OBSTACLES IN THE IMPLEMENTATION AND PUBLICATION OF RNP APPROACHES AT EUROPEAN AIRPORTS

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This article analyzes the problems in the implementation of RNP approaches in Europe in accordance with ICAO Resolution A37-11, which is aimed to increase the safety during approach and landing by publishing RNP approach according to PBN Manual. It also analyzes the trends in this area in the Czech Republic.

K e y w o r d s: APV SBAS, LPV, ICAO, RNP APCH, GNSS, approach with vertical guidance

1 INTRODUCTION

In an effort to improve air traffic we must always look for safety. Any system, to be put into operation, must ensure that the current level of safety is maintained or increased, in a better case. As approach and landing are the most dangerous parts of flight, civil aviation organizations (ICAO and EASA in Europe) are investigating the possibilities of increasing safety in this phase of flight using instrument approach procedures. They are divided into:

- precision approach and landing operations,
- approach and landing operations with vertical guidance and
- non-precision approach and landing operations.

Precision approach and landing operations currently uses mostly the ILS system, which exhibits excellent precision guidance on the final approach with landing even in zero visibility. Non-precision approach and landing operations use systems such as NDB, VOR or LOC. The main problems of non-precision approach are less accurate signals of NDB, VOR and the absence of a continuous guidance in the vertical direction. This led to using high MDA (Minimum Descend Altitude).

APV SBAS was renamed and according to a new agreement in PBN terminology it is named "RNP APCH down to LPV". This technology uses GPS SBAS corrected signal to increase the accuracy of positioning. The SBAS navigational signal is used for continuous guidance in the lateral and vertical direction with the Signal in Space performance requirements, 16 meters horizontally and 20m vertically [8].

It is obvious that this method of navigation is in many aspects superior to non-precision approach systems. The main and most important contributions of the approach with vertical guidance are safety, reduction crew's workload and reduction of CFIT (Controlled Flight into Terrain). Also improvements in availability of airport should not be ignored with respect to meteorological conditions and the consequent reduction in the number of failed approaches and diversions due to improvement in RVR and decision height minima.

Table 1 - Terminology - PANS-OPS vs. ICAO PBN Manual (Doc9613)

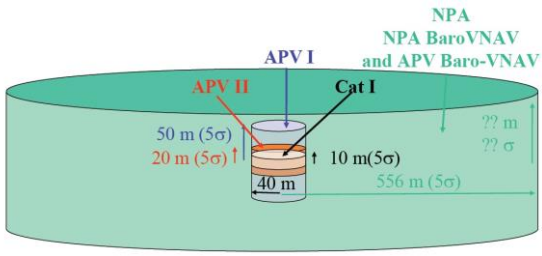
PANS-OPS Terminology	PBN Terminology	Chart Minima
NPA	RNP APCH down to	LNAV (MDA)
APV Baro-VNAV	RNP APCH down to	LNAV/VNAV (DA)
-	RNP APCH down to	LP (MDA)
APV SBAS	RNP APCH down to	LPV (DA)

2 PROBLEMS IN RNP APPROACH IMPLEMENTATION

The process of introduction the most accurate RNP Approach (LPV minima) faces some barriers briefly described in this chapter.

2.1 Availability of signal

EGNOS Open Service, the European SBAS signal, used to improve the accuracy of GPS is available since 1 October 2009, but the EGNOS SoL (Safety of Life) in service only since 2 March 2011 [5]. Nevertheless, it is the EGNOS SoL, which provides the necessary signal integrity



essential for use in critical applications such as aircraft navigation.

Fig. 1 - ICAO GNSS signal performance requirements [4]

2.2. Avionics Certification

Because of the relative novelty of this solution there are just few regulations published so far, particularly in Europe. Whereas in the USA, approaches based on SBAS have been in operation for 8 years.

Different dates of implementation of SBAS systems largely determine the different approaches to certification of aircraft using RNP approach. As the USA was the first in the World with SBAS system, they are focused on aircraft operators. Each operator can fit the necessary avionics in his aircraft and have it certified. The seven-year delay in Europe caused orientation towards manufacturer, who can certify his product - SBAS avionics and its installation into the aircraft. The advantage of this approach is that at the time of the certification process completion it will be automatically applicable to all aircraft of that type.

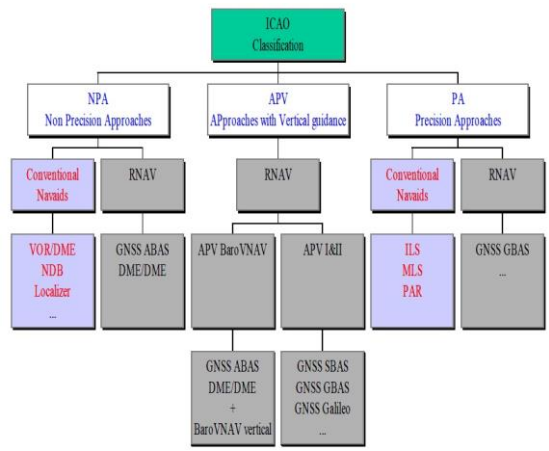
However, delay with EGNOS certification still persists. AMC 20-28 addressing the question of fulfilling the requirements for avionics certification for LP and LPV minima is still only at the design stage. For now, the certification is all in EASA authority, which should delegate these competences to the NAA (National Aviation Authorities).

2.3 Requirements for Airports

The ICAO resolution A37-11 [1] requires that 100% of instrument RWY ends have to introduce LNAV / VNAV or LPV minima RNP approach until the end of 2016 (with key milestones of 30% in 2010 and 70% in 2014). There is one exception - runway is allowed to have only LNAV minima if it is used by aircraft with MTOW equal or less than 5700 kg.

It is the delay in the implementation of SoL signal that caused the failure to implement LPV approach at European airports in the 30% of runways thresholds, as stated in the 2010 milestone. The only option at that time was the introduction of LNAV / VNAV minima (barometric vertical guidance). The regulations for this minima are already created and new major manufacturer's aircrafts (Airbus, Boeing) are LNAV / VNAV certified.

Fig. 2 - ICAO approach classification and related systems [4]



Also, certification of airports has not yet been clarified. To avoid the need to create entirely new requirements for approach with vertical guidance (APV), the requirements are divided into two parts depending on decision height [2]:

- For DH (decision height) under 300 feet - the same requirements as for precision approach (PA) are applied, such as approach lighting system for Category I.
- For DH of 300 feet and above - the same requirements as for non-precision approach (NPA) are applied.

2.4 Costs associated with the introduction of RNP approaches at airports

In order to determine these costs, we have identified four different directions of the introduction of RNP approaches. They are

distinguished by initial state of radio navigation equipment at the airport and the target RNP implementation for the airport project. These different directions are:

1. Airports that have ILS (precision approach) and introducing LPV because they want to attract smaller aircraft operators.
2. Airports that have NDB, VOR, LOC (non-precision approach), introducing LPV, which may allow them approaches to Category I accuracy.
3. VFR airports, introducing LPV to allow for airport growth and development.
4. Airports that have ILS, VOR, NDB, or LOC, introducing LNAV / VNAV, due to the simplicity of the solution and the possibility of immediate use.

Airports that belong to the first group have all necessary infrastructures and a change from precision approach to RNP approach is only about the development and publication of the new approach procedures.

For smaller regional airports (group 2) the situation is more complex. Beside from issues mentioned above, one of the main obstacles is lack of funding for airport development. Airports do not have the resources to build ILS, which would enable them to ensure further development by allowing operation under low visibility conditions. Therefore, the transition from the NPA to RNP APCH appears to be a convenient alternative. At the same airport, operators can minimize the cost required, if they choose the correct decision height (see section 1.3), because they only need to design the new approach procedure and then certified it.

VFR airports are the most discriminated ones because of the necessity of changing the status from VFR to IFR and build e.g. approach lighting system. Still, there is no investment in the construction of radio navigation equipment, which suggests that RNP approaches are less financially demanding than approaches based on ILS or VOR. However, the ICAO resolution A37-11 does not take into account the VFR airports. This may change after 2016, but the current priority is IFR airports. Until then, the introduction of RNP approaches at VFR airports is up to operators decision.

Last but not least, classifiable obstacle is potential competition between airports. Therefore, smaller airports must decide whether to join the business with the big players to gain a competitive advantage by using EGNOS signal years before big airports.

3 RNP APCH IMPLEMENTATION IN EUROPE

Since March 2011 so far, EGNOS signal has been used only at eight airports [7]. Most states within Europe have implemented LNAV / VNAV approach while it was the only possible solution to meet first ICAO milestone in 2010 (par. 2.3.). In Germany, they have introduced a nationwide LNAV / VNAV, which has similar signal accuracy like non-precision approach. On the other hand, if they implement LPV, they would gain far more accurate signal than the baro-VNAV (vertical guidance based on barometric altitude measurements) and therefore benefit from lower DH.

Fig. 3 - LPV procedures published in Europe in first year since EGNOS Sol introduction [7]

Within the already published LPV's we want to pinpoint two important things:

- The introduction has always been a joint effort of the aircraft operators, airports and ANSPs (Air Navigation Service Providers) - other airports should choose this direction too,

because the costs arising from the introduction of this approach will start returning immediately.

- LPV approach was implemented largely at regional airports - the reasons are that a large international airport, served by operators with large fleets of aircraft
  - have sufficient infrastructure consisting of ILS and prefer to introduce LNAV / VNAV, due to the simplicity and the possibility of immediate use by the aircraft operators and
  - LPV approach's main advantage of lower DH could not be applicable (is not needed) due to the presence of ILS - this reason may fade away over time with SBAS avionics extending into a large number of aircraft and with significant decreasing of ANSP' navigation costs.

4 RNP APCH IN THE CZECH REPUBLIC

In the Czech Republic, as in other parts of Europe, the RNP APPCH down to LNAV / VNAV has been implemented to meet the ICAO Resolution milestone for 2010. These were published at runways thresholds 06, 13, 24, 31 at Praha-Ruzyne airport (LKPR) and runways 10, 28 at Brno-Turany airport (LKTB) [3]. Currently impulses come for the introduction of LNAV / VNAV approach in Karlovy Vary.

Airport		THRs	ILS CAT/THR	LNAV/VNAV THR		
LKTB		2	I / 1	2		
LKKB		2	I / 1	N/A		
LKKU		2	I / 1	N/A		
LKKV		2	N/A	N/A		
LKMT		2	II / 1	N/A		
LKPD		2	LOC / 1 II / 1	N/A		
LKPR		4	I / 3 IIIb / 1	4	ICAO resolution A37-11	
LKVO		2	LOC /1	N/A	2012	2014 – 70%
IFR	8	18		6	33,33%	12,6
In ČR	92				30% was enough	Will it be done?

Table 2 - RNP Approach implementation process in Czech Republic

5 CONCLUSION

EGNOS SoL signal is fully available to aviation and the availability of basic technology is not a limiting factor to the implementation of RNP approaches already for one year. During this period, however, only 8 airports used it.

There must be published RNP approach to thirteen instrumental runways thresholds in the Czech Republic by 2014. Six of them have already introduced LNAV / VNAV. On the seven remaining thresholds (i.e. a minimum of 4 airports) we suggest to implement LPV. This could be achieved with the first from four proposed directions of development applications (see Chap. 1.4) e.g. at the airport LKKU and LKMT or applications of the second direction at LKVO. Nowadays there is a strong demand from aircraft operators for application the 4th direction at LKKV. Just to be complete, we propose airports being able to fulfill the third direction: LKCS, LKHK, LKMH, LKLN, LKPO and LKPM.

It is pity that nobody has pressed forward the question of LPV approach introduction in the Czech Republic for a long time and everyone (airports, ANSP, aircraft operators, Civil Aviation Authority, the state) has been waited to see what happens. Nowadays, in this question, ŘLP (Czech ANSP) is the most active. However, other stakeholders must join as soon as possible so as to ensure that the Czech aviation would not "crawl far behind the rest of Europe."

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