How to implement EGNOS based approaches in an airport
EGNOS, the European SBAS system, has been designed to answer the aviation sector’s needs for secure landing approaches with the EGNOS SoL (Safety of Life) service.

Traditionally, the aviation industry relies on expensive (in terms of both CAPEX and OPEX) ground radio navigation systems such as ILS (Instrument Landing System) for landing operations in airports. Today, EGNOS represents a real alternative.

The SoL service guarantees the position given by the receiver within certain limits imposed by aviation standards. Moreover, an integrity function, which consists of a warning message sent to the pilot within six seconds of a malfunction, is included in the system. It can therefore permit IFR (Instrument Flight Rules) operations and improve airport productivity and safety in landing, especially in non ILS equipped airports through the so called LPV procedures (lateral approach with vertical guidance), also known as APV procedures (approach procedure with vertical guidance).

In LPV and APV, the aircrew is provided with geometric guidance along the final approach path. By reducing the decision height and improving lateral guidance, EGNOS may reduce the number of delays, diversions and cancellations at airports while improving airport turnover and profitability, and avoiding the installation of expensive land based navigation aids. In order to enable such operations:

- The EGNOS Service Provider (ESSP) has been certified as an Air Navigation Service Provider (ANSP) under the Single European Sky service provision regulation. This certificate has been issued by the French DGAC to ESSP in accordance with a larger group of participants under the lead of the DGAC, composed by the main European ANSPs (Italy, Germany, Spain and the United Kingdom);
- The aircraft needs to be equipped with a certified SBAS receiver and be approved for the operations;
- The airport’s runways procedures must be certified as well in order to perform SBAS based APV approaches.

The following process describes what is needed to obtain the airworthiness certification and the operational approval for each single runway of the airport.

**Process flow**

**High Level Process**
The national Air Navigation Service Providers (ANSP) in the EGNOS service area may proceed with the publication of SBAS precision approach procedures (LPV) based on EGNOS. In order to proceed in the publication it is compulsory for the ANSP of the Member State to have established a working agreement with ESSP as required by the Single European Sky (SES) regulation.

EUROCONTROL is enabling the use of EGNOS by defining its concept of operations, supporting procedures design, conducting a generic safety assessment, supporting EASA in the development of airworthiness and operational approval material, developing a NOTAM (notice to air men) tool and managing pre-operational projects.

Pre-Implementation phase
When an ANSP decides to define and publish a national Required Navigation Performance Approach (RNP APCH) procedure it is important to consider all stakeholders involved and to create an implementation team. This group should be multi-disciplinary to ensure all necessary aspects of the implementation of RNP APCH procedure are recognised and adequately addressed, whether they are intended for a State, a group of airports or a single airport.

The Required Navigation Performance Approaches are the necessary guidelines that should be designed to allow aircrafts to approach and land. The RNP APCH sets the approach modality and instrumentation required; moreover minimum altitude levels (minima) are set according to the kind of instruments used during landing. Depending on arrangements in different States, the implementation of RNP APCH operations may be initiated by different stakeholders such as the aviation authorities, ANSPs, or airport operators.
The first task that the team should address when implementing RNP APCH on a national basis should be a survey of the airport/s. To begin the process, one or two candidate airports should be identified to conduct pilot implementations. This will make the processes easier before rolling out the implementation on a wider scale.

It is important to remember that implementation at non-instrument runways are not currently envisaged by the international standards. First implementations should therefore take place at runways that already have an instrument approach procedure.

When choosing the airports, the capabilities of each one needs to be assessed to determine whether RNP APCH operations can be implemented there. If this is not possible, the modifications needed to allow the implementation must be assessed.

The assessment should address the following features:

- **Aerodrome infrastructure** should be assessed in order to determine the type and number of runways available at the chosen airports. Only instrument runways should be considered. Depending on the type of instrument runway (non-precision or precision), the minimal that can be set will be substantially different: for RNP APCH to LNAV/VNAV or LPV
  - to a non-precision approach runway the DA/H shall not be below 300 ft;

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1 ICAO: PB TF5, WP05 – Guidance Material RNP APCH
to a precision approach runway the DA/H below 300 ft. is permitted

**Meteorological data** should be collected, such as wind statistics, cloud ceiling and RVR per runway end. This data can be used to estimate the benefits in terms of improved runway accessibility. Moreover, the lower minima that RNP APCH permits will improve runway use in the case of bad weather

**GNSS infrastructure:** All RNP APCH operations rely on the use of GPS and as such the ANSP needs to agree to the use of GPS. APV procedures in the European sky rely on the use of GPS augmented by EGNOS. In the case of an airport or the ANSP wanting to implement RNP APCH to LPV minima, an assessment of the EGNOS coverage should be made to confirm its suitability at the specific aerodrome

**Other infrastructures**
- RNP APCH operations are based upon GNSS. Nevertheless, some conventional Navigational Aid Systems (NAVAIDS) such as VOR, DME and NDB may be used in the missed approach segment of RNP APCH procedures and also as a backup. Therefore, it is suggested to perform an evaluation of the availability of the current NAVAIDS
- The availability of a local QNH (barometric pressure adjusted to sea level) is a requirement for the publication of RNP APCH to LNAV/VNAV minima. Remote QNH is acceptable in the case of RNP APCH to LNAV and LPV minima (TBC). This is accounted for in the procedure design

The implementation team should perform an initial airspace assessment to evaluate the impact that the deployment of RNP APCH would have on traffic (departure and arrival routes) and consequently on the aircraft operators:

**Survey of traffic characteristics:** RNP APCH implementation is driven by the categories of airspace users:
- RNP APCH operations based on barometric vertical guidance are more likely to be used as a first option by commercial air transport operators whose aircraft are more likely to be equipped with barometric VNAV functions
- RNP APCH operations based on SBAS (EGNOS) may be the best option for regional operators and general aviation where BaroVNAV capability is usually not available.

Therefore the type of air traffic flying in and out of an airport will influence the decision to implement one or another type of APV approach.
If there is not a predominant type of traffic in the airport it is recommended to implement an RNP APCH procedure with all three minima lines (LNAV, LNAV/VNAV and LPV). The cost of designing and publishing a unique procedure covering all three types of minima will be lower than the cost of producing three different procedures (one for each minima).

It is important to forecast future traffic trends when deciding which procedure should be implemented at a new airport.

- **Survey of Aircraft Operators:** the implementation of RNP APCH procedures should be conducted in close co-operation with aircraft operators. It is critical to understand the current and projected RNAV capabilities onboard the aircraft operating at the chosen airport; a survey is the best option when gathering this kind of information from aircraft operators.

**RNP APCH procedure implementation**

Since APV approaches based on SBAS are relatively new operations, the procedure criteria for RNP APCH operations are still in an interlocutory phase, therefore limited expertise and previous examples are currently available.

The following documents are a useful repository of criteria and other information for RNP APCH procedure designing:

- **ICAO Doc 8168 (PANS OPS) Volume II, Part III and ICAO Annex 10 Volume I** include requirements for RNAV training for procedure designers with focus on final approach segment.
- **ICAO Doc 9905:** this manual is intended for aircraft operators and procedure designers of instrument approaches, based on required navigation performance (RNP) using area navigation (RNAV) avionics systems.
- **AMC 20-26 (Airworthiness Approval and Operational Criteria for RNP AR - Authorizations Required - Operations)** provides means of compliance for applicants for the approval to conduct RNP AR Operations and the applicable criteria to obtain the approval.
- **AMC 20-27 (Airworthiness Approval and Operational Criteria for RNP APPROACH Operations including APV BARO/VNAV operations)** provides an acceptable mean that can be used to obtain airworthiness approval of an RNAV system based on a GNSS standalone receiver or multisensory system including at least one GNSS sensor in order to conduct RNP APCH operations.
AMC 20-28 (Airworthiness Approval and Operational Criteria for RNAV GNSS approach operation to LPV minima using SBAS) provides an acceptable mean that can be used to obtain airworthiness approval of an RNAV system based on a GNSS standalone receiver or multisensory system including at least one GNSS sensor in order to conduct RNP APCH operations.

Another important point to consider concerning the publication of LPV procedures is that a unique SBAS channel number is needed for every published approach. As far as today, as agreed with ICAO and FAA, EUROCONTROL is the key authority in Europe for SBAS channel allocation. The procedure designer (ANSP or the airport) is expected to request the appropriate organisation for a channel number.

Before implementing any change in the ATM/ANS, according to EC Regulations 2096/2005 and 1315/2007, it is essential that risk assessment and mitigation activities are carried out.

Moreover, a performance and safety monitoring system and procedures including an occurrence reporting mechanism should be defined.

RNP APCH procedures may be published either as backup for precision approaches or as primary approaches. When they are published as a primary approach, conventional navigation aids may be also be added in the segment of missed approach as a means of mitigation in case of GNSS outage.

RNP APCH Procedure validation
Once designed, the procedure should undergo a validation process. The objective of procedure validation is to verify all obstacle and navigation data and assess the practical viability of the procedure. Validation is composed of two elements: ground validation and flight validation.

Ground validation is compulsory and must always be undertaken. If, when undertaking ground validation, it is possible to verify the accuracy and integrity of all obstacles and data considered in the procedure and any other factors normally considered in the flight validation, then the flight validation could be considered unnecessary.

Recent experience from some States, which have already undergone recent implementation projects, highlights the importance of good project management. It is critical to always consider a reasonable amount of time for unexpected events, especially those related to procedure coding.
Summing up, a good implementation plan should at least include the following elements:

- the objective behind the particular RNP APCH implementation, the strategic target and the expected benefits
- the airspace users chosen as target (air transport, business, general aviation etc.)
- a deployment strategy which clearly indicates which type of RNP APCH (LNAV, LNAV/VNAV and/or LPV) will be implemented and for which runway end. It is strongly recommended to implement all three types of RNP APCH procedures at the same time for a particular runway.

**Introduction into service**
At this stage, predefined safety and performance monitoring tools and procedures need to be put in place, including an occurrence reporting mechanism.

**Post-implementation activities**
Once the “RNP APCH to LPV Minima” operations are introduced, their performance should be monitored. It is critical to collect data on success and failure rate of RNP APCH. If unacceptable events occur, the procedures should be removed and the whole operational procedure should be reviewed in order to put in place the most suitable modifications.

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2 ICAO: PB TF5, WP05 – Guidance Material RNP APCH
**FIGURE 2 – PROCESS FOR APV/EGNOS PROCEDURES DESIGN & PUBLISHING**

**PROCESS 1**

Identify Navigation specification for implementation

- **Step 1** Agree Operational Requirement
- **Step 2** Create PBN Implementation Team
- **Step 3** Agree Objectives, Scope and Time Scales
- **Step 4** Analyse Reference Scenario
- **Step 5** Safety and Performance Criteria
- **Step 6** CNS/ATM Assumptions, Enablers & Constraints
- **Step 7** Design Routes and Holds
- **Step 8** Initial Procedures Design

**Activity 1** The background to RNP APCH Implementation

**Activity 2** Create the implementation project team

**Activity 3** Agree project objectives, scope and timescale

**Activity 4** Survey of candidate airports

**Activity 5** Assessment of airport capabilities

**Activity 6** Survey of traffic characteristics and aircraft operators

**Activity 7** ATC and AIS services

**Activity 8** Check RNP and RNP required for each scenario

**Activity 9** Navigational and non-navigational aspects

**Activity 10** Confirm ICAO navigation specification

**Activity 11** Benefits and costs for RNP APCH Implementation

**Activity 12** Choose which type of RNP APCH to implement

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3 ICAO: PB TF5, WP05 – Guidance Material RNP APCH
EUROPEAN OUTLOOK
In Europe several countries are already upgrading their airport infrastructure to support EGNOS APV landings.

- **France**: DSNA, the French ANSP has defined a program to provide EGNOS based procedures on the entire France IFR runways. Three airports have published their APV/SBAS procedures in 2011 and over 60 are planned for in 2012.

- **Switzerland**: As of November 17th 2011, new EGNOS based approach procedures can be used at two Swiss airports, Les Eplatures and St. Gallen-Altenrhein. The publication of these two new procedures has been made possible by the signature of an EGNOS Working Agreement (EWA) between the Swiss Air Navigation Service Provider “Skyguide” and the EGNOS Service provider, ESSP.

- **UK**: On Dec 15 a procedure was published at Alderney in the Channel Islands, introducing the first commercial operation using EGNOS.

- **Spain, Italy, Poland, Turkey**: In these states, trials of European projects have been performed. Several approaches procedures and landing were performed by aircraft relying on EGNOS systems.

RELATED DOCUMENTS
1. ICAO Publications
2. ICAO Flight Procedures
3. EASA AMC 20-26 - Airworthiness Approval and Operational Criteria for RNP Authorisation Required (RNP AR) Operations

MORE INFORMATION
What is SBAS?
Aviation
How to use EGNOS / SBAS in my airport or airplane
Aviation case study: Landing with satellite navigation

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\(^3\) Eurocontrol
\(^5\) Ibidem
\(^6\) Eurocontrol