Performance Based Navigation

OBJECTIVES

- Why PBN concept ?
- Know the structure of the PBN manual
- Identify navigation specification according to the area of operation
- Identify the type of sensor usable according to RNAV navigation specification
- Identify the functionalities associated with PBN application

Performance Based Navigation concept

ICAO decided to create the PBN concept (behind the 11th Air Navigation Conference in 2004)
PBN concept developed by a dedicated ICAO SG (The PBN SG)
Performance-based navigation (PBN) is a revision of the required navigation performance (RNP) concept

Why PBN Concept

Before PBN manual, there was an ICAO RNP manual which was not constraining. Depending on there need, states or aircraft manufacturers could choose for the same kind of operations :

- Different value of RNP,
- Different RNAV functionalities,
- Integrity requirement or not regarding the positioning computation

Why PBN Concept

- The continued growth of traffic and the need to provide greater flight efficiency makes it necessary to optimize available airspace. This is being achieved world-wide by enhanced Air Traffic Management and by exploiting technological advancements in the fields of Communication Navigation and Surveillance. More specifically, the application of *area navigation* techniques in all flight phases contributes directly to improved airspace optimisation. Area navigation is enabled by the use of an on-board navigation computer commonly referred to as a RNAV system.
- RNAV system capabilities are increasingly being exploited with a view to maximizing airspace resources. To this end, both flight crew and ATC need to understand RNAV system capabilities and ensure that these match airspace requirements. The use of RNAV systems lies at the core of Performance Based Navigation (PBN), which introduces approval requirements for use of these systems in airspace implementations

Why PBN Concept

- Main PBN SG objectives are the: Common understanding of the performance Based navigation concept and the relationship between RNP and RNAV functionality
  - Clarification of RNAV and RNP terminology
  - Update of ICAO doc 9613 (RNP manual) that is called now the ICAO Performance Based Navigation (PBN) manual
  - Ultimately should prevent proliferation of navigation standard over the world with an harmonization between States

    Such acronyms raised
    - BRNAV / PRNAV in Europe
    - US RNAV type B
    - RNPRNAV approach
    - RNP SAAAR
    - RNP4
    - RNP5 in Middle East
    - RNP0.3

PBN Concept

PBN offers a number of advantages over the sensor-specific method of developing airspace and obstacle clearance criteria, i.e.:

- reduces the need to maintain sensor-specific routes and procedures, and their associated costs;
- avoids the need for developing sensor-specific operations with each new evolution of navigation systems, which would be cost-prohibitive;
- allows for more efficient use of airspace (route placement, fuel efficiency and noise abatement);
- clarifies how RNAV and RNP systems are used; and
- facilitates the operational approval process for operators by providing a limited set of navigation specifications intended for global use.

PBN Concept

- PBN specifies SYSTEM PERFORMANCE REQUIREMENT for aircraft operating on air traffic routes or instrument approach procedures, in a designated airspace.

- The performance requirements are defined in term of accuracy, integrity, continuity and availability

- and ALSO In term of FUNCTIONALITIES
  - Display
  - ARINC 424 leg…

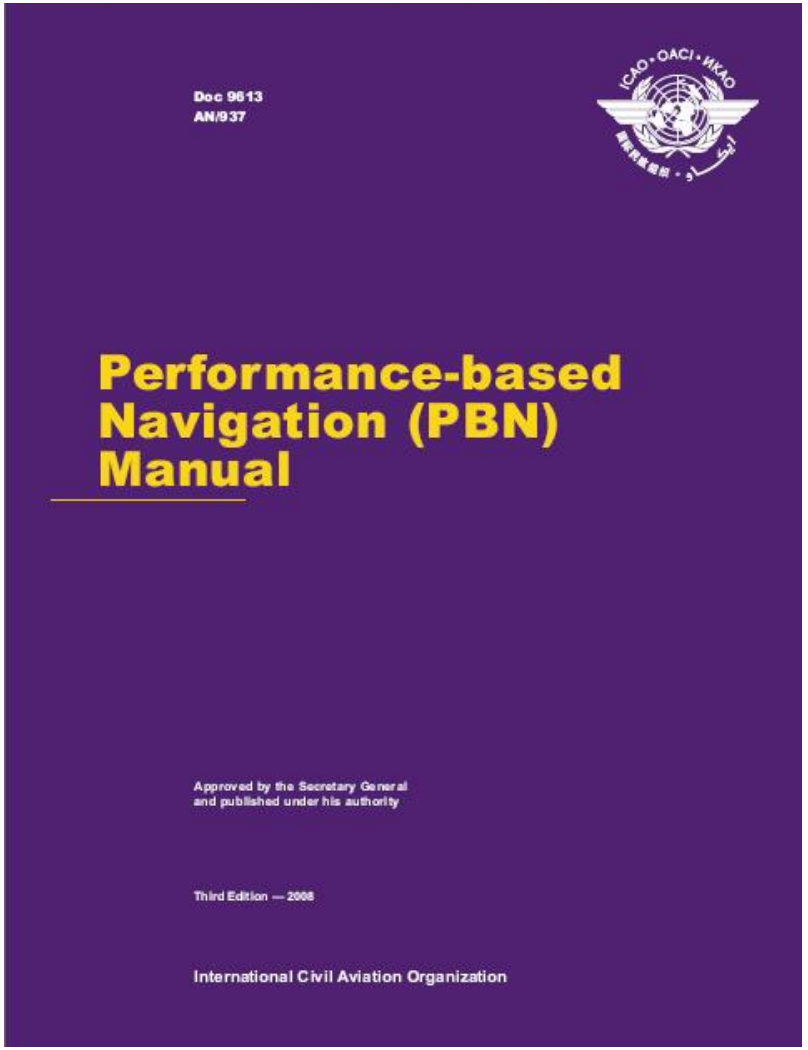
PBN Concept

- PBN:
  - Improves Safety
    - Reduces CFIT
    - Consistent predictable flight paths
    - Stabilized approach paths
  - Improves Operating Returns
    - Reduces fuel costs
    - Reduces investment in ground based systems
    - Reduces time in flight through more direct routes
  - Increases Airspace Capacity
    - More efficient direct routes
    - Reduces airspace conflicts
  - Is Environmentally Friendly

ICAO PBN MANUAL CONTENT : Doc 9613

- VOL I:
  - Concepts and definitions
  - Implementation guidance

- VOL II: Implementing RNAV and RNP specifications



PBN concept

- NO MORE sensor-based navigation

BUT

  - Performance-based navigation
  - Navigation specification (Aircraft and Aircrew)
  - Navaid infrastructure (Navigation aids)

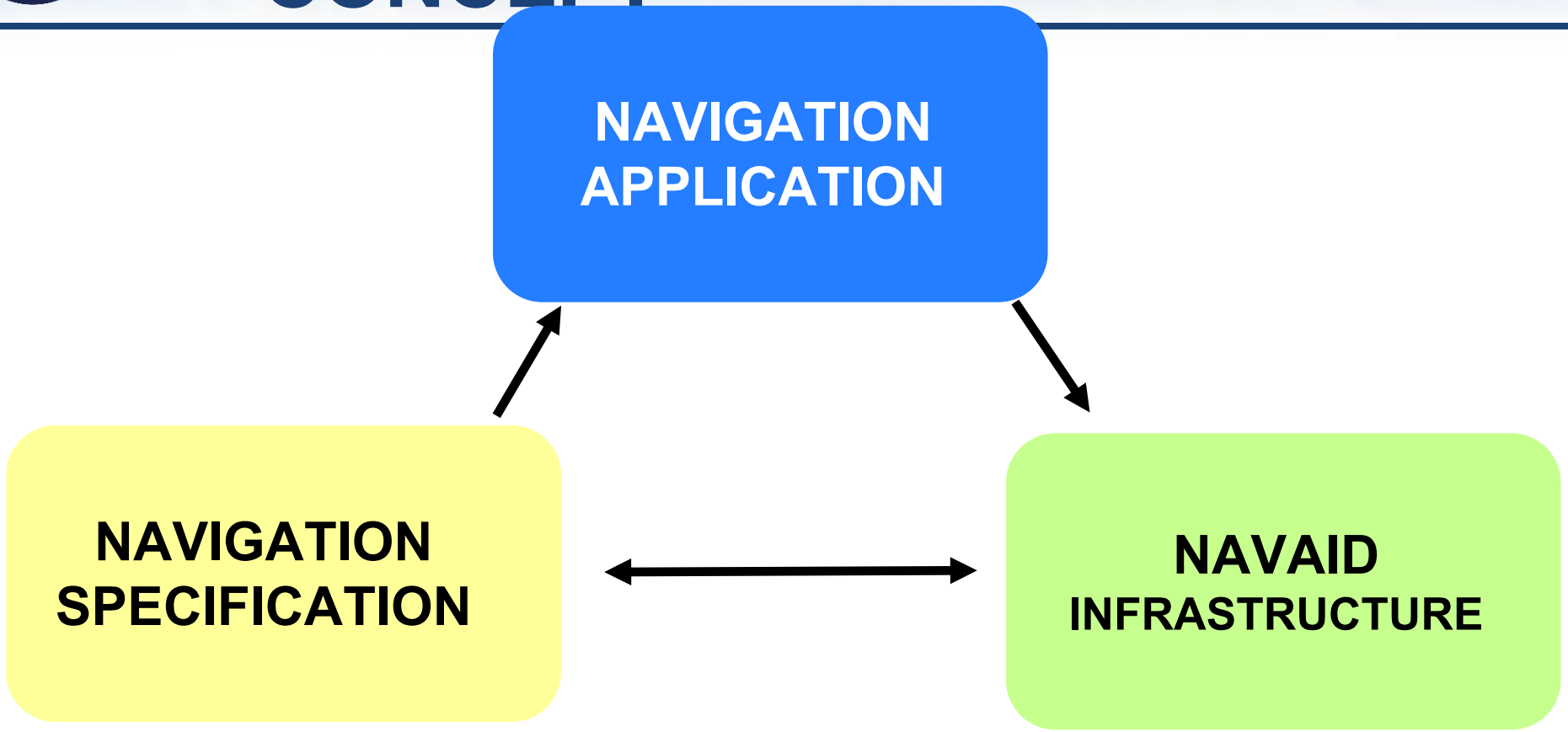
PBN concept

- ***Performance Based Navigation concept*** specifies system performance requirements for aircraft operating along an ATS route, on an instrument approach procedure or in a designated airspace.
- ***Performance requirements*** are defined in terms of
  - accuracy
  - integrity
  - continuity
  - availability and
  - functionalities needed for the proposed operation in the context of a particular Airspace Concept.

PBN concept

- 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

COMPONENTS OF PBN CONCEPT



Navigation is based on the use of an area navigation system (RNAV)

Navigation Application

- A NAVIGATION APPLICATION is the application a NAVIGATION SPECIFICATION and associated NAVAID INFRASTRUCTURE to ATS routes, instrument approach procedures and/or defined airspace volume in accordance with the Airspace Concept, allowing an aircraft to fly with the required performance level.

- Example in Europe
  - RNAV 1 in terminal area
- Example in Senegal
  - RNP1 in terminal area

- Navigation application is part of the required elements :
  - Communication
  - Surveillance
  - ATM procedures

Navaid infrastructure

- The **NAVAID Infrastructure** refers to ground- and space-based navigation aids (except the Non Directional Beacon (NDB), which is excluded from use in PBN)
  - Ground-based navigation aids
    - VOR
    - DME
  - Space-based navigation aids
    - GNSS elements

- Example in Europe for RNAV1 in terminal aera
  - GNSS ; DME/DME
- Example in Senegal for RNP1 in terminal aera in non radar surveillance capability
  - GNSS

The availability of the navaid infrastructure has to be considered in order to enable the navigation application.

Each State will need to consider the NAVAID Infrastructure and their NAVAID policy when defining their PBN requirements

Navigation specification

- 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 as part of the avionic functionality. The Navigation Specification provides material which States can use as a basis for developing their certification and operational approval documentation

- The navigation specification describes:
  - the performance of the on-board system in terms of accuracy, continuity and integrity
  - the functionalities of the system (ex type of display,…)
  - the usable infrastructures and sensors
  - the requirements for training and practice of controllers and flight crews

What's new about PBN?

PBN requires the use of an on-board RNAV system
PBN creates requirements for airworthiness certification and operational approval to use RNAV systems in airspace implementations
The RNAV system's functionality as well as its navigation accuracy in the NAVAID Infrastructure environment of the subject airspace must conform to the requirements stipulated in the relevant ICAO navigation specification

Components of PBN Concept

NAVIGATION SPECIFICATION

RNAV X

~~OPMA~~

X refers to the accuracy or Total System Error (TSE) required 95% of the the total flight time

RNP X

OPMA

RNAV x: A navigation specification without an on-board performance monitoring and alerting function

RNP x: A navigation specification with an on-board performance monitoring and alerting function (OPMA)

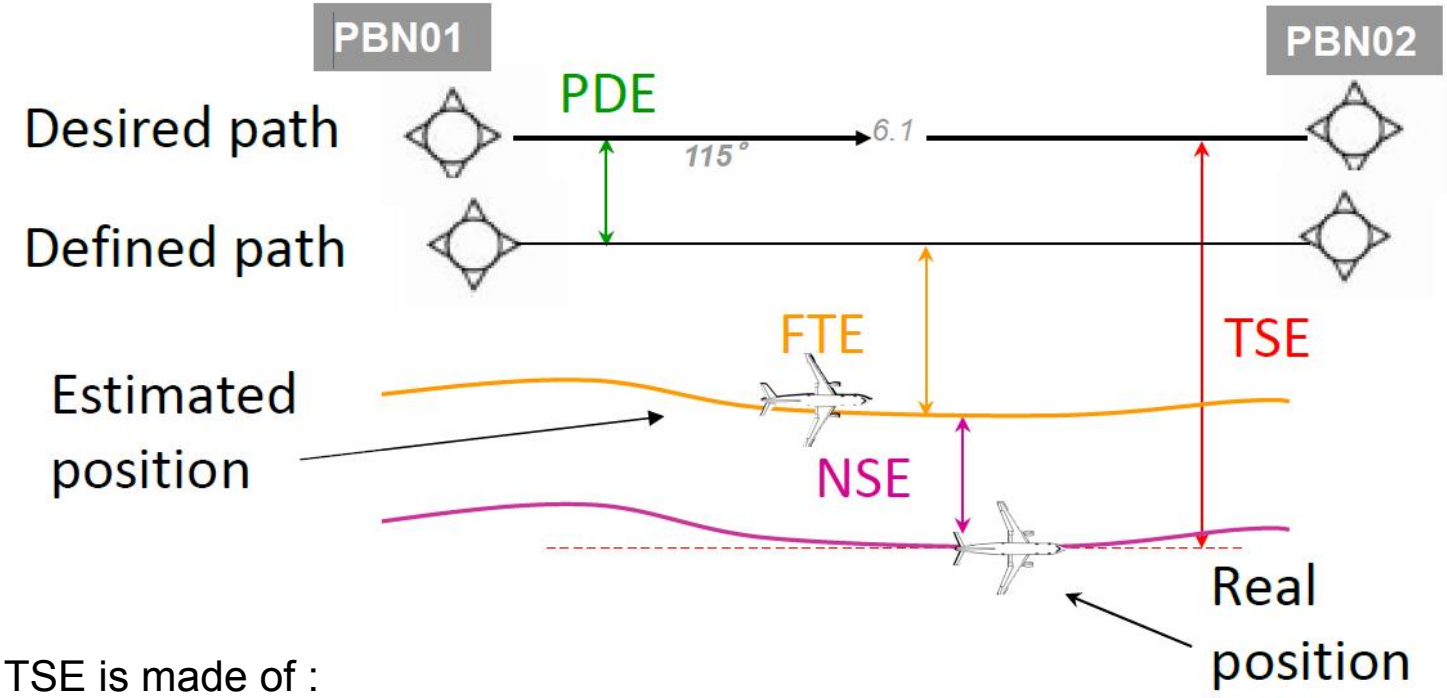
PBN concept – Total System Error (TSE)

The TSE is the Total system error.
For RNAV **X** or RNP **X**
TSE has to be lower than the required accuracy « **X** Nm» during 95% of the flight.
Exemple RNAV **2** => The TSE has to be lower than **2** Nm during 95% of the flight
TSE is made of :

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

Total System Error (TSE)

- $TSE = (PDE^2+FTE^2+NSE^2)^{1/2}$



TSE is made of :

Path Definition Error (PDE)

Flight Technical Error (FTE)

Navigation System Error (NSE)

Path Definition Error (PDE)

- Errors between the desired path and the defined path
- WPTs coordinates in WGS 84
- Possible Error Source:
  - Errors in the defined coordinates of the WPt
  - Mis interpretation of the source by the data base encoder
  - Errors induced by data resolution must also be considered
- PDE is managed through a quality process and development methodology in data processing (codage process)
  - DO 200A
  - LOA Type 1 and 2
- The end user is the operator
  - He has to assess that adequate development methodology has been applied
  - Crew procedures to check that what is encoded is what is published.

PDE : Database and the coding cycle

1. Development Methodology

REPERES	IDENTIFICATION	COORDONNEES *COORDINATES*	CODAGE PROPOSE *PROPOSED CODING*	STATUT *STATUS*
		8.6"N - 008° 55' 09.4"E	IF	Fly By
IAF/IF	BAMDI	42° 46' 34.5"N - 008° 47' 30.4"E	IF/TF	Fly By
FAF	KC408	42° 42' 28.4"N - 008° 47' 31.7"E	TF	Fly By
MAPT	MAPTB	42° 36' 01.31"N - 008° 47' 33.54"E	TF	Fly Over
MATF	BUNAX	42° 30' 16.0" N - 008° 30' 11.0" E	DF	Fly By
MATF	CALNO	42° 47' 58.0" N - 008° 21' 52.0" E	TF	Fly Over
MATF	BAMDI	42° 46' 34.5" N - 008° 47' 30.4" E	DF	Fly Over

LOA type 1
Jeppesen
Lido
…

LOA type 2
Honeywell
Thales
Collins,
Universal,
Garmin,…

2. Procedure Check

Crew gross check

Flight Technical Error (FTE)

Ability to follow the defined path

- FTE in manual mode (Pilot follows the deviation from the CDI)
- FTE with the FD
- FTE of the Autopilot

Error depends on the flight phase (sensibility of the deviation indicator, AP ….)

		Coupled	
Flight Phase	Manual (nm)	Flight Director (nm)	Autopilot (nm)
Oceanic	2.0	0.5	0.25
En Route	1.0	0.5	0.25
Terminal	1.0	0.5	0.25
Approach	0.5	0.25	0.125

FTE assumptions from RTCA DO 208 Appendix E

Navigation System Error (NSE)

Difference between the estimated position and the real position

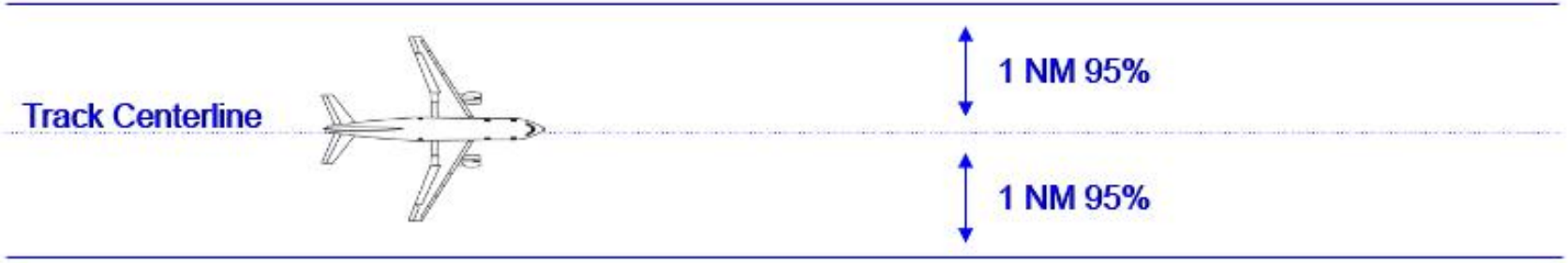
Takes into account:

- Transmitted Signal error
- Position calculation error

PBN concept

RNAV 1

No ALERT on board



PBN concept

RNP 1

ALERT and Crew procedure

The Key difference

On-board performance Monitoring and alerting function

On-Board performance monitoring and alerting function

- ***What is an On-board performance monitoring and alerting function ?***
  - A function on board the aircraft detecting and informing the crew when the RNAV system is unable to satisfy the performance prescribed in the *navigation specification.*
  - This function should monitor all type of errors which may affect the aircraft ability to follow the desired flight path.
  - The required level of on board monitoring and alerting is stipulated in each RNP navigation specification.

On-Board performance monitoring and alerting function

NSE Monitoring and Alerting

Alerting

- Alerting Threshold: (1x accuracy) Nm
- (SIS: alert if probability to get a lateral position error greater than 1x accuracy exceeds 10-7/hour)

FTE Monitoring and Alerting

Lateral deviation

- Crew procedure based on display scaling
- Effective threshold: ½ full scale deflection
- Pb missed alerting: not quantified. Crew procedure.

PDE Monitoring and Alerting

- Based on Data quality process
  - LOA or equivalent
  - Gross error check: Crew procedure

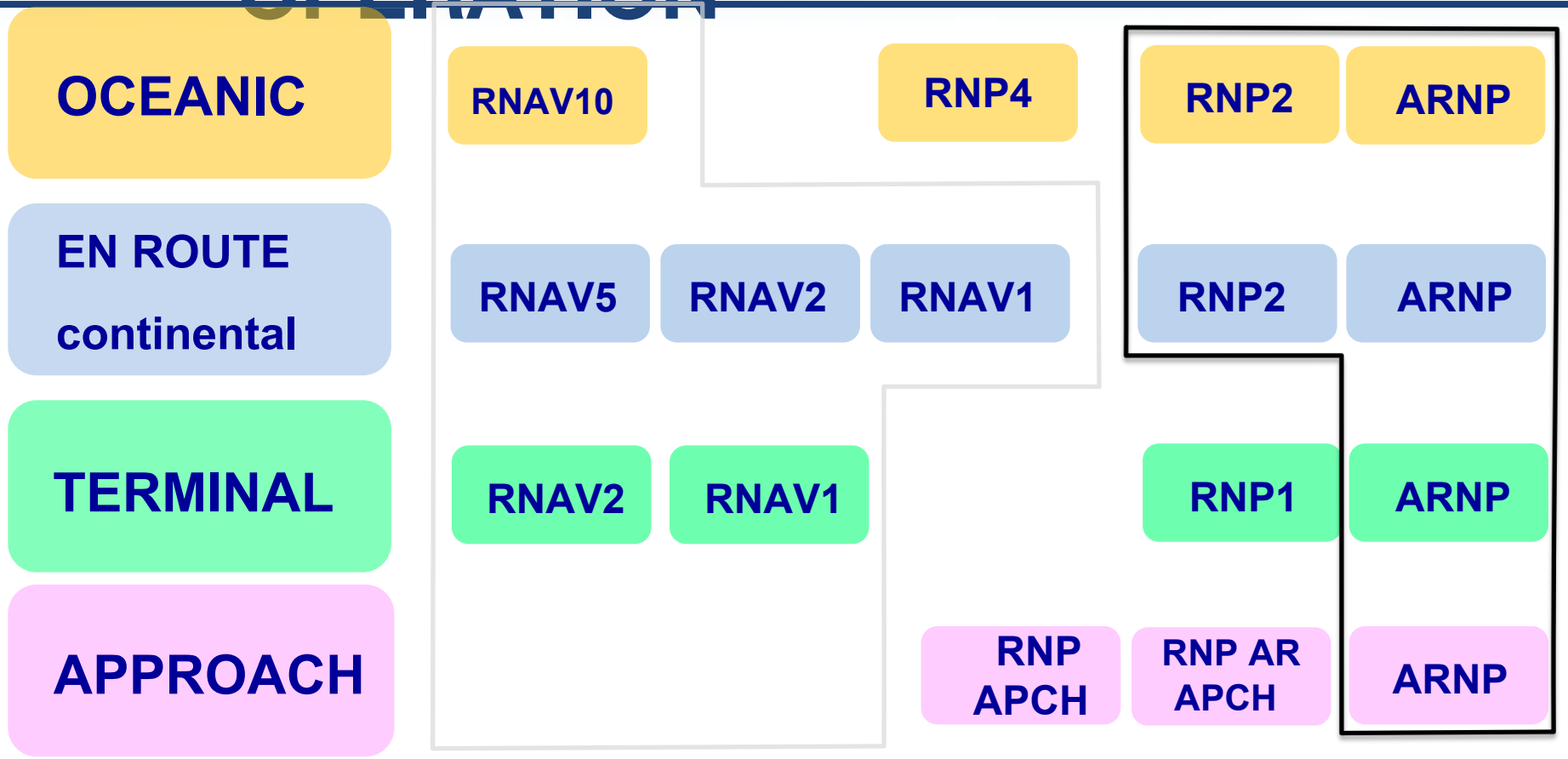
TSE Monitoring and Alerting

All error components monitored or controlled

NAVIGATION SPECIFICATION

- Approval process
- A/C requirement
- Operating procedures for navigation system
- Pilot training
- Navigation data base
- Oversight of operators (equipment, crew)

APPLICATION IN RELATION WITH AREA OF OPERATION



New PBN Navigation specification

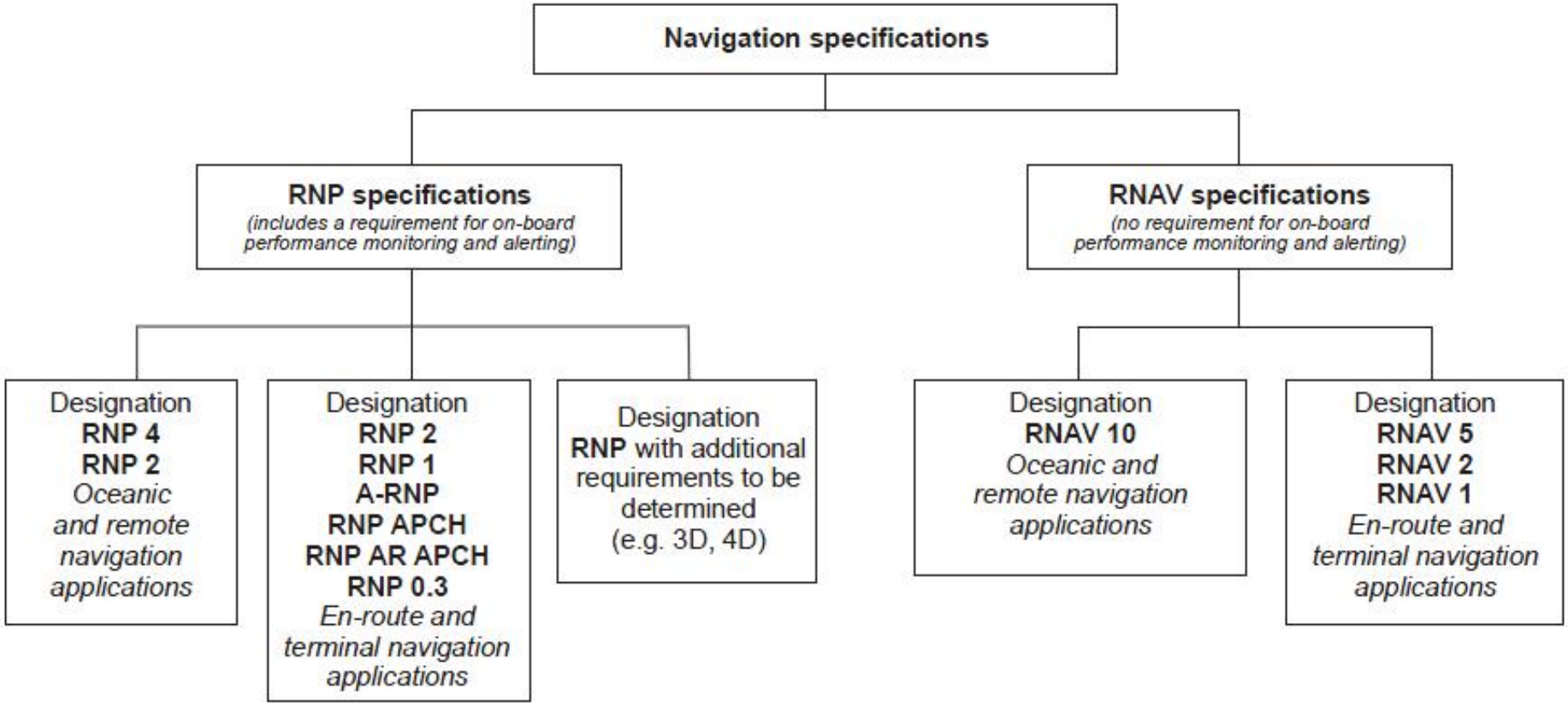
RNP 2 => en route applications; in geographic areas with little or no ground NAVAID infrastructure, limited or no ATS surveillance, and low to medium density traffic.

RNP 2 in continental applications => more dedicated for general aviation
RNP2 in oceanic/remote => transport category aircraft operating at high altitude

Advanced RNP => covers all the nav spec plus specific functions such as Radius to Fix (RF), Fixed Radius Transition (FRT), Time of Arrival Control, Barometric VNAV (in terminal airspace) and scalability (optional)

RNP 0.3 => for aircraft/helicopter RNP 0.3 operations en route and in terminal airspace of airports as well as operations to and from heliports and for servicing offshore rigs

Navigation specifications



inconsistent RNP designations

The existing RNP 10 designation is inconsistent with PBN RNP and RNAV specifications. RNP 10 does not include requirements for on-board performance monitoring and alerting. For purposes of consistency with the PBN concept, RNP 10 is referred to as RNAV 10 in the PBN manual. Renaming current RNP 10 routes, operational approvals, etc., to an RNAV 10 designation would be an extensive and expensive task, which is not cost-effective. Consequently, any existing or new operational approvals will continue to be designated RNP 10, and any charting annotations will be depicted as RNP 10

PBN - ICAO resolution A37-11

- The ICAO Resolution A37-11 “Performance-based navigation global goals” was adopted by the Assembly of the ICAO at its 37th meeting (October 2010)

“The Assembly:

- *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);*
- *Resolves that: 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 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 5 700 kg or more*
- *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;*

PBN Plans

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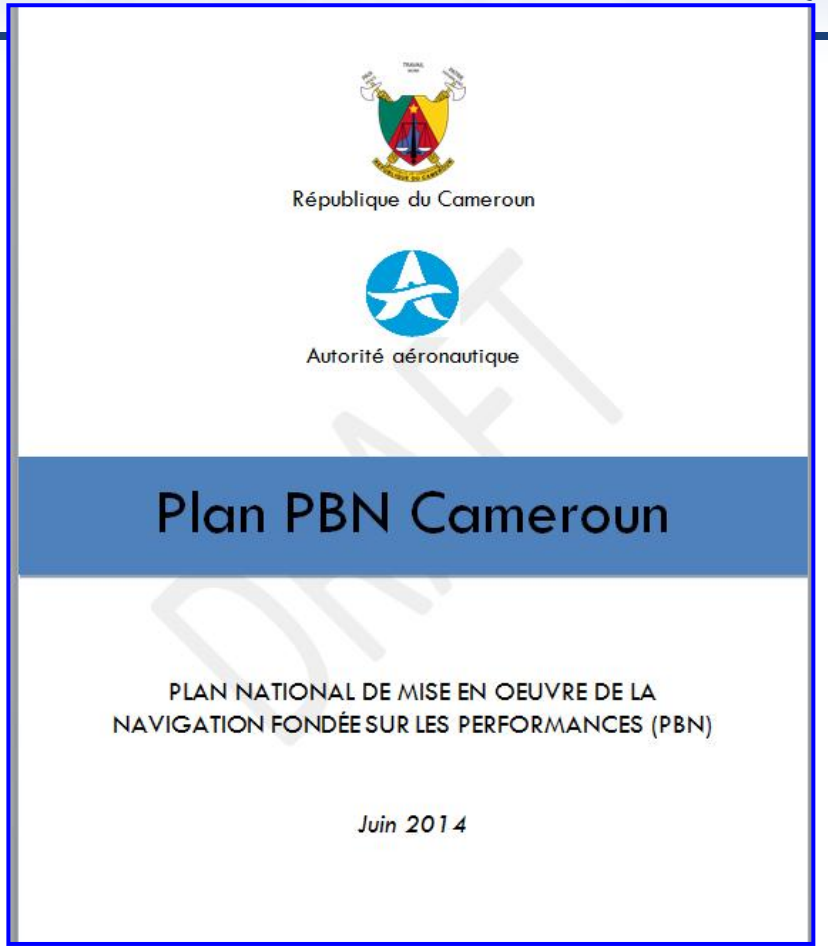
PLAN NATIONAL DE MISE EN OEUVRE DE LA NAVIGATION FONDEE SUR LES PERFORMANCES

Première Edition



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PLAN NATIONAL DE MISE EN OEUVRE DE LA NAVIGATION FONDÉE SUR LES PERFORMANCES (PBN)

Juin 2014

PBN Plans

SENEGAL

Oceanic: RNAV 10 and study to implement RNP 4

Continental en route:
RNAV 10 and RNAV 5 in some places where its implementation is operationally justified

Terminal Area:
Implementation SID and STAR RNP 1 in international airports

Approach:
- RNP APCH approaches ($RNAV_{(GNSS)}$) in Dakar,Cap Skirring, Ziguinchor,Tambacounda and Saint Louis including a certain number with vertical guidance (APV Baro-VNAV)

CAMEROUN

Continental en route:
RNAV 5 and RNAV 2 in Brazzaville and N'Djamena FIRs

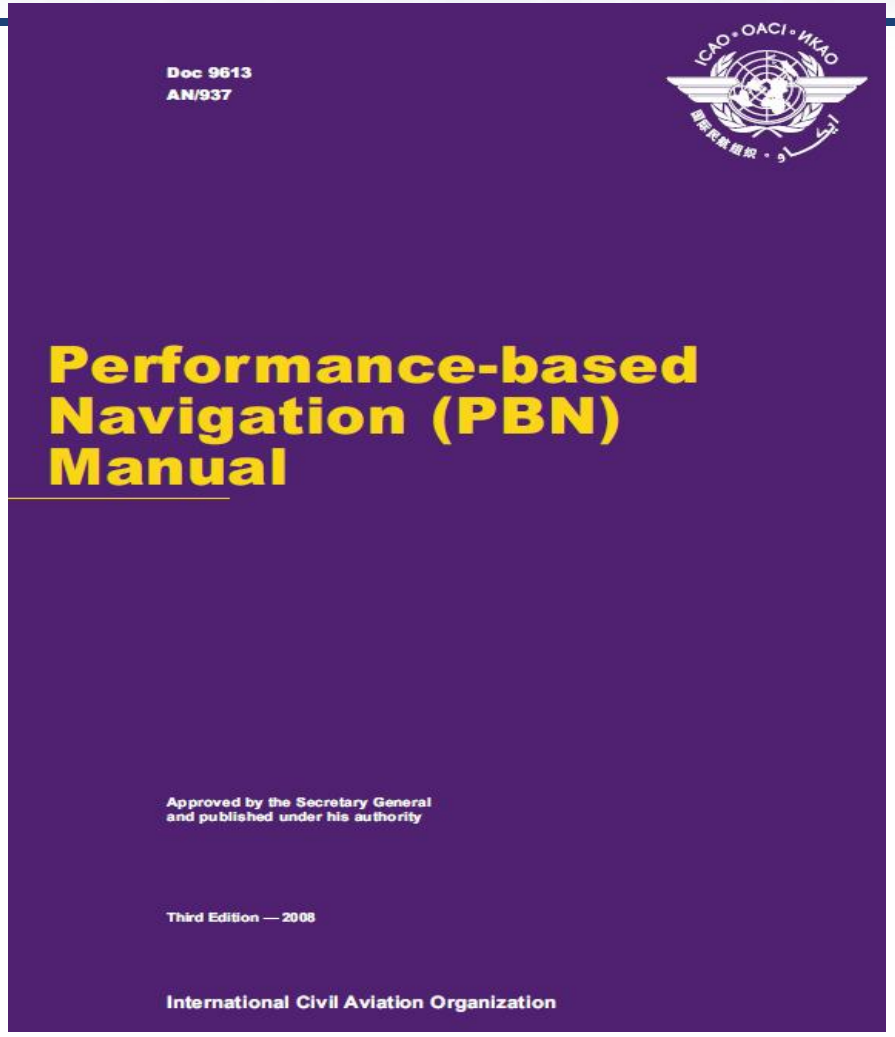
Terminal Area:
Implementation SID and STAR RNAV1 in Yaoundé, Douala, Garoua; RNP 1 in Maroua and Ngaoundéré

Approach:
- RNP APCH approaches ($RNAV_{(GNSS)}$) in Yaoundé, Douala, Garoua and Maroua including a vertical guidance (APV Baro-VNAV)
- RNP APCH approaches (RNAV(GNSS)) in Bafoussaam, Bertouaa and Ngaoundéré (LNAV only)
- RNP AR APCH in Bamenda

Part B: Implementation Guidance

- Provides guidance for implementing RNAV or RNP applications in a given Region
- Provides a framework for using the ICAO Navigation Specifications published in Volume II of this manual.

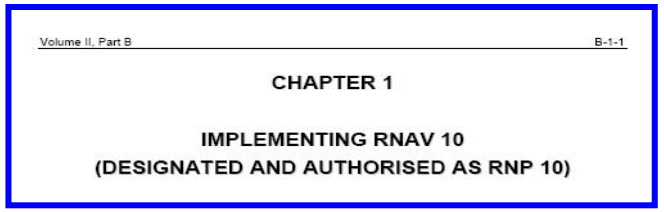
PBN : VOLUME II



VOLUME II

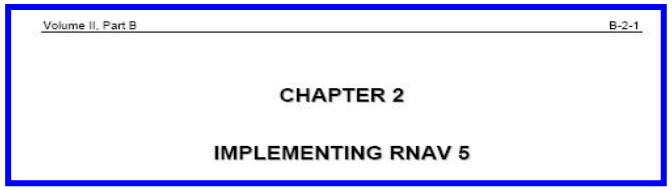
IMPLEMENTING RNAV AND RNP

Vol II : Implementation of RNAV and RNP applications


Volume II, Part B B-1-1

CHAPTER 1

IMPLEMENTING RNAV 10
(DESIGNATED AND AUTHORISED AS RNP 10)


Volume II, Part B B-2-1

CHAPTER 2

IMPLEMENTING RNAV 5

For each application RNAV or RNP a same format is used to describe :

- Area of operation and purpose
  - Chapter Introduction:
- ANSP consideration
- Navigation specification

ANSP (Air Navigation Service Provider) CONSIDERATION

- NAVAID INFRASTRUCTURE
- Communication ATS surveillance
- Route spacing
- OBSTACLE CLEARANCE
  - Reference to ICAO doc 8168 appropriate chapters
- Publication
- Control Training
- Status monitoring

AREA OF OPERATION: EN ROUTE

PBN APPLICATION		RNAV5		RNAV2	RNAV1	RNP2
Navaid infrastructure		VOR DME GNSS INS		DME GNSS INS	DME GNSS INS	GNSS
Nav Spec	On board	VORDME DMEDME GNSS INS		GNSS DMEDME DMEDME/INS	GNSS DMEDME DMEDME/INS	OPMA
	TSE	≤ 5 NM		≤ 2 NM	≤ 1 NM	≤ 2 NM
	Leg type			IF CF TF DF VA VM VI CA FA FM	IF CF TF DF VA VM VI CA FA FM	IF CF TF DF
	Function	Offset		Data base FB turn	Data base FB turn	Data base FB turn
Surveillance		Procedural	ATS	Radar	Radar Or FOSA	Procedural
Communication		Voice	voice	voice	voice	voice
ATM	Separation minima	30 Nm	Vary ⇆ 18 Nm ⇉16.5 Nm	Radar separation At least 8 Nm	Radar separation	Vary
	Publication	RNAV5		RNAV 2 Critical DME if any	RNAV1 Critical DME if any	RNP2

KEY ELEMENTS

- When VORDME sensor is acceptable
  - RNAV5
- Surveillance impact on Separation minima
  - Typical use of RNAV5 : RADAR environment
- Difference between RNAV2 and RNAV1
  - RNAV2 intended for en route operation (e.g .US),
  - RNAV2 allows use of simpler deviation displays
  - RNAV 2 using DMEDME + IRU allows longer time than RNAV1 and so reduced DME infrastructure

AREA OF OPERATION: TERMINAL

PBN APPLICATION		RNAV2	RNAV1	RNP1
Navaid infrastructure		DME GNSS INS	DME GNSS INS	GNSS
Nav Spec	On board	GNSS DMEDME DMEDME/IRU	GNSS DMEDME DMEDME/IRU	OPMA
	TSE	<2 NM	<1 NM	<1Nm
	Leg type	IF CF TF DF VA VM VI CA FA FM	IF CF TF DF VA VM VI CA FA FM	IF CF TF DF VA VM VI CA FA FM
	Function	Data base (LOA) FB turn	Data base (LOA) FB turn	Data base FB turn
Surveillance		Radar	Radar separation Or FOSA	ATS or procedural
Communication		voice	voice	Voice
ATM	Separation minima	Radar separation	Radar separation	Doc 4444
	Publication	RNAV 2 Critical DME if any	RNAV1 Critical DME if any	RNP1

KEY ELEMENTS

- The intend of RNAV1 is to STANDARDIZE PRNAV and USRNAV.
  - PBN indicates how to migrate to RNAV1
- RNAV1 is typically used for terminal operation in radar environment
- RNP1 is intended where no radar
- RNAV1 accommodates larger fleet of Aircraft
- RNAV1 can be supported by GNSS,DMEDME or DMEDME/IRU

APPROACH

AREA OF OPERATION: APPROACHES

- NO RNAV application only RNP approaches
- Based on GNSS
- RNP APCH = RNAV(GNSS)

AREA OF OPERATION: APPROACHES

- The « basic one » called RNP APCH (e.g. T or Y approaches)

- The « advanced one » called RNP AR
  - SPECIAL authorization required

AREA OF OPERATION : APPROACH

PBN APPLICATION		RNP APCH	RNP AR
Navaid infrastructure		GNSS	GNSS
Nav Spec	On board	OPMA	OPMA
	TSE	Final 0.3 NM	From 0.3 to 0.1
	Leg type	IF TF DF (VA CA FA)*	IF CF TF DF VA VM VI CA FA FM RF
	Function	Data base (LOA) FB turn	Data base (LOA) FB turn VNAV
Surveillance		ATS or procedural	ATS or procedural
Communication		voice	voice
A T M	Separation minima	Doc 4444	Doc 4444
	Publication	RNP APCH RNAV (GNSS)	RNP AR RNAV (RNP)

RNP APPROACH: LATERAL NAVIGATION

- Flight plan construction builds from an embedded updated NAVIGATION DATA BASE
- Provides display of all necessary flight navigation parameter for conducting safely an approach
- OPMA
- Accuracy :
  - INITIAL, INTERMEDIATE, Missed Approach segments
    - TSE ≤ 1 NM
  - FINAL
    - TSE ≤ 0.3 NM
- Missed approach based on conventional navaid or RNAV
  - If RNAV, contingency procedure should be assessed (for loss of RNAV capability)

RNP APPROACH: VERTICAL NAVIGATION

No requirement

- Procedure could be flown using Baro VNAV GUIDANCE if APV BaroVNAV procedure is published and A/C certified

ADVANCED RNP (ARNP APPLICATION

- Used to support RNP operations in en-route continental airspace and on SIDs, STARs and approach procedures.

  ARNP requirements include

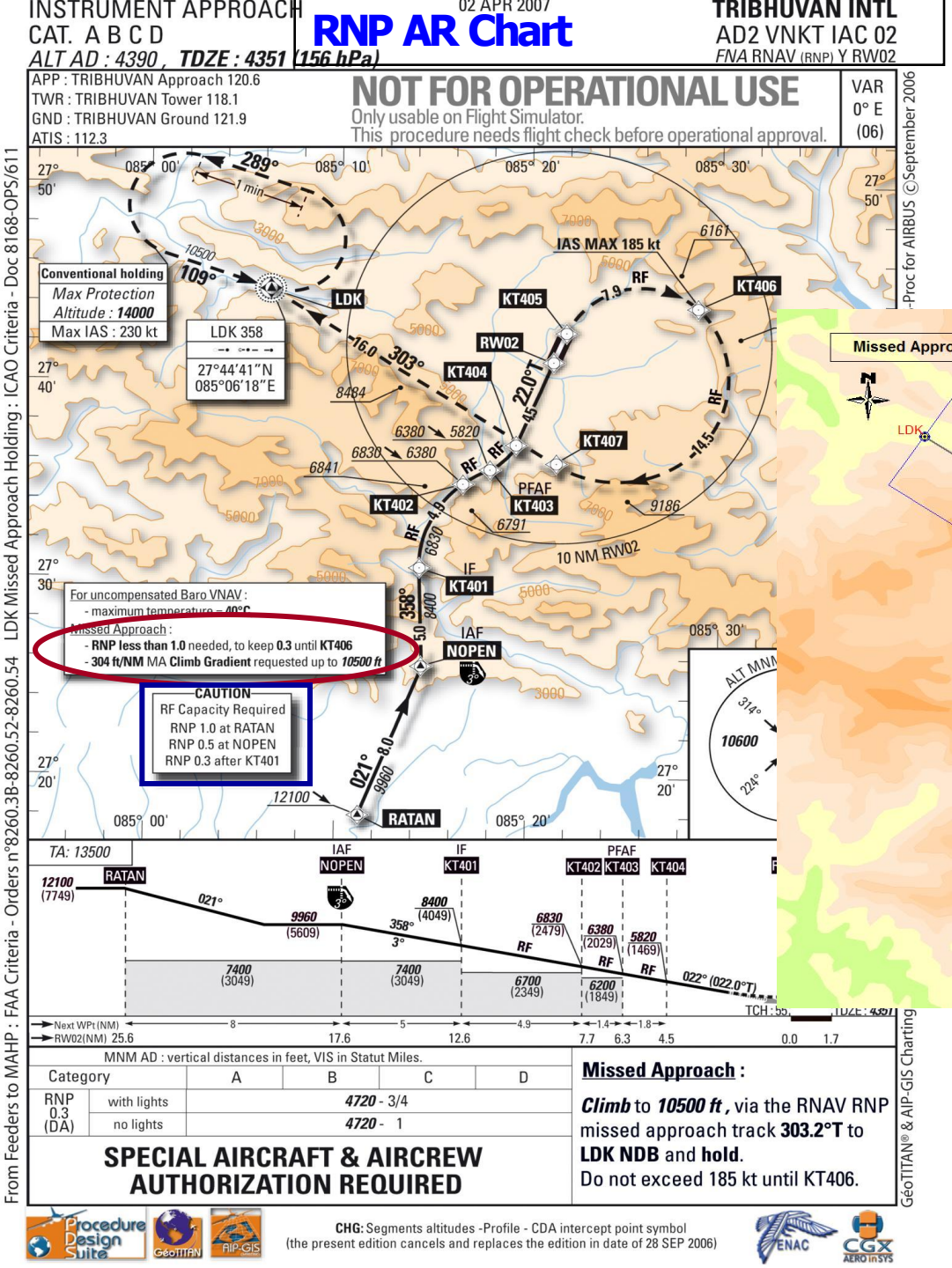
  – RNP 0.3 in final approach
  – RNP 1 or 2 in en-route continental
  – RNP 1 in SIDs, STARs, initial/intermediate approaches and missed approaches.

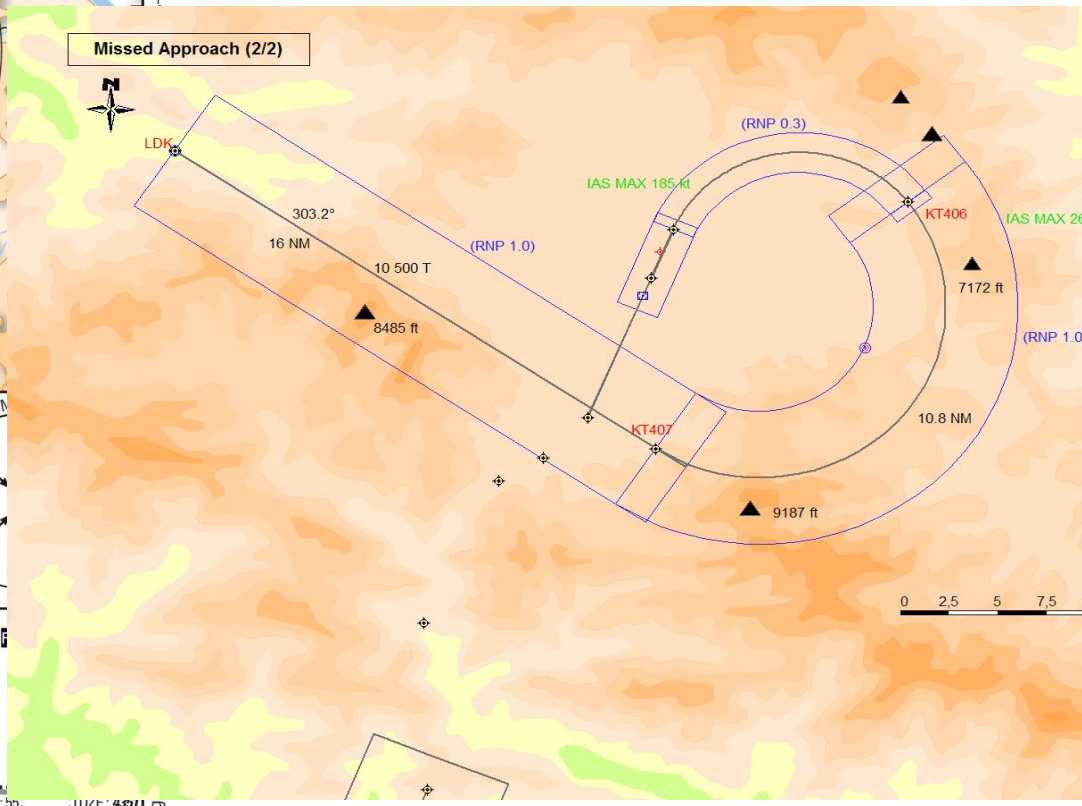
  Optional requirements include applications for oceanic/remote airspace and a scaleability option which allows any RNP value between 1.0 and 0.3, in 0.1NM increments, in all terminal flight phases outside final approach

RNP AR APCH

SPECIAL AUTHORIZATION

- Scaleable RNP (0.3NM – 0.1NM)
  - Flexible concept
  - Approach example:
    - straight initial segment of 0.25 Nm
    - followed by a curved intermediate segment of 0.18 Nm
    - followed by a curved final segment of 0.2 Nm
    - and finally followed by a missed approach of 0.3 Nm
- Specific functionalities:
  - VNAV based on Vertical Error Budget (VEB) concept
  - use of RF path terminator possible


INSTRUMENT APPROACH CHART
02 APR 2007
RNP AR Chart
TRIBHUVAN INTL
AD2 VNKT IAC 02
FNA RNAV (RNP) Y RW02
CAT. A B C D
ALT AD : 4390 , TDZE : 4351 (156 hPa)
APP : TRIBHUVAN Approach 120.6
TWR : TRIBHUVAN Tower 118.1
GND : TRIBHUVAN Ground 121.9
ATIS : 112.3
NOT FOR OPERATIONAL USE
Only usable on Flight Simulator.
This procedure needs flight check before operational approval.
VAR 0° E (06)
IAS MAX 185 kt
Conventional holding
Max Protection Altitude : 14000
Max IAS : 230 kt
LDK 358
27°44'41"N
085°06'18"E
LDK
KT405
KT406
RW02
KT404
KT407
PFAF
KT403
KT402
IF
KT401
IAF
NOPEN
RATAN
10 NM RW02
For uncompensated Baro VNAV :
- maximum temperature = 40°C
Missed Approach :
- RNP less than 1.0 needed, to keep 0.3 until KT406
- 304 ft/NM MA Climb Gradient requested up to 10500 ft
CAUTION
RF Capacity Required
RNP 1.0 at RATAN
RNP 0.5 at NOPEN
RNP 0.3 after KT401
TA: 13500
12100 (7749)
9960 (5609)
8400 (4049)
6830 (2479)
6380 (2029)
5820 (1469)
7400 (3049)
6700 (2349)
6200 (1849)
022° (022.0°T)
Next WPt (NM) 8 17.6 5 12.6 4.9 7.7 1.4 6.3 1.8 4.5 0.0 1.7
RW02(NM) 25.6
MNM AD : vertical distances in feet, VIS in Statut Miles.
Category A B C D
RNP 0.3 (DA) with lights 4720 - 3/4
no lights 4720 - 1
SPECIAL AIRCRAFT & AIRCREW AUTHORIZATION REQUIRED
Missed Approach :
Climb to 10500 ft , via the RNAV RNP missed approach track 303.2°T to LDK NDB and hold.
Do not exceed 185 kt until KT406.
From Feeders to MAHP : FAA Criteria - Orders n°8260.3B-8260.52-8260.54 LDK Missed Approach Holding : ICAO Criteria - Doc 8168-OPS/611
-Proc for AIRBUS ©September 2006
GéoTITAN® & AIP-GIS Charting
CHG: Segments altitudes -Profile - CDA intercept point symbol
(the present edition cancels and replaces the edition in date of 28 SEP 2006)


Missed Approach (2/2)
LDK
303.2°
16 NM
10 500 T
8485 ft
(RNP 1.0)
(RNP 0.3)
IAS MAX 185 kt
KT406
7172 ft
KT407
10.8 NM
9187 ft
0 2,5 5 7,5

KEY ELEMENTS

- NO RNAV application in APPROACH only RNP
- Based on GNSS
- General Case : RNP APCH
- RNPAPCH = RNAV(GNSS)
  - RNP1 down to Intermediate and Missed APP
  - RNP0.3 for Final
  - No need to re-design nor re-certify
  - Published as RNAV (GNSS)
- RNP AR = SPECIAL AUTHORIZATION
  - Special aircraft (RNP 0.3 to 01)
  - Special training
  - ONLY for SPECIAL CASES
  - Only to meet specific requirements that cannot be met by RNP APCH

CONCLUSION

- Navigation APPLICATION caters for AIRSPACE concept
  - navaid infrastructure, fleet, ATM
- System functionalities are as important as accuracy .
- Large part of PERFORMANCE is TRAINING

Any questions?