สำนักงานการบินพลเรือนแห่งประเทศไทย
The Civil Aviation Authority of Thailand

PERFORMANCE BASED NAVIGATION (PBN) OPERATIONS GUIDELINES

CAAT-GL-OPS-PBN

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Approved by

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Abbreviations

Abbreviations	Meaning
ADS-C	Automatic Dependent Surveillance-ContractAircraft
ABAS	Aircraft based Augmentation Systems
AFM	Aircraft Flight Manual
AAIM	Aircraft Autonomous Integrity Monitoring
APCH	Approach
VPA	Approach Procedure with vertical Guidance
AR	Authorization Required
ATC	Air Traffic Control
ATO	Approved Training Organizations
CPDLC	Controller Pilot Datalink
CTA	Communications Air Carrier Certificate
DME	Distance Measuring Equipment Fault
DEF	Detection and Exclusion Flight
FMS	Management System Ground Based
GBAS	Augmentation System Global Navigation
GNSS	Satellite System Global Positioning
GPS	Global Positioning System
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IRS	Inertial Reference System
MEL	Minimum Equipment List
LNAV	Lateral Navigation
LOA	Letter of Acceptance
LPV	Localizer Performance with Vertical Guidance
NOTAM	Notice To AirMen
PBN	Performance Based Navigation
pins	Point in Space
POH	Pilot Operating Handbook
RAIM	Receiver Autonomous Integrity Monitoring
RNAV	Area Navigation
PBN	Required Navigation Performance
SBAS	Satellite Based Augmentation System
TAWS	*Terrain Awareness and Warning System*
VFR	Visual Flight Rules
VNAV	*Vertical Navigation*

0. Introduction

0.1 Background

PBN is a concept developed by ICAO to specify the operational performance of the navigation system required in an airspace, enroute or an instrument approach procedure.

This concept has made it possible to develop different navigation standards/specifications. The ICAO PBN manual (Doc 9613) defines the PBN concept as well as the different navigation specifications applied to the different flight segments.

A Navigation Specification specifies in detail:

- the performance required of the area navigation system in terms of accuracy,
- integrity and continuity,
- the required navigation features (functionality),
- navigation sensors,
- the conditions to be fulfilled by the flight crew.

There are two types of navigation specifications: RNAV navigation specifications and RNP navigation specifications:

- RNP X: Navigation specification with requirement for on-board performance monitoring and alerting (OPMA) function.
- RNAV X: Navigation specification without the requirement of on-board performance monitoring and alerting function.

“X” refers to the lateral navigation accuracy requirement in NM required for 95% of the flight time

0.2 Purpose

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0.3 Applicability

CAT, NCC, NCO and SPO operators who will carry out the PBN operations including ATOs who will provide the IR/PBN training course.

0.4 References

TCAR OPS Air Operation (Cover) Regulation and TCAR OPS Part, with the associated AMCs and GM including:

- **Part ORO - Organisation requirements for Air Operators**
  - ORO.FC.105 (2) - Designation as pilot-in-command/commander

    - ORO.FC.130; ORO.FC.230; ORO.FC.330 - Recurrent training and checking
    - ORO.GEN.160 – Occurrence reporting
    - ORO.FC.145 - Provision of training
- **Part CAT - Commercial Air Transport**
    - CAT.OP.MPA.126 - Performance-based navigation
    - CAT.OP.MPA.135 - Routes and areas of operation — general
    - CAT.OP.MPA.175 - Flight preparation
    - CAT.OP.MPA.182 - Destination aerodromes — instrument approach operations
    - CAT.IDE.A.345; CAT.IDE.H.345 - Communication and navigation equipment for operations under IFR or under VFR over routes not navigated by reference to visual landmarks
    - CAT.IDE.A.355 - Electronic navigation data management
- **Part NCC - Non-commercial operations with complex motor powered aircraft**
    - NCC.OP.116 - Performance-based navigation — airplanes and helicopters
    - NCC.OP.153 - Destination aerodromes — instrument approach operations
    - NCC.GEN.106 - Pilot-in-command responsibilities and authority
    - NCC.IDE.A.250; NCC.IDE.H.250 - Navigation equipment
    - NCC.IDE.A.260 - Electronic navigation data management
- **Part NCO - Non-Commercial Air Operations with Other-Than Complex Motor- Powered Aircraft**
    - NCO.OP.116 - Performance-based navigation — airplanes and helicopters
    - NCO.OP.142 - Destination aerodromes – instrument approach operations
    - NCO.GEN.105 - Pilot-in-command responsibilities and authority
    - NCO.IDE.A.195; NCO.IDE.H.195 - Navigation equipment
- **Part SPA - Specific approvals**
    - SPA.PBN.100 - PBN operations
- **SPO - Specialised operations**
    - SPO.OP.116 - Performance-based navigation — airplanes and helicopters
    - SPO.OP.152 - Destination aerodromes – instrument approach operations
    - SPO.GEN.107 - Pilot-in-command responsibilities and authority
    - SPO.IDE.A.220; SPO.IDE.H.220 - Navigation equipment

- **Additional references**
    - ICAO Doc 9613 PBN Manual
    - ICAO Doc 9997 PBN operational approval manual
    - ICAO Doc 4444 PANS-ATM
    - ICAO Doc 7030 Regional Supplementary
    - ICAO ANNEX 11

1. Authorisation and Assessment Concepts

Apart from RNP 0.3 operations (for helicopters only) and RNP AR, PBN operations do not require specific approval. However, before carrying out PBN operations, it is therefore not necessary to submit an application for obtaining approval from the CAAT. On the other hand, it is recommended that the operator compile a regulatory compliance matrix (see §2).

1.1 CAT Operators

For AOC holder (CAT): the compliance matrix may be assessed by the CAAT following a change notification or during oversight activity. The implementation of the PBN may require an **MEL** modification which requires prior approval and is accompanied by the implementation of the **training programme** which will be approved by the CAAT.

1.2 NCC and SPO Operators

For non-commercial operators of complex motor-powered aircraft (NCC) or specialised operators (SPO), compliance may be checked during surveillance activities by the CAAT. The implementation of the PBN may require an **MEL** modification which will be approved by the CAAT and is accompanied by the implementation of appropriate training program under the ORO.FC.145.

1.3 NCO Operators

For non-commercial operators with other-than-complex motor-powered aircraft (NCO), the implementation of PBN is accompanied by the **training** within ATO.

Note*: TCAR PEL Part FCL stipulates that "pilots may fly in accordance with PBN procedures after they have been granted PBN privileges" (IR/PBN being endorsed on the licence). The details for having PBN privilege are described in FCL.615*

2. PBN Compliance Evidences

The PBN compliance evidences must contain relevant extracts from the operations manual (when required) and the following:

- Eligibility and airworthiness of the aircraft for the conduct of PBN operations
- Extracts from the MEL for equipment affecting PBN capability
- Operational procedures:
  - Normal procedures;
  - Abnormal, emergency and contingency procedures.
- Navigation Database Management Procedure
- Flight Crew training programme (tailor to planned PBN operations)

The operator can use the compliance matrix in Appendix 9 – Correspondence matrix with the documentation reference.

3. Prerequisite for PBN Operations

3.1 Aircraft Eligibility – Reference Documents

The operator must ensure and be able to demonstrate that the aircraft is eligible for the desired PBN operations. Aircraft's navigation (avionic) performance should be referenced in one of the following documents:

- AFM (Aircraft Flight Manual) or supplement for the installed RNAV system;
- POH (Pilot Operating Handbook); or
- any other manufacturer document referenced in the AFM.

The regulatory requirements and references are specific to each navigation specification.

Refer to the following TCAR OPS GMs is depending on the nature of operation:

Aeroplanes:

GM2 CAT IDE.A.345	GM1 NCC.IDE.A.250	GM1 NCO.IDE.A.195	GM1 SPO.IDE.A.220

Helicopters:

GM2 CAT IDE.H.345	GM1 NCC.IDE.H.250	GM1 NCO.IDE.H.195	GM1 SPO.IDE.H.220

3.2 System Description and Limitations

The following elements must appear in the operations manual (or flight manual for an NCO aircraft):

- An **introduction** to PBN and its technical and operational **specifications**;
- A detailed **description of the system** must be written in the manual:
  - Type and number of installed;
  - Pilot's guide.
- A **description of the navigation sensors** on which the requested navigation specification is based and the **capabilities / limitations for the operator**:
  - Single-sensor installation (GNSS or DME or IRS);
  - Multi-sensor installation.
- A **description of the software version of the system** and its functionality to capture/maintain RF segments, holding patterns (HM, HF, HA segments) and offset for example.

3.3 MEL Management

The CAT/SPO/NCC operator must develop MEL compatible with its type of operations. As such, it must deal with the PBN operations envisaged under its various aspects in its MEL. This MEL should be developed according to the MEL user guide and must be approved by the CAAT. The MEL will take into account the **equipment** aspects and the **navigation database**.

In the context of an ATO operating NCC aircraft, the MEL is approved under the operations manual.

The MEL is optional for an NCO operator. If an MEL is developed, it must take into account the elements presented above, however this does not require approval by the CAAT.

3.4 Operational Procedures

3.4.1 Flight preparation

The operator/PIC must develop/use procedures (normal, and abnormal/emergency) enabling the monitoring of a PBN procedure, adapted to the airplane and its equipment.

- **MEL Management**: Any restrictions in the Minimum Equipment List must be adhered to
- **Flight plan**:(See new PANS ATM requirements in Appendix 1 – Flight plan)
- **Selection of departure, enroute and arrival procedures**: The pilot must ensure that the RNAV/RNP procedure to be carried out is compatible with the RNAV/RNP system installed and the functionalities supported by the system.

Example 1: an RNAV1 procedure which requires only GNSS sensor (GNSS required mention on the chart) cannot be carried out by an RNAV1 certified aircraft with only a positioning based on the DME-DME.

Example 2: Some navigation specifications and specific procedures require specific functional capabilities such as RF segments, holding or offsets. The operator must ensure that its navigation system is compatible with the functionality required by the procedure.

- **RAIM prediction:**

Depending on the navigation system installed in the aircraft, it may be necessary to perform a RAIM prediction to ensure that the number of operational and visible satellites when performing the GNSS procedure will allow the system to deliver positioning with the desired accuracy and integrity.

This checking mainly concerns aircraft equipped with a GNSS system which do not use information from an inertial unit or a satellite complement. Refer above all to the AFM limitations or the manufacturer's operational documents (FCOM, POH) to determine whether RAIM prediction is required or not.

When a RAIM prediction is needed to consider a PBN operation (in arrival, departure or approach phase), RAIM availability must be confirmed for the range scheduled time of use of the PBN procedure on the following time segment: *[15 min before the start of the procedure; 15 min after the end of the procedure]*

- either the on-board equipment forecasting tool or identical software. In this case, the information on the possible unavailability of satellites must be entered in the predictive program of this equipment or this software. This information is given by the NOTAMs relating to the state of the GPS constellation.
  or
- forecasts calculated by software or tools available on the Internet, such as Augur, developed by Eurocontrol (https://augur.eurocontrol.int/tool/)

In the event of a planned unavailability of RAIM of GNSS, the crew is supposed to use other means of navigation, choose another destination or delay the flight.

Remark:

1. For aircraft with hybrid positioning information based on IRS and GPS, RAIM prediction may not be required or limited to certain cases (depending on GPS constellation availability). This should be detailed in the relevant sections of the reference documentation (e.g. AFM, FCOM, POH see 3.1).

2. For users of SBAS systems, depending on the installation conditions (e.g. Fault detection and execution: FDE, refer to the manufacturer's documentation), the RAIM prediction may not be necessary for flights in airspaces covered by the SBAS signal. It is therefore necessary to examine the SBAS NOTAMs to ensure the availability of the signal.

- **Fault detection and execution: FDE**

An FDE availability prediction (detection and exclusion of failures) is necessary for aircraft operating in oceanic or remote spaces (RNAV 10 or RNP 4 space) and whose navigation is based exclusively on GNSS. The aim is to be able to continue the RNAV 10 or RNP 4 operation based on the GNSS despite the possible failure of a satellite.

The maximum authorised duration of unavailability of the FDE is 34 minutes in RNP 10 (RNAV 10) and 25 minutes in RNP 4.

- **Notes**

The pilot must check any NOTAM or any instruction that may affect the availability or feasibility of the RNAV/RNP procedures he is likely to perform. There may be different NOTAMs indicating the non-availability of the GNSS signal:

- NANUs (Notice Advisory to NAVSPACE Users issued by the US Coast Guard): They provide information on the status of the GPS constellation. These NANUs are useful to take into account inoperative satellites during a RAIM prediction.
- EGNOS NOTAM: They allow you to know the availability of the EGNOS signal (this is the practice in EUROPE).
- NOTAM RAIM: They allow to know the availability of RAIM.

RAIM and EGNOS NOTAMs are issued if an unavailability of more than 5 min of the RAIM or the EGNOS signal is expected for an area on which a GNSS approach is published.

In the United States, RAIM and WAAS are available by consulting a website: gps.gov

- **Database**

The flight crew must ensure that the database is valid, and that it is appropriate for the flight (see procedures relating to the processing of Databases).

- **Clearance selection at destination:**

When an RNP APCH approach is planned at destination, the crew must ensure that a conventional procedure (non-GNSS) is available on the alternate aerodrome (CAT.OP.MPA.182 (f)).

When a conventional approach is selected for the destination aerodrome, an RNP APCH approach can be selected for the alternate aerodrome. Operational constraints related to RNP APCH requirements then apply, as for any RNP APCH approach.

3.4.2 Normal procedures

Checks to be carried out:

- **Active flight plan** by comparison between the charts and the information read on the navigation system before starting the procedure:
    - Sequence of WPs
    - Consistency of route alignment – tracks and distances
    - Altitude and speed constraints
    - Final descent angle
    - Type of WP: Fly-By or Fly-Over
    - Type of route segments (for example an RF segment)

- The availability of radio navigation aids required by the procedure.

Example:

- o Case of go-arounds based on a conventional means.
- o Case of critical radio navigation aids: Arrivals (STAR) or departures (SID) can identify **critical DMEs** to the procedure which must be selected when the navigation system bases its navigation exclusively on the DME/DME or DME/DME /IRU

3.4.3 Abnormal Procedures

Abnormal procedures adapted to the architecture of the navigation system, to failures and alarms related to the GNSS equipment and to the display system, must be developed in the case of:

- Loss of the navigation system (FMS, “stand alone” GNSS);
- Suspected database error;
- Navigation error alarm, loss of integrity signaled (ex: UNABLE RNP, GPS PRIMARY LOST, INTEG…);
- Loss of GNSS (in case of protected PBN procedure using exclusively GNSS).

Phraseology: In an abnormal situation, following a failure or degradation of the RNAV/RNP system, in accordance with ICAO docs 7030 and 4444, the pilot must inform ATC using the following terms, as soon as the failure or degradation of its navigation capacity, and thereafter at each initial contact on a new frequency:

- UNABLE RNAV/RNP [specify type, ex RNAV1, RNP1…] DUE TO [reason, ex. equipment, loss of RAIM, RAIM alert…]

3.4.4 Case of ATC instruction

To respond to an ATC instruction, direct to waypoints can be made. In this case these waypoints must be extracted from the database and in no way be created manually.

As part of the approaches, air traffic controllers can provide radar vectoring to the final approach segment before the FAF.

In this case, the RNAV/RNP system must have the capability to indicate the horizontal deviation relative to the extended final segment of the approach to facilitate interception of the extended final segment of the approach via a Direct-To/Course function.

- Guidance leading to an interception of the final axis less than 2NM to the FAF should not be accepted.
- Manual entry by the pilot of coordinates into the GNSS system for use in the terminal area is not authorised.
- “Direct To” clearances to the IF can be accepted provided that the aircraft intercepts the final segment more than 2NM from the FAF for stabilisation of the final trajectory.
- “Direct To” clearances to the FAF should not be accepted.
- “Direct To” clearances to a waypoint not belonging to the procedure should not be accepted.

3.5 Procedures Relating to the Processing of Navigation Databases

The operator is responsible for the integrity of the navigation database that he loads into RNAV/RNP system. He must put controls in place to guarantee the integrity of the data that is loaded and updated on board the aircraft.

- The navigation database must be obtained from a supplier hold a LOA type 2, or according to the development and certification process provided by the type 2 DAT providers.
- These conditions do not guarantee that there are no errors in the database. As well as, for aerodromes that may present a risk in the event of a coding error, it is desirable that the operator continues to remain vigilant on the content of the databases, and quickly reports any errors.

3.5.1 Database processing

The operator must ensure that the loading of the database, in particular at each cycle AIRAC, does not alter the content thereof. He must also ensure that the database loaded on the aircraft is indeed the one compatible to the equipment, in particular if this operator manages a diversified fleet.

The operator must report very quickly to its navigation database supplier any error detected on a database.

The procedures concerned will be suspended by the operator (by a company NOTAM if necessary) to ensure that flight crew are not using it.

3.5.2 Case of “non-WGS-84” procedures:

One of the prerequisites of a PBN procedure is that the coordinates in the navigation databases are in the **WGS 84** repository. If PBN operations are contemplated in a state that does not use the WGS 84 repository to define coordinates of the waypoints, an impact analysis must be carried out by the operator. Indeed, the use of a different reference can generate path definition errors (PDE – Path Definition Error) and thus impact the safety of the flight.

4. Particularities of Navigation Specifications

4.1 RNAV 10

This navigation specification application is used for "oceanic" or "remote area" for which navigation can only be done using long range navigation system (inertial unit system and/or GNSS) while allowing longitudinal and lateral separation between aircraft 50 NM.

The RNP 10 application is standardised in the ICAO PBN manual by RNAV 10 because it does not impose a warning on board the aircraft if the accuracy criterion is not met. However, given the breadth of existing airspace designations and operational approvals under the RNP 10 designation, it is expected that new airspace designations and aircraft approvals will continue to use the term "RNP 10".

4.1.1 Sensors used - limitations

Two Long Range Navigation Systems (LRNS) are required, therefore a single failure does not result in a total loss of navigation.

The sensors used are either inertial units (IRS) or GNSS sensors:

- For aircraft **without GNSS** (avionics architecture with 2 or more IRS), the operator must comply with the time limit guaranteeing its performance (6.2 flight hours from the last alignment of the IRS).
- In the installation case **GNSS without IRS**, an FDE prediction is required for flight planning. The aim is to be able to continue the GNSS-based RNAV10 operation despite the possible failure of a satellite.
- For facilities multi-sensor (**GNSS + IRS**), time limitation will only apply in case of GNSS failure, FDE prediction may not be required.

Refer to the AFM limitations or the manufacturer's SOPs.

4.1.1 Specific requirements

Designated RNAV10 airspaces providing a minimum longitudinal and/or lateral separation of 50NM between aircraft have communication and surveillance requirements:

- CPDLC (Controller Pilot Datalink Communications)
- ADS-C (Automatic Dependent Surveillance-Contract).

In addition, for ADS-C, a duration between two transmissions of information from **27 minutes** must be respected.

***Note**: In NAT-HLA airspace, most routes (tracks) require RNAV 10 capability. In addition, some will require CPDLC and ADS-C (see guide for this purpose in ICAO NAT Doc 007).*

4.2 RNP4

This PBN application is used for "oceanic" or "remote area" trajectories for which navigation can only be done using on-board means (GNSS) while allowing longitudinal and lateral spacing between aircraft of 30 NM

4.2.2 Sensors used – limitations

Two RNP 4 compatible Long Range Navigation Systems (LRNS) are required, so that a single failure does not result in a total loss of navigation.

In RNP 4, the GNSS must be used for the positioning calculation. This results in the requirement to have two GNSS sensors in MEL.

- For facilities **GNSS only**: an FDE prediction must be established to ensure that navigation can continue despite the possible failure of a satellite.
- For facilities multi sensors (**GNSS + IRS**), the FDE prediction is not required (according to AFM provisions). The loss of one GNSS out of the 2 before entering RNP 4 airspace can then be considered.

4.2.1 Specific requirements

RNP 4 designated airspaces providing a minimum longitudinal and/or lateral separation of 30NM have communication and surveillance requirements:

- CPDLC (Controller Pilot Datalink Communications)
- ADS-C (Automatic Dependent Surveillance-Contract).

In addition, for ADS-C, a duration between two transmissions of information from **14 minutes** must be respected.

The aircraft must also be equipped with an FMS making it possible to carry out a **parallel offset**. This offset can be executed to the left or to the right of the initial route and must respect the precision and performance required initially. The FMS must allow the creation of offsets of up to 20 NM and more.

Note*: In NAT-HLA airspace, ½ degree routes (tracks) require RNP 4 capability, as well as CPDLC and ADS-C (guideline for this purpose in ICAO NAT Doc 007).*

4.3 RNP 2 Oceanic

The RNP 2 Oceanic application is primarily intended for aircraft operating at high altitudes in light to medium traffic areas without the aid of NAVAID.

4.3.1 Sensors used – limitations

RNP 2 in the oceanic area, the GNSS must be used for the positioning calculation.

4.3.2 Specific requirements

There are no special requirements for RNP 2 operations in oceanic and remote enroute areas.

4.4 RNAV1 / RNAV2

RNAV1 is used for the development of arrival (STAR) and departure (SID) procedures as well as certain initial and intermediate approaches (IAF, IF). RNAV1 meets the same requirements as P-RNAV with the following exception: RNAV1, unlike P-RNAV, does not rely on VOR/DME sensors to calculate aircraft position.

4.4.1 Sensors used – limitations

The RNAV equipment must be able to automatically determine the aircraft's position from one or a combination of the following sensors:

- DME/DME
- DME/DME/INS or IRS
- GNSS

Aircraft operators who only base their position calculation on DME/DME or DME/DME/IRS will not be able to perform RNAV procedures that require GNSS. This limitation should be clearly brought to the attention of flight crews.

4.4.2 Specific requirements

An RNAV1 or RNAV2 route should be fully extracted from the navigation database by its identifier. However, in response to an ATC clearance, the route can be modified by inserting or deleting a waypoint. Inserted waypoints must be taken from the navigation database and <u>must not be manually entered</u> as Lat/Long or bearing/distance. Flyby waypoints must not be changed to flyover and vice versa.

4.5 RNP 1 / RNP 2

The RNP 1 application makes it possible to develop departure (SID) and arrival (STAR) procedures as well as certain initial and intermediate approaches. Compared to RNAV1, the interest of RNP1 lies essentially in the possibility of coding turns by an RF segment which makes it possible to ensure good predictability of the trajectory.

4.5.1 Sensors used – limitations

RNP navigation specification requires the use of GNSS as the primary means of navigation, some aircraft manufacturers have also demonstrated RNP1 capability in DME/DME/IRS. This capability is mainly used as a backup following the loss of the GNSS signal.

The RNAV equipment must be able to automatically determine the aircraft's position from one or a combination of the following sensors:

- GNSS
- DME/DME/INS or IRS[1] (e.g. FAA AC 90-105)

4.5.2 Specific requirements

An RNP1 procedure should be entirely extracted from the navigation database by its identifier. However, in response to an ATC clearance, the route can be modified by inserting or deleting a waypoint. Inserted waypoints must be taken from the navigation database and <u>must not be manually entered</u> as Lat/Long or bearing/distance. Flyby waypoints should not be changed to flyover and vice versa

4.6 RNP APCH (GNSS)

The term RNP APCH refers to RNP approach procedures without prior approval (unlike RNP AR approaches).

[1] The use of DME/DME for this Nav Spec requires specific State authorisation

Some of these approaches are charted as RNAV(GNSS) or RNAV(GPS) or even GPS. The PBN manual navigation specification associated with these approaches is “**RNP APCH**” see Appendix 5 – Conventional approach, Overlay and RNP APCH - Terminology.

An RNP approach covers three possible types of approach procedure:

Non-Precision approach	Identified on IAP chart be line of minima	LNAV
Approach with vertical glide path (APV) Baro-VNAV	Identified on IAP chart be line of minima	LNAV/VNAV
Approach with vertical glide path (APV) SBAS	Identified on IAP chart be line of minima	LPV

4.6.1 Sensors used – limitations

For the **LNAV**:

- Lateral: GNSS (GPS + ABAS or GPS + SBAS)

For **LNAV / VNAV**:

- Lateral: GNSS
- Vertical: Baro-VNAV

The vertical deviation display (V-dev) should be located in the pilot's primary field (PFD or ND).

For **LPV**:

- Lateral and vertical: GNSS (GPS + SBAS)

***Note**: Aircraft subject to the carriage of TAWS class A and which do not support mode 5 (Glide Slope) for LPV may be limited to a DH of 250ft (according to AFM limitations).*

4.6.2 Specific requirements

Special precautions related to the use of the Baro-VNAV function should be taken into account on altimeter setting and the effect of temperature (e.g. cold temperature).

4.6.3 Point in Space (PinS) approaches (specific to Helicopters)

Point in Space approach procedures known as PinS are RNP APCH procedures reserved exclusively for helicopters (under TCAR OPS Part SPA PinS require prior approval from the Authority). The breakthrough with instruments is carried out to a waypoint: the PinS. At PinS the pilot then makes the decision to continue the approach or to abort it if the visual references are not acquired. Depending on the type of published PinS procedure, there are then two possibilities to continue the approach:

- “Proceed VFR”
- "Proceed visually"

Like RNP APCH approaches, PinS approaches can have LNAV, LNAV/VNAV or LPV minima.

The operational requirements (sensors used, crew training) for PinS approaches are the same as for conventional RNP APCH procedures, as are the precautions associated with the use of the Baro-VNAV function.

Examples of publication of PinS procedures are given in Annex 7 – Example of PinS procedures.

4.7 Advanced RNP (A-RNP)

(reserved)

5. Flight Crew Training under TCAR OPS (AIROPS) and TCAR PEL Part FCL (AIRCREW)

5.1 Reminder

In accordance with TCAR OPS regulations, pilots must have undergone adequate training to carry out PBN operations.

AMC1 CAT.OP.MPA.126	AMC1 NCC.OP.116	AMC1 NCO.OP.116	AMC1 SPO.OP.116

For operators subject to part ORO (e.g. CAT, NCC, SPO) and part ORA (e.g. ATO), the qualification and proficiency check programme must take PBN operations into account.

For the approval of Instrument ratting: IR training programs including PBN, this guide is considered an acceptable means of compliance.

Also refer to the CAAT guideline to 2D/3D operations.

5.2 Training content

The training consists of a **theoretical** part and a **practical** part. It will be issued according to a program approved by the CAAT as detailed in §1.

This training will be carried out with a flight crew composition in accordance with the minimum composition set by the operator or the ATO training manual and operations manual or the flight manual, for the performance of these RNP APCH approaches.

5.2.4 Theoretical ground training

5.2.4.1 Theoretical training in PBN

The theoretical training must cover the training objectives presented in Annex 8 – PBN Learning Objectives.

These objectives cover the following main points:

- The principles of PBN in terms of accuracy, integrity, continuity and functionality
- The different navigation specifications and differences between RNAV and RNP
- Ground infrastructure and aircraft systems required
- Functions specific to RNAV and RNP systems (RF segment, offset, RNAV standby, etc.)

5.2.4.2 Theoretical training in the RNAV system

Operation of the RNAV/RNP system

- Principles of operations of the RNAV/RNP system
- Possible limitations of the system and their impacts on the planned PBN operations
    ○ According to its version (P/N, software version, coupling, etc.)
    ○ its approved PBN capability.
    ○ The different segments supported by the RNAV system (for example RF segment)
    ○ The different functions supported (waiting, parallel trajectories (offset),..)
- Database verification procedure
- Enter data into the RNAV/RNP system and cancel it
- Integration of the RNAV system in the cockpit
    ○ Automation (AP, FD)
    ○ Announcement of different flight modes
    ○ Interactions with other avionic systems
- The different navigation sensors (DME, VOR, IRU, GNSS) used by the RNAV/RNP system
- Display of information and symbols
- Sensitivity and management of the CDI according to the flight phases
- Procedure for entering a flight plan
- Procedure for checking the consistency of the selected instrument procedure
- Modification of the flight plan, management of discontinuities, management of changes (runways, arrival, destination airport, alternate, … etc.)
- Alarms and information or error messages generated by the system.
- Selection and follow-up of a route, anticipation turn, identification of the main WPts
- Manual or automatic flying
- Direct-To function
- The different modes of interception of an RNAV/RNP route/procedure
- System management of RNAV/RNP transitions to conventional approaches (ILS, VOR, etc.)
- Selection of the different types of RNP APCH approach
- Identification of PBN procedures (SID, STAR, LNAV, LNAV/VNAV, LPV) by the RNAV/RNP system and how they are announced

Remark: This list is indicative and not exhaustive. Most of these items may have been seen through type qualification. In view of the variety of avionic systems and their integration in the cockpit, it is recommended to rely on the manufacturer's documentation to establish the training/familiarization program for the navigation system

5.2.5 Practical training

5.2.5.1 Practical ground training

The practical training on the ground must cover the handling and use of an RNAV/RNP navigation system comparable to that installed on the aircraft and cover all the functionalities supported by the navigation system likely to be used when carrying out of a PBN procedure.

For the purposes of this training, the equipment used may be presented or installed on a computer support, a PC-based simulator, an FSTD - flight training system or an aircraft on the ground.

The duration of this training will depend on the complexity of the RNAV/RNP system used and the manufacturer's recommendations.

Training on a simple RNAV/RNP system (example: GNS 430W) will have a minimum duration of 2 hours. This training must take into account the recommendations of the system manufacturers when they exist (example: Garmin G1000).

In the context of the NCO operator, if a pilot receives his practical training in an ATO on a system different from the one he will use, it is important that he should familiarizes himself with his own RNAV/RNP system.

5.2.5.2 Practical training in flight or on an FSTD

This training will be carried out:

- either on an aircraft of the same class or of the same type as that used in operation;
- either on a synthetic trainer, representative of the aircraft used in operations, or complying with ORA.ATO.135.

In both cases, the RNAV/RNP equipment must be comparable to that used in operations.

This training will include at least[2] four RNP APCH approaches.

Two of them must include an interruption following the simulation of a degraded situation (loss of RNAV capacity or RAIM alarm, for example).

As part of an approval of an IR training program including PBN operations, the number of RNP APCH approaches must be at least equivalent to the number of conventional approaches.

5.2.5.3 Certificates

The person in charge of the approved training organization will certify the completion and satisfactory realization of this training for each trainee.

This training certificate must accompany the flight log. Only training courses covering the entire content of the training will be subject to certification

[2] There may be several different ways to operate GNSS approaches depending on the type of aircraft or the avionics configuration of the aircraft, these differences should be taken into account in the development of the training program.

Appendix 1 – ATS Flight Plan

Indication of PBN capability in ATS flight plan

Insert the indicators specified below in the following fields:

Item 10: R (= PBN eligible), Item 18: PBN/[…]

	RNAV SPECIFICATIONS
A1	RNAV 10 (RNP 10)
B1	RNAV 5 all permitted sensors
B2	RNAV 5 GNSS
B3	RNAV 5 DME/DME
B4	RNAV 5 VOR/DME
B5	RNAV 5 INS or IRS
B6	RNAV 5 LORANC
C1	RNAV 2 all permitted sensors
C2	RNAV 2 GNSS
C3	RNAV 2 DME/DME
C4	RNAV 2 DME/DME/IRU
D1	RNAV 1 all permitted sensors
D2	RNAV 1 GNSS
D3	RNAV 1 DME/DME
D4	RNAV 1 DME/DME/IRU
	RNP SPECIFICATIONS
L1	RNP 4
O1	Basic RNP 1 all permitted sensors
O2	Basic RNP 1 GNSS
O3	Basic RNP 1 DME/DME
O4	Basic RNP 1 DME/DME/IRU
S1	RNP APCH
S2	RNP APCH with BARO-VNAV
T1	RNP AR APCH with RF (special authorization required)
T2	RNP AR APCH without RF (special authorization required)

***Note**: New code for item/18 – planned effective in 2024*

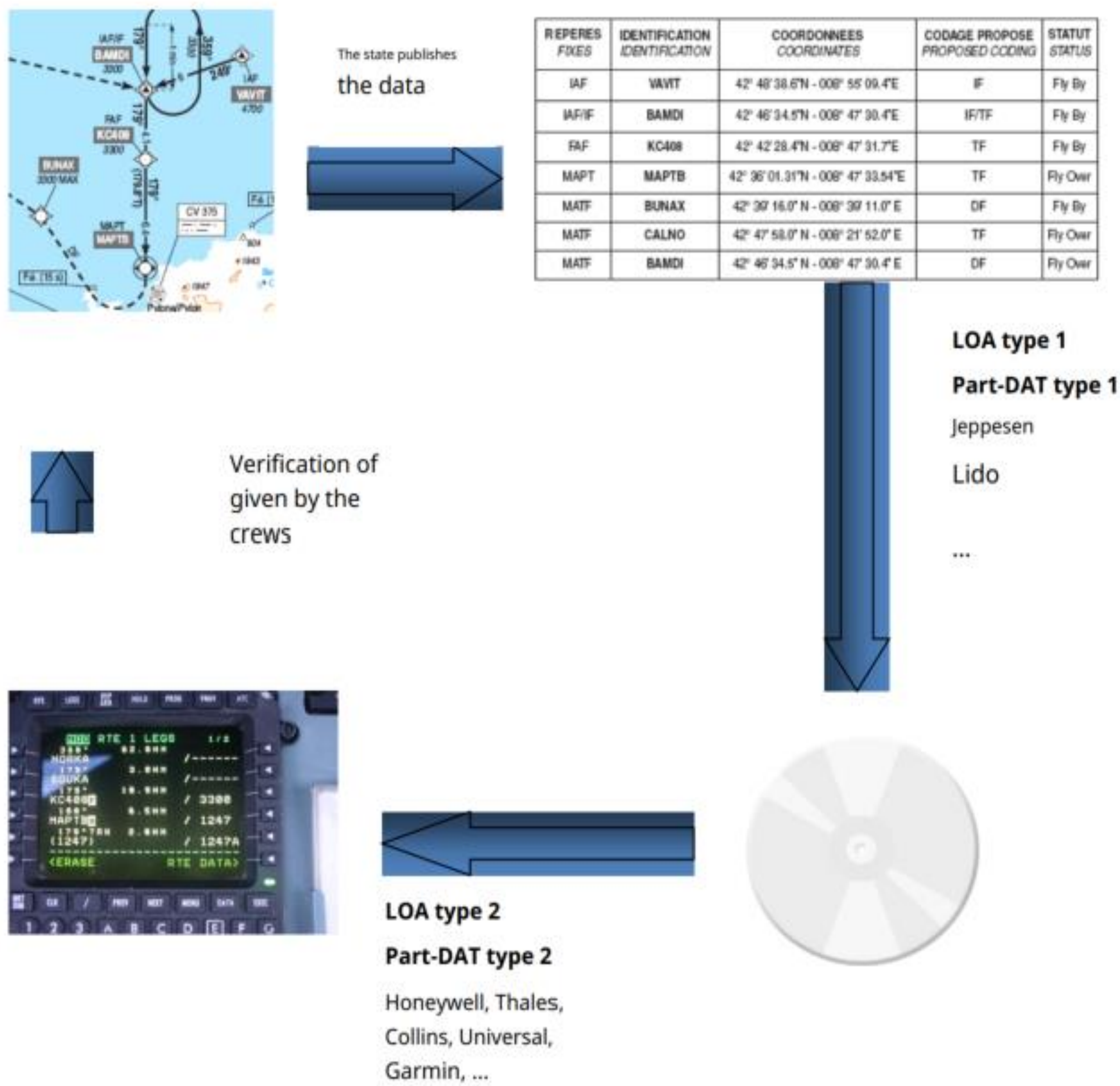
RNP 2 continental	:	M1*
RNP 2 oceanic	:	M2*
RF Leg**	:	Z1*
RFT**	:	Z2
RNP 0.3 (H)	:	R1

A-RNP : P1* (ICAO-plan to be reviewed)

* FAA will introduce in 2022

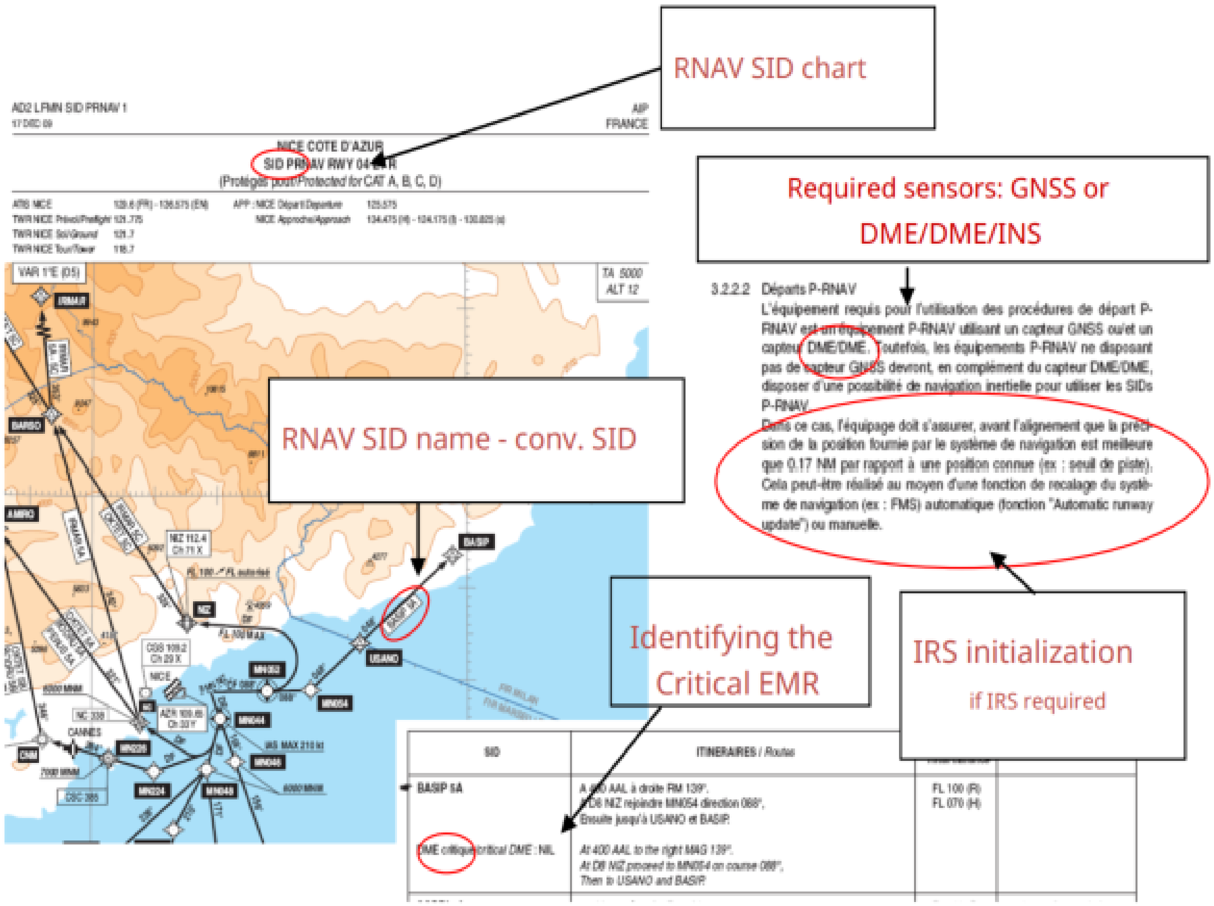
** RF/FRT as independent function and combination with other Nav Spec

Appendix 2 – Navigation Database Cycle



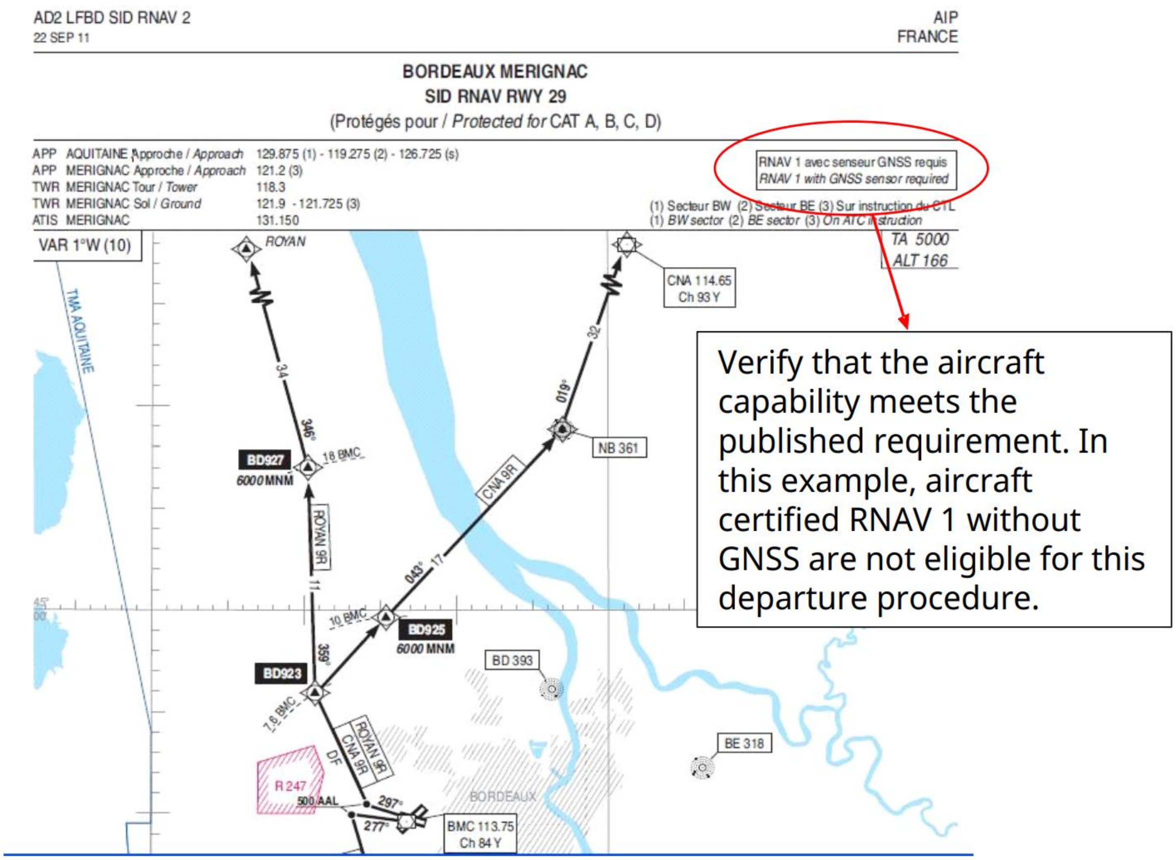
REPERES *FIXES*	IDENTIFICATION *IDENTIFICATION*	COORDONNEES *COORDINATES*	CODAGE PROPOSE *PROPOSED CODING*	STATUT *STATUS*
IAF	VAVIT	42° 48' 38.6"N - 008° 55' 09.4"E	IF	Fly By
IAF/IF	BAMDI	42° 46' 34.5"N - 008° 47' 30.4"E	IF/TF	Fly By
FAF	KC408	42° 42' 28.4"N - 008° 47' 31.7"E	TF	Fly By
MAPT	MAPTB	42° 36' 01.31"N - 008° 47' 33.54"E	TF	Fly Over
MATF	BUNAX	42° 39' 16.0" N - 008° 39' 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

Appendix 3 – Example of RNAV 1 SID



Appendix 4 – Example of Limitation

Flight Crew should know the capability of their aircraft and limitation



Appendix 5 – Conventional approach, overlay and RNP APCH-Terminology

A. **Conventional approach (non-precision)**: example of publication **VOR/DME RWY27**

- The primary means of navigation is the VOR DME associated with the approach
- Performance is possible using the FMS, **provided that** the VOR DME raw data are displayed to check the consistency of the information given by the FMS. In the event of a difference between the FMS flight path and the VOR axis, the latter must be followed or a go-around performed in the event of excessive deviation from the VOR axis.

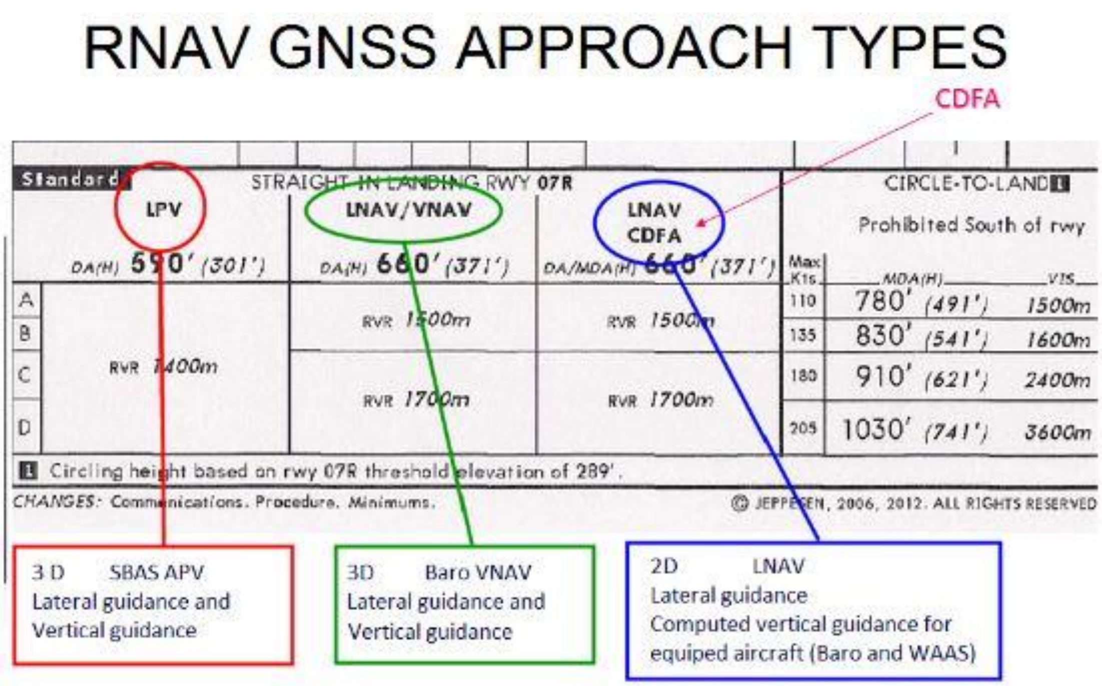
B. **Overlay approaches**: example of publication **VOR/DME or GPS RWY 27** (mainly found in the United States)

- The primary means of navigation is either VOR DME or GNSS.
- To perform them with the RNAV/GNSS system, the operator must comply with PBN requirements (RNP APCH)

C. **RNP APCH approaches**: publication example **RNP RWY 07R**

- The primary means of navigation is GNSS (either GPS + ABAS or GPS+SBAS)
- see the following diagram for the interpretation of the various minima cases (LNAV MDA; LNAV/VNAV DA; LPV DA)

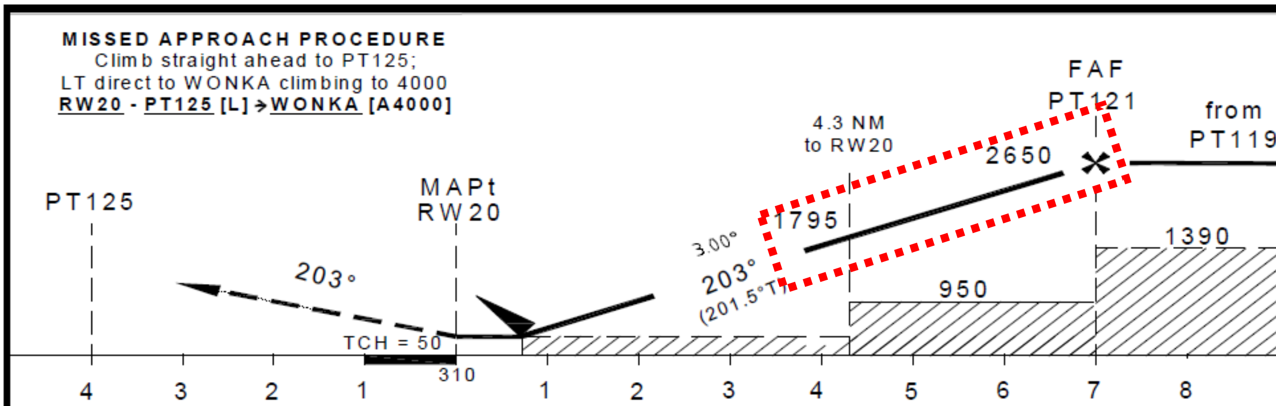
Note: *For more information on **chart title change** click.*



Vertical plane management: CDFA (use of V/S, FPA, VNAV for equipped aircraft)

Appendix 6 – Step Down Fix: SDF

On some charts, descent markers (step down fix - SDF) may be published



OCA (OCH)	A	B	C	D
LNAV/ VNAV	560 (250)	560 (250)	560 (250)	560 (250)
LNAV	610 (300)	610 (300)	610 (300)	610 (300)

DIST THR	1	2	3	4	5	6	7
ALTITUDE	740	1059	1377	1696	2014	2332	2651

The SDF are used to "**eliminate**" an obstacle, when designing the non-precision procedure, to determine the landing minima (in the example above, it enables the minima to be reduced from 950 ft to 250 ft), it is associated with the minimum flight path altitude and its distance from the MAPT (1795 ft and 4.3 Nm respectively in the above example). The pilot must then ensure that he does not descend below this altitude at a distance greater than the MAPT (in the above example the aircraft must not pas below 1795 ft before 4.3 Nm from the MAPT).

SDF are not used for APV BaroVNAV or APV SBAS approaches. However, as these approach procedures are generally published with a non-precision RNP APCH (old terminology: RNAV(GNSS)) LNAV minima approach, some SDF may be published even though LNAV/VNAV and/or LPV minima are already published on the approach chart

Verification of the altitude/distance at passing the SDF is only required for pilots using the LNAV minima.

Attention:

In the absence of harmonization on this subject, according to the publication of the SDF on the chart (naming of the SDF as a waypoint) and according to the navigation system used, these points may end up coded in the navigation database. Consequently, after the FAF, the “next waypoint” could, in certain cases, be the SDF and not the MAPt and the distance displayed to the next waypoint not the distance to the MAPt but the distance to the SDF. Flight crew must be made aware of this problem.

They must be able to identify them on the map and ensure how they are managed by their navigation system.

Appendix 7 – Example of PinS procedure

Approach procedure to **Toulouse Blagnac heliport** v 0.7

AIP
FRANCE

AD2 LFBO IAC

APPROCHE AUX INSTRUMENTS
Instrument approach
CAT H
ALT AD : 499 (18 hPa)

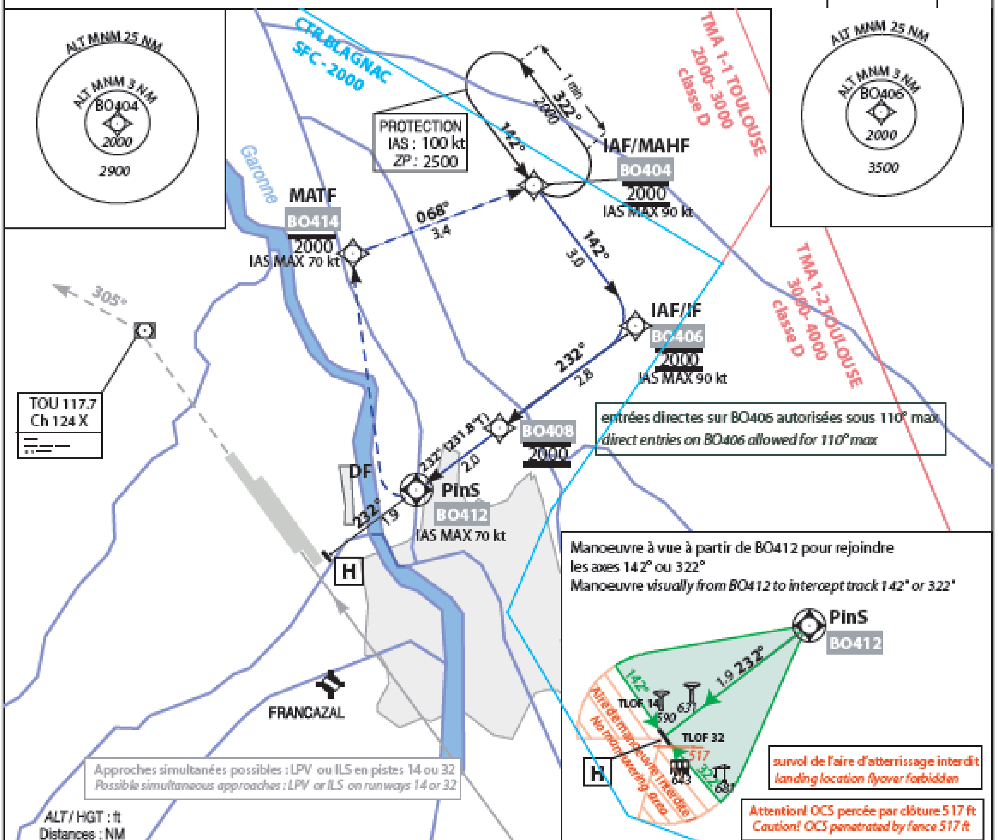
TOULOUSE BLAGNAC HELISTATION

RNAV H (GNSS) 232

ATIS BLAGNAC : 123.125
APP : TOULOUSE Approche / *Approach* 129.3 (1) 125.175 (2) 120.350 124.975(S)
BLAGNAC Approche / *Approach* 121.1
TWR : BLAGNAC Tour / *Tower* 118.1

(1) Secteur Est / *East sector*
(2) Secteur Ouest / *West sector*

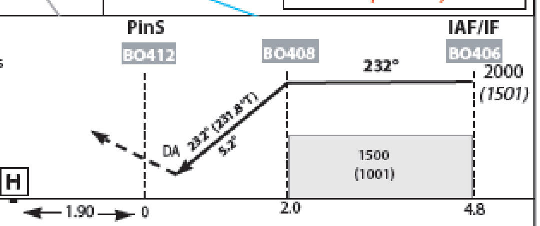
EGNOS	VAR
E23A	0°
FHPCH 155	(10)



TA : 5000

API : A BO412, tourner à **droite** direct vers **BO414**, puis à **droite** vers **BO404** en montée vers **2000** (1501).
Ou suivre les instructions du contrôle.

*Missed APCH : At BO412, turn **right** direct to **BO414**, then turn **right** to **BO404** climbing up to **2000** (1501).*
Or proceed according to ATC.



MNM AD : distances verticales en pieds, VIS en mètres. / *vertical distances in feet, VIS in metres.*

REF HGT : ALT AD

CAT	LPV M-VS *OCH : 469*		DIST PinS BO412		
	DA (H)	VIS	NM	1	2
			ALT	1450	2000
H	970 *(470)*	3600	*(HGT)*	*951*	*1501*

Observations/*Remarks* Panne de guidage GNSS durant l'approche voir AIP ENR 1.5/ *GNSS guidance loss during approach see AIP ENR 1.5*

BO408 - BO412 2.0 NM	60	65	70	75	80	85	90
	2 min 00	1 min 51	1 min 43	1 min 36	1 min 30	1 min 25	1 min 20
VSP (ft/min)	555	600	645	690	740	785	830

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Appendix 8 – PBN Learning objectives

PBN concept (as described in ICAO doc 9613)
PBN principles
List the factors used to define area navigation (RNAV) or required navigation performance (RNP) system performance requirements (accuracy, integrity and continuity).
Explain the concept of continuity
Explain the concept of integrity
State that, unlike conventional navigation, PBN is not sensor-specific.
Explain the difference between raw data and computed data.
PBN components
List the components of PBN as navigational aid (NAVAID) infrastructure, navigation specification and navigation application.
Identify the components from an example
PBN scope
State that in oceanic/remote, en-route and terminal phases of flight, PBN is limited to operations with linear lateral performance requirements and time constraints.
State that in the approach phases of flight, PBN accommodates both linear and angular laterally guided operations, and explain the difference between the two.
Navigation specifications
RNAV and RNP
State the difference between RNAV and RNP in terms of the requirement for on-board performance monitoring and alerting
Navigation functional requirements
List the basic functional requirements of the RNAV and RNP specifications (continuous indication of lateral deviation, distance/bearing to active waypoint, GS or time to active waypoint, navigation data storage and failure indication).
Designation of RNP and RNAV specifications
Interpret X in RNAV X or RNP X as the lateral navigation (LNAV) accuracy (total system error) in nautical miles, which is expected to be achieved at least 95 % of the flight time by the population of aircraft operating within the given airspace, route or procedure.
State that aircraft approved to the more stringent accuracy requirements may not necessarily meet some of the functional requirements of the navigation specification that has a less stringent accuracy requirement.

State that RNAV 10 and RNP 4 are used in the oceanic/remote phase of flight.
State that RNAV 5 is used in the en-route and arrival phases of flight.
State that RNAV 2 and RNP 2 are also used as navigation specifications.
State that RNP 2 is used in the en-route and oceanic/remote phases of flight.
State that RNAV 1 and RNP 1 are used in the arrival and departure phases of flight.
State that required navigation performance approach (RNP APCH) is used in the approach phase of flight.
State that required navigation performance authorisation required approach (RNP AR APCH) is used in the approach phase of flight.
State that RNP 0.3 navigation specification is used in all phases of flight except for oceanic/remote and final approach, primarily for helicopters.
Use of performance-based navigation (PBN)
Airspace Planning
State that navigation performance is one factor used to determine minimum route spacing
Approval
State that the airworthiness approval process assures that each item of the area navigation equipment installed is of a type and design appropriate to its intended function and that the installation functions properly under foreseeable operating conditions
State that some PBN specifications require operational approval
Specific RNAV and RNP system functions
Recognize the definition of an RF leg
Recognize the definition of a fixed radius transition: FRT
Recognize the definition of a fly-by turn and a fly-by turn
Recognize the definition of a holding pattern
Recognize the definition of an “ARINC 424 path terminator”
Recognize the definition of the following path terminators: IF, TF, CF, DF, FA, CA
Recognize the definition of an offset flight path
Data processes
State that the safety of the application is contingent upon the accuracy, resolution and integrity of the data.
State that the accuracy of the data depends upon the processes applied during the data origination.
PBN operations

PBN principles
Recognize the definition of path definition error: PDE
Recognize the definition of flight technical error: FTE
Recognize the definition of navigation system error: NSE
Recognize the definition of total system error: TSE

On-board performance monitoring and alerting (OBPMA)
State that on board performance monitoring and alerting of flight technical error is managed by on board systems or crew procedures.
State that on board performance monitoring and alerting of navigation system error is a requirement of on -board equipment for RNP.
State that on board performance monitoring and alerting of path definition error is managed by gross reasonableness checks of navigation data.
Abnormal situations
State that abnormal and contingency procedures are to be used in case of the loss of PBN capability.
Database management
State that unless otherwise specified in operations documentation or AMC, the navigational database must be valid for the current AIRAC cycle.
Requirements of specific RNAV and RNP specifications
RNAV10
State that RNAV 10 requires that aircraft operating in oceanic and remote areas be equipped with at least two independent and serviceable LRNSs comprising an INS, an IRS FMS or a GNSS,
State that aircraft incorporating dual inertial navigation systems (INS) or inertial reference units (IRU) have a standard time limitation
State that operators may extend their RNAV10 navigation capability time by updating.
RNAV5
State that manual data entry is acceptable for RNAV5
RNAV/RNP1/2
State that pilots must not fly an RNAV/RNP1/2 SID or STAR unless it is retrievable by route name from the on-board navigation database and conforms to the chartered route.

State that the route may subsequently be modified through the insertion (from the database) or deletion of specific waypoints in response to ATC clearances.
State that the manual entry, or creation of new waypoints by manual entry, of latitude and longitude or place/bearing/distance values is not permitted.
RNP4
State that at least two LRNSs, capable of navigating to RNP 4, and listed in the flight manual, must be operational at the en try point of the RNP airspace
RNP APCH
State that pilots must not fly an RNP APCH unless it is retrievable by procedure name from the on-board navigation database and conforms to the chartered procedure.
State that an RNP APCH to LNAV minima is a non-precision instrument approach procedure designed for 2D approach operations
State that an RNP APCH to LNAV/VNAV minima has lateral guidance based on GNSS and vertical guidance based on either SBAS or Baro-VNAV
State that an RNP APCH to LNAV/VNAV minima may only be conducted with vertical guidance certified for the purpose
Explain why an RNP APCH to LNAV/VNAV minima based on Baro-VNAV may only be conducted when the aerodrome temperature is within a promulgated range
State that the correct altimeter setting is critical for the safe conduct of an RNP APCH using Baro-VNAV
State that an RNP APCH to LNAV/VNAV minima is a 3D operation
State that an RNP APCH to LPV minima is a 3D operation
State that RNP APCH to LPV minima requires a FAS datablock
RNP AR APCH
State that RNP AR APCH requires authorization
A-RNP
State that Advanced RNP incorporates the navigation specifications RNAV5, RNAV2, RNAV1, RNP2, RNP1 and RNP APCH
State that Advanced RNP may be associated with other functional elements
PBN Point in Space (PinS) Departure
State that a PinS departure is a departure procedure designed for helicopter only
State that a PinS departure procedure includes either a “proceed VFR” or a “proceed visually” instruction from landing location to IDF
Recognizes the differences between “proceed VFR” and “proceed visually” instruction.

PBN Point in Space (PinS) Approach
State that a PinS approach is an instrument RNP APCH procedure designed for helicopter only and that may be published with LNAV minima or LPV minima
State that a PinS approach procedure includes either a “proceed VFR” or a “proceed visually” instruction from the MAPt to a landing location
Recognizes the differences between “proceed VFR” and “proceed visually” instruction.

Appendix 9 – Correspondence matrix with the documentation reference

	Part CAT	Part NCC	Part NCO	Part SPO
Performance Based navigation	**CAT.OP.MPA.126**	**NCC.OP.116**	**NCO.OP.116**	**SPO.OP.116**
Operational procedures - Normal, abnormal, emergency procedures - MEL - Qualification / Training of pilots - RNAV system airworthiness monitoring	AMC1 CAT.OP.MPA.126	AMC1 NCC.OP.116	AMC1 NCO.OP.116	AMC1 SPO.OP.116
Verifications and Monitoring - During flight preparation - Before leaving - Before arrival and approach - Baro-VNAV Considerations - Accuracy of lateral navigation	AMC2 CAT.OP.MPA.126	AMC2 NCC.OP.116	AMC2 NCO.OP.116	AMC2 SPO.OP.116
Database management	AMC3 CAT.OP.MPA.126	AMC3 NCC.OP.116	AMC3 NCO.OP.116	AMC3 SPO.OP.116
Display and Automations	AMC4 CAT.OP.MPA.126	AMC4 NCC.OP.116	AMC4 NCO.OP.116	AMC4 SPO.OP.116
ATC (Vectoring Radar) clearances	AMC5 CAT.OP.MPA.126	AMC5 NCC.OP.116	AMC5 NCO.OP.116	AMC5 SPO.OP.116
Alerting and Abort (RNP APCH)	AMC6 CAT.OP.MPA.126	AMC6 NCC.OP.116	AMC6 NCO.OP.116	AMC6 SPO.OP.116
Emergency procedures	AMC7 CAT.OP.MPA.126	AMC7 NCC.OP.116	AMC7 NCO.OP.116	AMC7 SPO.OP.116
Operating route and area - RNAV 10: Limitations associated with inertial navigation	AMC1 CAT.OP.MPA.135	AMC8 NCC.OP.116	AMC8 NCO.OP.116	AMC8 SPO.OP.116
Flight preparation	CAT.OP.MPA.175	NCC.GEN.106	NCO.GEN.105	SPO.GEN.107
Flight Preparation for PBN	AMC1 CAT.OP.MPA.175	AMC1 NCC.GEN.106	AMC1 NCO.GEN.105	AMC1 SPO.GEN.107

- NOTAM - RAIM/FDE - IRS limiting (RNAV 10)				
Navigation database - Adapted - Up to date	AMC2 CAT.OP.MPA.175	AMC2 NCC.GEN.106	AMC2 NCO.GEN.105	AMC2 SPO.GEN.107
Destination aerodrome – PBN Operations	CAT.OP.MPA.182 (f) AMC1 and GM1	NCC.OP.153 AMC1	NCO.OP.142 GM1	SPO.OP.152 AMC1
Aircraft PBN eligibility and identification of navigation systems used	GM2 and 3 CAT.IDE.A.345 GM2, 3 CAT.IDE.H.345	GM2 and 3 NCC.IDE.A.250 GM2 and 3 NCC.IDE.H.250	GM2 and 3 NCO.IDE.A.195 GM2 and 3 NCO.IDE.H.195	GM2 and 3 SPO.IDE.A.220 GM2 and 3 SPO.IDE.H.220
Management of navigation databases - Acceptability - Distribution - Error report	CAT.IDE.A.355 CAT.IDE.H.355	NCC.IDE.A.260 NCC.IDE.H.260	NCO.IDE.A.205 NCO.IDE.H.205	SPO.IDE.A.230 SPO.IDE.H.230