDLIN 1M, LENSA 1M, LOMVI 1M

AIP NORGE/NORWAY

AD 2 ENGM 4 - 29

## STANDARD ARRIVAL CHART INSTRUMENT (RNAV 1 STAR BASED ON GNSS OR DME/DME)



ATIS: 126.125
APP: 120.450
DIR: 136.400
FIN: 128.900
TWR: 118.300 120.100

ALT AND ELEV ARE IN FT  
DIST IN NM

**OSLO/GARDERMOEN**  
**RWY 19L/RW**  
NORWAY

ADOPI 3M, BELGU 3M, RIPAM 4M

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## ICAO Pans-Ops Naming Req's

1.4.2.2 Until 30 November 2022, approach charts depicting procedures that meet the RNP APCH navigation specification criteria shall include the term RNAV(GNSS) in the identification (e.g. RNAV<sub>(GNSS)</sub> RWY 23) or, alternatively, as described in 1.4.2.3.

1.4.2.3 From 1 December 2022, charts depicting procedures that meet the RNP APCH navigation specification criteria shall include the term RNP in the identification (e.g. RNP RWY 23). The identification shall also include a parenthetical suffix when exceptional conditions occur as described in Table III-5-1-1.



# PBN and Charting Approach

AIP NORGE/NORWAY

AD 2 ENGM 5 - 13

INSTRUMENT APPROACH CHART - ICAO		PLAN VIEW SCALE: 1:350 000		
<b>3<sub>9</sub></b>	ATIS: 126.125	AD ELEV: 681		
	APP: 118.475    120.450	THR ELEV: 675	DIST IN NM	
	DIR: 136.400 (119.975) FIN: 128.900	HGT RELATED TO THR RWY 19R	ELEV, ALT AND HGT IN FT	
	TWR: 118.300 (118.700)	CIRCLING HGT RELATED TO AD ELEV		
MSA 25 NM ARP	GND: 121.600	BEARINGS ARE MAGNETIC - VAR 2.8 ° E (2015)		
			OSLO <b>GARDERMOEN</b> <b>RNAV(GNSS) RWY 19R</b> TRANSITION ALTITUDE 7000	

CAT OF ACFT		A	B	C	D
OCA(H) STRAIGHT - IN	LPV 3.1%*	930 (255)	940 (265)	950 (275)	960 (285)
	LPV 2.5%*	1020 (345)	1030 (355)	1040 (365)	1050 (375)
	LNAV/VNAV	970 (295)	980 (305)	1000 (325)	1030 (355)
	LNAV	1040 (365)		1060 (385)	1080 (405)
CIRCLING		1280 (599)		1920 (1239)	2230 (1549)
<b>NOTE:</b> CIRCLING W OF RWY ONLY. *MINIMUM MISSED APCH CLIMB GRADIENT.					



## PBN Abbreviations...

**B-RNAV, P-RNAV, RNAV 1, RNAV 2, RNAV 10, RNP 4, RNP 2, RNP 1, RNP 0.3,  
RNP 0.1, RNP 10, GPS, GNSS, TSE, ANP**

**RNP AR, RNP AR APCH, RNP SAAAR, ADVANCED RNAV, APV, LTS, OTS,  
GLS, RF, FRT**

**ABAS, GRAS, GBAS, SBAS, BARO-VNAV, LNAV, RAIM, LPV, RNAV GPS,  
RNAV VISUAL**

**abbreviations are to appear everywhere and confuse people**



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# Norwegian Achievements & the Way forward

- Point Merge System Arrivals in 4 TMAs (GM, ZV, BR and VA)
- Roughly 50 % APV coverage in Instrument RWY Ends
- Trials on EGNOS coverage and published LPV procedures, northern Latitude Issue (N70°)
- Implementation of Helicopter Company IFPs to Hospitals
- 3 Airports will have RNP AR procedures (GM, HD and EV)
- Exploring 3,9 ° VPA for BaroVNAV on short field RWYs



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