Plan PBN France

FRENCH PLAN FOR IMPLEMENTATION OF PERFORMANCE BASED NAVIGATION

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FRENCH PLAN FOR IMPLEMENTATION OF PERFORMANCE BASED NAVIGATION

context and issues

The ICAO resolution

Resolution A37-11 "Performance-based navigation global goals", of which an excerpt is given below, was adopted by the Assembly of the ICAO at its 37th meeting (October 2010):

"The Assembly:

1 *Urges all States to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with the ICAO PBN concept laid down in the Performance-based Navigation (PBN) Manual (Doc 9613);*

2 *Resolves that: states complete a PBN implementation plan as a matter of urgency to achieve:*

1} *implementation of RNAV and RNP operations (where required) for en route and terminal areas according to established timelines and intermediate milestones;* ***and***

2} *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***

3} *implementation of straight-in LNAV-only procedures, as an exception to* 2} *above, for instrument runways at aerodromes where there is no local altimeter setting available and where there are no aircraft suitably equipped for APV operations with a maximum certificated take-off mass of 5 700 kg or more;*

3 *Urges that States include in their PBN implementation plan provisions for implementation of approach procedures with vertical guidance (APV) to all runway ends serving aircraft with a maximum certificated take-off mass of 5 700 kg or more, according to established timelines and intermediate milestones;*

…"

This resolution applies to all ICAO member states. In accordance with France's international commitments, the French Directorate-General for Civil Aviation (Direction Générale de l'Aviation Civile or DGAC) has drawn up and plans to implement the present plan.

Furthermore, the European Commission has recently entrusted Eurocontrol with providing assistance in developing regulations that will define the requirements in terms of navigation performances relating to en route, terminal and approach areas. This regulation (known as IR PBN) aims to harmonise the implementation of ICAO resolution A37-11. The European Commission has entrusted Eurocontrol with a study mandate whose report, accompanied by proposals, will be presented late in May 2013.

1 - PBN signifie en anglais "Performance-Based Navigation"

European and national context

Evolution in air traffic

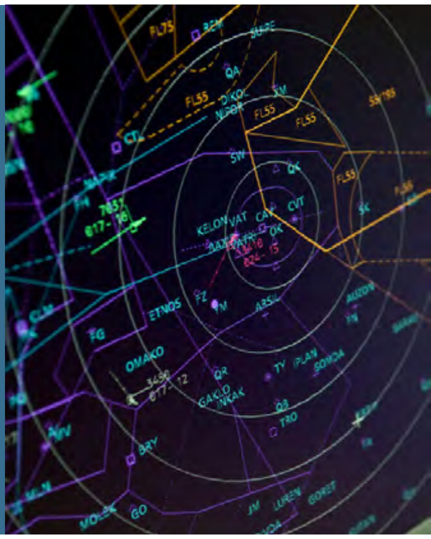
In 2007, the traffic controlled in France came to more than 2.9 million IFR flights a year.
The nature of IFR flights controlled breaks down more or less constantly as follows:

- 45% of overflights;
- 39% of international flights (from or to France);
- 16% of domestic flights.

After three years of diminished growth (economic crisis in 2008/2009 and eruption of the Icelandic volcano), a mean increase in traffic in France by about 16% is predicted between 2010 and 2016[1].

Performance-related issues

European Union legislation relating to air traffic management performance demands improvements in performance, especially in terms of capacity, to reduce the delays imposed on air carriers in the form of traffic regulation, in terms of environmental effectiveness, through the reduction in distances covered, and in terms of economic efficiency, while guaranteeing the same safety level.
These requirements are to be found in Performance Plans established nationally or at the level of Functional Airspace Blocks. In the French Performance Plan and in the FABEC (Functional Airspace Block Europe Central established between France, Germany, Belgium, Luxemburg, the Netherlands and Switzerland) Performance Plan, that are mutually complementary, various indicators and objectives are featured.
In the en route air space, boosting capacity of the air traffic management system involves



making routes denser on the horizontal plane, together with reduced longitudinal spacing between aircraft especially in oceanic areas.
When it comes to environmental effectiveness, the aim is to reduce the impact of civil aviation in terms of emissions of CO_2 and other greenhouse effect gases by diminishing individual aircraft fuel consumption. In this respect, optimising flight paths in terms of fuel consumption also contributes to making operating savings for the airlines.
The idea is also to improve traffic regularity by offering more precise and reliable instrument approach and departure procedures where this can be justified by operational considerations.

The PBN concept's contribution to improving performance

To achieve these objectives, there is a need to fully use the navigation capacities already available with various airborne equipments, so avoiding costly aircraft modifications.
The public authorities must guarantee that the various interests are taken into account and, especially, that the navigation solutions are suited to the different categories of airspace users (major airlines, regional

1 - Source: Eurcontrol Short-and Medium-Term Forecast of Service Units: May 2011 Update aviation, business aviation, aerial work and light aviation), to the infrastructures served, the density of traffic, environmental conditions, etc.

The PBN concept seems in this respect to offer the flexibility and level of requirements needed for this ambitious policy. Among the immediate benefits expected might be mentioned the increase in the number of routes allowing flight altitude and climb and descent profiles to be optimised, a reduction in the length of low altitude flight paths, vertical guidance in final approach becoming widespread, continuous climb and descent profiles and a reduction in operational minima.

This concept is also firmly based in high level research and development programmes, especially within the SESAR (Single European Sky ATM Roadmap) programme, the technological strand of the single European sky.

An appropriate infrastructure

France's rich aeronautical history is evinced in the 500 or more aerodromes in the French metropolis and in overseas territories hosting civil aviation (not including private aerodromes), including a large number of aerodromes with IFR procedures. The scale of the country also justifies regular flights between the regional metropolises and Paris or the major European cities. This network relies on a range of navaids whose significance is illustrated by the following figures:

- **Number of aerodromes** with IFR procedures: 158
- **Ground navaids in metropolitan France and overseas:**
  - VOR: 100
  - DME: 65
  - NDB: 166
  - Cat. I ILS (not including airports dedicated solely to military purposes): 102

Furthermore, major changes have marked the French airport landscape over the last few years.

Since 2005, decentralisation has enabled 150 aerodromes with a local or regional vocation to be transferred from the State to the local authorities and the creation of the first airport companies. Only the aerodromes with a national or international vocation, these being small in number, were

excluded from this decentralisation process, as also those of overseas territories authorities and military ones.

The transfer of competences relates to the development, maintenance and management of the platforms. The authority benefiting from the transfer thus becomes the authority responsible, or the organising authority, for the public airport service within the framework of conventions signed with the State.

Implementation of the PBN concept, mainly based on satellite facilities, must enable an infrastructure that matches their future needs and fulfils the requirement to ensure cost control to be gradually redefined with all the players concerned.

Coordinating national and international activities for implementation of PBN operations in France

Working from the needs and constraints it has identified, the DGAC has developed a Master Plan for implementation of PBN operations in France. This plan, detailed in the following section 3. "MASTER PLAN FOR IMPLEMENTATION OF PBN OPERATIONS IN FRANCE", must allow for the deployment of PBN operations commensurate with France's international commitments and the above mentioned issues.

However, there is a need for the interests of all civil and military aviation stakeholders to be duly taken into consideration through a concerted implementation process. To this purpose, coordination of PBN activities nationally and internationally is proposed as follows.

Coordinating activities nationally

A PBN coordinating committee is set up under DGAC control, to which the following are associated:
- the Ministry of Defence;
- the Union of French Airports (UAF);
- the unions of autonomous airlines (SCARA);
- the National Federation of Commercial Aviation (FNAM);
- the association of representatives of French airlines (BAR);
- a representative scope of the airlines operating in France, whether commercial or non-commercial.

Aircraft manufacturers and equipment manufacturers will also be invited depending on the subject.

This committee aims to offer a forum, so that the direction taken by the DGAC take into account the various issues. It will annually review the actions (past, present and future) regarding the implementation of PBN operations in France.

Thematic meetings will consider specific issues, for instance regarding the deployment of APV or helicopters procedures

And the French Air Navigation Services Provider (DSNA) will present its thoughts, plans and actions for rationalisation of ground navaids to this committee after consultation with the various stakeholders concerned. It will keep it informed of progress on a regular basis.

International activities

The implementation of PBN operations in France will be closely related to the various changes taking place at a European level and the decisions that may be made.

The DGAC will rely on the PBN France Plan in relation to the different European and international bodies. Development of the future "IR PBN" (mandate conferred on Eurocontrol) will in this respect be extremely important (see above).

International cooperation and support in deployment of the PBN strategy

The DGAC is already heavily involved in supporting States that wish to implement PBN operations. Through ENAC, the DGAC takes part in training and information initiatives concerning the design of PBN procedures and their validation. Some of these actions are conducted to the benefit of the ICAO and manufacturers.

French know-how in this field is sufficiently comprehensive to allow other States to develop their national competence by seeking support through training, tutorship or expertise from ENAC or the DGAC in the following fields:

- designing flight procedures;
- data retrieval and validation;
- publication;
- aeronautical information (NOTAM);
- validation;
- management of aeronautical databases.

Master plan for the implementation of PBN operations in France

The following Master Plan is proposed for the implementation of PBN operations in France. It establishes the working hypotheses that need to be taken into account by all the stakeholders and by the coordinating bodies defined above.
It is established over three periods: the short term (2012/2014), medium term (2015/2019) and long term (2020 and afterwards).
For the first two periods, the objectives and means considered to achieve them are specified for the various flight phases.
A specific section for helicopter operations is also proposed.
Note: for further information on the PBN navigation specifications used in the paragraphs below, see Appendix "The PBN Concept".

Short term (2012/2014)

This first phase constitutes a transition starting out from what already exists in terms of ground and airborne facilities. Its main objective is of a dual nature:

- set up working bodies as defined above to validate the working assumptions with all the stakeholders,
- pursue deployment as already commenced of certain PBN operations in the various types of French airspace, in relation to the priorities identified.

The various navigation specifications retained by the DGAC to accompany this transition are, by particular field:

- Oceanic: RNP4 or RNAV10;
- Continental en route: RNAV5;
- Terminal: RNAV1;
- Approach: RNP APCH (and thoughts devoted to RNP AR APCH).

Océanic

For overseas areas inside which ATC services are provided by a French organisation, the use of RNP4 or RNAV10 navigation specifications in the upper airspace will be studied on a case by case basis in relation to needs by the air navigation service provider concerned. An RNAV 10 oceanic airspace already exists in French Polynesia

Continental en route

The network based on the RNAV5 navigation specification (also known as BRNAV in Europe) has been in existence since 1998.

France applies the policy defined within the scope of regional air navigation agreements with the other members of the ICAO region considered, and in Europe, of ECAC[2].

Terminal Area

Gradual implementation of RNAV1

Within the scope of a co-ordinated approach under the aegis of Eurocontrol, France, with the other ECAC member States, has committed to gradual implementation of RNAV1 trajectories (also called PRNAV in Europe) in the Terminal Areas.

Within this framework, certain major French Terminal Areas have been covered by partial re-organisation with the publication by the DGAC of RNAV1 arrival and departure trajectories.

The following elements will be taken into account by the DGAC to establish the publication plan for the years to come:

- need to improve traffic flow;
- need to reduce environmental impact;
- local users' needs and equipments;
- possibility of withdrawing navaids by replacing some conventional trajectories by new RNAV1 ones.

Monitoring within the framework of the PBN coordinating committee set up will allow national feedback.

The airlines will thus be invited, through these working bodies, to monitor the planned deployment of these RNAV1 trajectories and inform the DGAC as soon as possible of the equipment and RNAV 1 approval plan for their fleet.

Operational benefits

As air traffic provisions are remodelled, RNAV1 arrival and departure trajectories will be designed, in particular, to reduce the distance covered and allow for optimised flight profiles on takeoff and landing. Users equipped with RNAV1 capability will thus benefit from time and fuel savings.

These RNAV1 trajectories will also improve efficiency in running climb and continuous descent operations.

Continuous Descent Operations (CDO concept) or Continuous Climb Operations (CCO concept) are flight techniques that allow a flight to be piloted on arrival at and on departure from an aerodrome while avoiding level-offs and reducing engine thrust.

2 - *cf. Navigation application and navaid infrastructure strategy for the ECAC area up to 2020*

The advantages are both environmental and economic:
- raising the crossing heights and reducing aerodynamic drag of aircraft contributes to reducing noise nuisance in the environment close to the runway;
- reducing the power delivered by the engines and the number of engine speed changes allows fuel consumption and emissions of greenhouse effect gases to be significantly reduced.

The DGAC has already published charts allowing for Continuous Descent Operations for the Paris-Orly, Marseille-Provence and Strasbourg-Entzheim aerodromes. New studies are in process for the Paris-Charles-de-Gaulle and Toulouse-Blagnac platforms. However, as these procedures have a direct impact on capacity, they can only be rolled out gradually and will first be subjected to certain limits in use.

Navaids Rationalisation

These re-organisations of the air space will allow for evaluation as to whether maintaining certain NDB or VOR facilities used only for en route operations or in terminal areas may be useful.

However, this rationalisation process must be weighted and the study will be conducted in co-ordination with the airlines concerned.

The ruggedness of the replacement system will also determine the schedule for streamlining the navaids network around a minimum network to be defined and to be upgraded in relation to new satellite navigation resources available and published procedures.

Approach

Gradual implementation of $RNAV_{(GNSS)}$ approaches

The objectives targeted by the DGAC are the publication, by the end of 2016, of an $RNAV_{(GNSS)}$ approach over all controlled IFR aerodrome runway ends, including a certain number with vertical guidance (APV SBAS or APV Baro-VNAV). In this respect, the DGAC's current resources allow for production of about 30 procedures a year, this number being dependent, among other factors, on the complexity of the cases involved.

The following elements will be taken into account by the DGAC, in co-ordination with the operators of the aerodromes concerned, to draw up the publication plan over the years to come:
- local users' needs and equipments;
- need to improve safety (publication of an APV on aerodromes where no procedure with vertical guidance is available);
- possibility of withdrawal of navaids;
- data available (recording of recent obstacles for example);
- level of runway approval and equipment.

Monitoring within the framework of the PBN coordinating committee set up will allow national feedback.

During this phase, the DGAC will also initiate studies for the implementation of RNP AR APCH procedures on controlled IFR aerodromes whose operational environment is complex.

As far as non-controlled IFR aerodromes are concerned, the aerodrome operators concerned will be invited to discuss with the DGAC as to the possible implementation of partnerships that can support a policy of deployment of $RNAV_{(GNSS)}$ procedures suited to their needs and constraints.

Benefits and limitations of APV Baro-VNAV procedures

Nowadays, the main part of the Airbus or Boeing aircraft fleet is equipped with systems capable of performing an APV Baro-VNAV procedure.

However, this relatively costly system is not present over the general aviation and helicopter fleets. It may be present on certain types of aircraft equipping business aviation or regional transport aviation.

APV Baro-VNAV approaches should thus firstly be published on aerodromes receiving commercial traffic, after study of the fleets concerned.

Although these approaches include vertical guidance, the latter does not achieve the levels of accuracy and integrity obtained with systems like ILS. When deployed on runways already equipped with an ILS, these approaches prove to be useful as a backup during periods of failure or scheduled maintenance of the ILS. In the absence of ILS, they will allow safety during the final approach phases to be improved. The Decision Height (DH) associated with this type of final approach can be brought down to a height of 250ft.

Benefits and limitations of APV SBAS procedures

In Europe, SBAS reinforcement has been enabled by bringing into operational service on 2 March 2011 of the Safety-of-Life service ensured by the EGNOS operator (ESSP)[3]. However, the SBAS service is not available in French overseas departments and territories, in New Caledonia and French Polynesia.

EGNOS receivers can be used during all flight phases, but it is in the approach domain that the main operational benefits are to be expected. The first APV SBAS type procedure was published in France at the Pau-Pyrénées airport in March 2011.

APV SBAS procedures represent an alternative resource for aerodromes that are not equipped with ILS. This mainly concerns aerodromes served by business aviation, regional airlines or general aviation. The advantage of implementing these procedures can be measured in terms of improved safety (vertical guidance in final approach) and regularity of service (reduction of operational minima). The Decision Height (DH) associated with this type of final approach currently stands at 250ft.

APV SBAS procedures are also beneficial for certain operations in helicopters when a steep slope is required. Such procedures, requiring no ground infrastructure, can be set up on sites for operations like hospitals or oil rigs.

The main limitation concerning these approaches is the current low level of equipment in fleets. Nevertheless, many aircraft manufacturers and equipment manufacturers are aware of the benefits and are starting studies to propose an SBAS capability. As an example, Airbus is to offer an SBAS capability on its new generation range of aircraft (as from the A350).

3 - *For further information: www.essp-sas.eu*

Navaids Rationalisation

The gradual deployment of RNAV$_{(GNSS)}$ procedures will allow the appropriateness of maintaining certain navigation means used for NDB, VOR or ILS Cat I approaches to be evaluated.
Thus, when an RNAV$_{(GNSS)}$ procedure is published at an aerodrome where a conventional approach procedure based on a NDB or VOR beacon exists, an analysis will be conducted to measure the advantages of maintaining that beacon and the related approach procedure.
Similarly, some ILS Cat I procedures may be replaced by an APV procedure.

Such analyses will be conducted on a case by case basis.
The following elements must be taken into account:
- the environment (obstacles);
- equipment of users flying to and from the aerodrome;
- economic viability (traffic justifying the installation being maintained);
- existence of a Delegation or a Public Service Obligation;
- existence of a special activity (school);
- significance within a national operating network, especially public transport.

Monitoring within the framework of the PBN coordinating committee, informed of the DSNA approach and its results, will allow national feedback.

Helicopters

Helicopter procedures on aerodromes

Some RNAV$_{(GNSS)}$ approach procedures in category H will be published on identified aerodromes in co-ordination with the users concerned.

Medical transportation

Following works between the DGAC and representatives of the helicopter community, a feasibility study for IFR procedures serving hospital heliports and for a network of low altitude IFR routes was launched in 2007. The objective is to improve the level of evacuation by helicopter to hospitals, as well as emergency transport between hospitals for specialised care.

On the basis of works already conducted, the first IFR approach and departure RNAV procedures based on the Point In Space (PinS) concept will be published during this phase for some hospital heliports as well as the first low altitude IFR links.

Studies to implement PinS type procedures with SBAS vertical guidance (more commonly referred to as “PinS LPV”) on these helistations will also be conducted.

Medium term (2015/2019)

This second phase is called on to consolidate the choices and assumptions of the initial phase. The main objective is to reinforce the changes induced by the first phase and improve on the benefits due to PBN trajectories by implementation of more precise navigation specifications.

The various navigation specifications retained by the DGAC to accompany this phase are, by domain:

- Oceanic: RNP4 and RNAV10;
- Continental en route: RNAV5 (and thinking initiated on application of Advanced RNP within the scope of FABEC);
- Terminal: RNAV1 (and thinking initiated on application of Advanced RNP within the scope of FABEC);
- Approach: RNP APCH and RNP AR APCH.

The assumptions used below for the period 2015/2019 will gradually be adjusted in relation to international works.

Oceanic

Looking at overseas areas within which ATC services are provided by a French organisation, the use of RNP4 or RNAV10 navigation specifications in upper airspace will continue to be studied for application on a case by case basis according to needs.

Continental en route

First thinking will be conducted by the DGAC, especially within the scope of FABEC, to analyse the benefits and the appropriateness of using new navigation specifications for the continental en route network, as with the future Advanced RNP, so as to reduce spacing between routes and improve traffic flow.

Terminal Area

Widescale deployment of RNAV 1

In order to improve the flow of traffic through a greater number of independent trajectories, the deployment of RNAV 1 will be made general by the DGAC over terminal areas. The level of equipment of the aircraft concerned should reach the threshold enabling effective operational application in terminal areas in terms of capacity.

This deployment will also be accompanied by enhanced deployment of continuous descent and climb operations.

Finally, as for en route, first thinking will be conducted by the DGAC and its FABEC partners to analyse the benefits and appropriateness of using new navigation specifications for terminal areas, as with the future Advanced RNP. Use of better levels of accuracy but also advanced functionalities (fixed radius turn enabled by the RF function) could indeed allow new design solutions to be offered in TMAs for complex operational environments.

Navaids Rationalisation

Thanks to the widescale deployment of RNAV1 procedures and a growing level of equipment in fleets, this phase should allow for the setting up of a first reduced navaids network used for en route operations or in terminal areas and usable as a potential backup for the source of GNSS positioning.

This network should rely mainly on DME and VOR facilities.

Gradual implementation of this reduced network by the DSNA will be monitored by the PBN coordinating committee in co-ordination with the main airlines concerned.

Approach

Widescale deployment of $\mathrm{RNAV}_{(\mathrm{GNSS})}$ approaches

This phase should conclude implementation of $\mathrm{RNAV}_{(\mathrm{GNSS})}$ procedures over all the runway ends of the controlled IFR aerodromes, with an increasing number of APV type procedures that may be used by a growing community of airlines provided with SBAS or Baro-VNAV capability. Improvement of the EGNOS

system scheduled for 2014 will also allow the Decision Height for certain APV SBAS procedures to be reduced to 200ft, equivalent to the performance of ILS Cat. I.
New RNP AR APCH procedures may be published at controlled IFR aerodromes with complex operating environments.
Finally, on the basis of partnerships that will have been defined between the DGAC and the aerodrome operators concerned, this phase should also see the deployment of $\text{RNAV}_{\text{(GNSS)}}$ procedures emerge on non-controlled IFR aerodromes.

Navaids Rationalisation
As for the case of navaids used for operations en route or in Terminal Areas, this phase should allow a first reduced navaids network used for approach (ILS Cat 1, VOR and NDB) to be implemented, at least as far as controlled IFR aerodromes are concerned.
The gradual setting up of this reduced network by the DSNA will be monitored by the PBN coordinating committee.
Maintaining ILS Cat. III capability at the major French airports will be ensured at least until 2030. In this respect, the DGAC is not for the time being considering the deployment of GBAS Cat. II/III stations before 2020. It is nevertheless pursuing its Research and Development activity in this field. One of the two European test stations in the SESAR programme will be deployed in Toulouse.

Helicopters
Helicopter procedures at aerodromes
The first experimentations for helicopter IFR procedures not interfering with airplane traffic at an aerodrome will be launched by the DGAC.

Medical transportation
According to the feedback and the policy decided on by the authorities concerned (public healthcare, civil protection, etc.), gradual generalisation of IFR approach and departure RNAV procedures based on the Point In Space (PinS) concept may be considered for hospital heliports with an interlinked network of low altitude IFR itineraries.
This deployment may also rely on the future RNP 0.3 navigation specification that is now being discussed at ICAO level and that has been developed mainly to respond to the specific needs of helicopter operations in constraining environments with low flying speeds.

Long term (2020 and after)
This third phase will be characterised by the implementation of the regulation known as “IR PBN” and in particular by the carrying mandate that it will define.
Furthermore, during this phase, the end of deployment of the European constellation (Galileo) associated with version V3 of EGNOS should allow the use of satellite resources alone for aircraft navigation to be consolidated and made thoroughly reliable. This phase should thus allow for a further step in rationalisation of the navaids network defined hitherto (ILS, VOR and DME).

APPENDIX

The PBN concept

Area navigation

Area navigation is a navigation method using an absolute position of the aircraft independently of the location of ground infrastructures.

Determining the position of the aircraft is generally based on the following means:

- autonomous aircraft systems (IRU or INS inertial positioning);
- ground systems (DME/DME or VOR/DME type positioning);
- satellite systems (GNSS positioning).

This navigation relies on an airborne database containing:

- waypoints[4] defined in the WGS 84 terrestrial reference framework (latitude and longitude);
- transitions between these waypoints;
- specific constraints (altitude, speed).

Area navigation is distinct from the method based on ground systems only (so-called “conventional” navigation) and allows more direct and efficient routes to be considered than those that can be obtained by conventional navigation.

A standardisation process for area navigation

The PBN concept relies, by definition, on establishing a certain number of “navigation specifications” associated with each phase of flight and based on the area navigation concept. They express a standardised requirement for navigation performances determined from the capacities of airborne navigation equipment and objectives of safety and improved traffic flow.

The performance based Navigation Manual (commonly referred to as the “PBN Manual”) published in 2008 by the ICAO (Doc 9613) thus defined the “navigation specifications” to be used to implement RNAV operations world-wide.

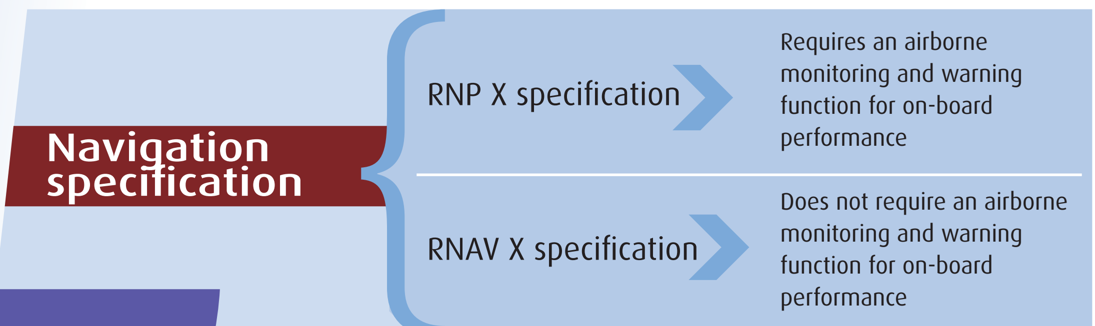
Navigation specifications: RNPx and RNAVy

One of the parameters taken into consideration in defining the navigation specification is integrity, a notion that expresses the level of confidence in the position calculated by the airborne navigation equipment. Systems using satellite data to compute the aircraft’s position are provided with algorithms[5] enabling them to evaluate that degree of confidence. When this is too low, considering the flight phase, the system warns the crew within a standardized lead-time.

Navigation specifications based on satellite positioning are known as RNP. They are generally distinguished from each other by a figure (RNP “x”) expressing the associated accuracy of navigation expressed in nautical miles (NM). In the same way as it manages the degree of confidence, the positioning system estimates the maximum error it commits. The crew is warned as soon as this error exceeds the threshold corresponding to a figure associated with the RNP.

Apart from some exceptions, it is necessary to have certified airborne GNSS equipment to be able to comply with an RNP x type navigation specification.

When the system calculating the aircraft position is not able to determine the latter’s integrity, the navigation specification is called RNAV. This is also associated with a numbered value to represent accuracy in the form of maximum estimated error. This is the case of navigation systems that calculate the aircraft position using just radiobeacons such as DME or VOR-DME. The crew is not, however, warned by the navigation system when it deviates from the desired path due to an erroneous position calculation[6] (absence of “likelihood tests”). These navigation specifications (of the RNAV “x” type) can be used when other means allow potential deviations that are not checked by the navigation system or the crew to be monitored (radar monitoring by a controller for example).



Navigation specifications
for arrival, approach and departure phases

	RNP type specifications		RNAV type specifications	
TERMINAL AREA	Basic RNP1		RNAV2	RNAV1
APPROACH	RNP APCH[7]	RNP AR APCH		

For the phases corresponding to arrival and departure trajectories on an aerodrome, it is planned, according to traffic density, radar equipment and communication resources, to be able to implement either an RNP type (Basic RNP 1) or RNAV type (RNAV 1 or RNAV 2) navigation specification.
However, for the approach phases, only RNP type navigation specifications can be implemented. These are designated by: RNP APCH and RNP AR APCH
The main differences between RNP APCH and RNP AR APCH specifications are as follows:
- the RNP value that can be used on the final approach segment is 0.3 NM for the RNP APCH specification and varies between 0.3 NM and 0.1 NM for the RNP AR APCH specification;
- to conduct a procedure based on the RNP AR APCH specification, the navigation system must integrate a so-called "RF" (Radius to Fix) capability to make turns with constant radius;
- vertical guidance in final approach is systematically associated with a procedure based on the RNP AR APCH specification;
- RNP AR APCH type operations require a special authorisation for aircrafts and pilot crews.

The RNP APCH navigation specification leads to approach procedures published under the name "$RNAV_{(GNSS)}$". This appellation is inherited from previous years with publication of the PBN Manual. It has been kept for (economic and technical) reasons related to aeronautical databases present on board aircraft.

Four types of approach can be published on one $RNAV_{(GNSS)}$ approach map for a runway threshold:
- Non Precision Approach (NPA) identified by the presence of the line of LNAV minima: only lateral guidance based on the ABAS reinforced GNSS signal is provided for final approach;
- Non Precision Approach (NPA) identified by the presence of the line of LP minima: only lateral guidance based on an SBAS reinforced GNSS signal is provided for final approach;
- approach with vertical guidance of barometric type in final (APV Baro-VNAV) identified by the presence of the line of LNAV/VNAV minima: lateral guidance is based on the ABAS reinforced GNSS signal;
- approach with SBAS type vertical guidance in final (APV SBAS) identified by the presence of the line of LPV minima: lateral guidance is based on the SBAS reinforced GNSS signal.


4 - A Waypoint or WP designates a point along a flight path. A section of the path is bounded and defined by the two WPs at either end.
5 - RAIM: Receiver Autonomous Integrity Monitoring
6 - Example incriminated: at high altitude, case of confusion between two DMEs with identical frequencies
7 - The DGAC has recently published a"Guide for RNP APCH operations commonly referred to as $RNAV_{(GNSS)}$" intended for airlines, aeroplane and helicopter pilots and training organisations

Navigation specifications for en route phases

	RNP type specifications	RNAV type specifications		
OCÉANIC	RNP4	RNAV10		
EN ROUTE		RNAV5	RNAV2	RNAV1

These navigation specifications developed for flight en route phases are deliberately not too constraining so that they can be used for all aircraft.
RNAV5 is also known under the name BRNAV in Europe and RNAV1 under the name PRNAV.

Elements concerning future navigation specifications

Thought is currently being devoted at the ICAO to update the PBN Manual.
As the present document is drawn up, the main changes expected are as follows:

- definition of a new navigation specification for continental en route operations under the name RNP 2;
- definition of a new navigation specification called RNP 0.3 applicable to departure, en route and approach operations, developed mainly for helicopter operations;
- definition of a new navigation specification called Advanced RNP whose objective is to be able to bring together various requirements (variable navigation details, capacity to make fixed radius turns, 4D management) answering both to the needs identified for en route, arrival, departure and in approach operations under a single navigation specification;
- introduction, as an option for RNP type navigation specifications, of new functionalities, such as performing fixed radius turns (RF or Radius to Fix) in Terminal Areas and FRT (Fixed Radius Transition) for the en route phase.

ABAS	Airborne Based Augmentation System
APV	Approaches with Vertical guidance
ATM	Air Traffic Management
Cat.	Category
CCO	Continuous Climb Operation
CDO	Continuous Descent Operation
DGAC	Direction Générale de l'Aviation Civile - French Directorate-General for Civil Aviation
DH	Decision Height
DME	Distance Measurement Equipment
EASA	European Aviation Safety Agency
ECAC	European Civil Aviation Conference
EGNOS	European Geostationary Navigation Overlay Service
ENAC	Ecole nationale de l'aviation civile – National School of Civil Aviation
ESSP	European Satellite Services Provider
FAA	Federal Aviation Administration (United States)
FABEC	Functional Airspace Block Europe Central
FRT	Fixed Radius Transition
GNSS	Global Navigation Satellite System
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INS	Inertial Navigation System
IR	Implementing Rules (under meaning of ruling (CE) No. 552/2004)
IRU	Inertial Navigation Unit
NDB	Non-Directional Beacon
NM	Nautical Mile
NOTAM	Notice to Airmen
NPA	Non-Precision Approach
PBN	Performance Based Navigation
PinS	Point in Space
RF	Radius to Fix
RNAV	Area Navigation
RNP	Required Navigation Performance
SBAS	Satellite Based Augmentation System
UAF	Union of French Airports
VOR	Very high frequency Omnidirectional Radio range
WGS	World Geodetic System

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