INDUSTRIAL RESEARCH

SESAR Solution PJ.01-06 SPR-INTEROP/OSED V3 - Part I

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PJ.01 EAD

ENHANCED ARRIVALS AND DEPARTURES

This SPR-INTEROP/OSED is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 731864 under European Union's Horizon 2020 research and innovation programme.

Abstract

This deliverable aims at providing guidance about the SESAR2020 Solution PJ.01-06 and its implementation. It records information to be added on top of what already exists. This information is about environment, operational scenarios, safety & performance requirements, regulation and any other information that will allow the community to understand the state of the art at the end of SESAR2020.

The work performed in this Solution was to assess and validate the benefit of integrating piloting supporting enhanced vision systems that can increase the safety and reliability of rotorcraft operations through dedicated symbology for specific rotorcraft operations, especially during arrival and departure operations including visual segments. The objective was to assess and validate the benefit of having SBAS based navigation for advanced Point-In-Space RNP approaches and departures to/from FATO by defining the corresponding rotorcraft specific contingency procedures in case of loss of communication. As the SBAS navigation, the corresponding contingency procedures was needed to comply as much as possible with profiles adapted to exploit rotorcraft performances, reduce fuel consumption and noise emission. The pilot was supported during these operations by dedicated symbology presented on a Head Mounted Display system.]

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The SPR/INTEROP-OSED Template includes the following parts:

- ***SPR/INTEROP-OSED Template – Part I (this volume)***
- SPR/INTEROP-OSED Template – Part II Safety Assessment Report (SAR)
- SPR/INTEROP – OSED Template – Part IV Human Performance Assessment Report (HPAR)
- SPR/INTEROP – OSED Template – Part V Performance Assessment Report (PAR)

According to SJU guideline, Part IIIA and IIIB of the Security Assessment Report is replaced by high level cyber security requirements, based on a self-assessment of the project members of Solution PJ.01-06.

The Cyber Security Requirements are mentioned in Chapter 4 of this Part I SPR-INTEROP/OSED document.

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1 Executive Summary

This document is the Operational Services and Environment Description (SPR-INTEROP/OSED) for solution PJ.01-06 relating to PJ01 Enhanced Arrival and Departures of the SESAR operational concept.

The SESAR 2020 Maturity Report states "Project 4.10 validated Solution PJ.01-06 (standard PinS approaches are considered as part of the baseline) covering OI step AOM-0104 to a final maturity of V3. Evidence gathered during V2 and V3 validation activities covered the "Standard PinS" concept with straight segments based on RNP APCH specifications (DOC 8168 requirements). The development of "Advanced PinS" with curved procedures in the initial, intermediate, final and missed approach segments, using possible new enablers (e.g. SVS, EVS) have been addressed in this solution.

In fact the OI step AOM-0104 has been split into two: The part that has achieved end of V3 (standards PinS approaches, AOM-0104-A) is in fact a gap in the baseline and should be captured there. The new OI step AOM-0104-B which is covered here should be only V2 since the full scope of the OI step was not addressed (new technologies and advanced PinS approaches).

The work performed in this Solution was to assess and validate the benefit of integrating piloting support of both enhanced vision systems that increased the safety and reliability of rotorcraft operations through dedicated symbology for specific rotorcraft operations including visual segments and automated flight path following by autopilot system. The objective was to assess and validate the benefit of having SBAS based navigation for advanced Point-In-Space RNP approaches and departures to/from FATO by defining the corresponding rotorcraft specific contingency procedures in case of loss of communication. As the SBAS navigation, the corresponding contingency procedures was needed to comply as much as possible with profiles adapted to exploit rotorcraft performances, reduce fuel consumption and noise emission. The pilot was supported during these operations by dedicated symbology presented on a Head Mounted Display system.

This solution should impact the following KPAs:

- Safety should be improved thanks to the use of an HMD during PinS operations (facilitating the VFR-to-IFR transitions during take-off and IFR-to-VFR transitions during approach, which are usually high-workload phases for the rotorcraft pilot), and through the introduction of GNSS contingency loss procedures (in particular in the final curved approach of a PinS procedure where the pilot shall maintaining safe separation during visual segment)
- Human performance for manual piloting should be improved thanks to the use of an HMD during PinS (pilot's eyes-out conformal display of the flight trajectory allows improved performance to follow precisely the allocated trajectory). This KPA isn't impacted for automated flight path following by autopilot system (reducing workload down to performance observation)
- Efficiency should benefit from advanced PinS procedures, in detail fuel consumption and respectively noise reduction as well as time consumption.
- Access and equity for rotorcraft users should improve through smaller footprints of advanced PinS connecting more FATOs to IFR routes.

2 Introduction

2.1 Purpose of the document

The Initial Operational Service and Environment Definition (SPR-INTEROP/OSED) describes the operational concept, the operational services, and their environment, use cases and is used as the basis for assessing and establishing operational, safety, performance and interoperability requirements for the related systems detailed in the Safety and Performance Requirements (SPR) and INTEROP sections of this document. The SPR-INTEROP/OSEDidentifies the operational services supported by several entities within the ATM community and includes the operational expectations of the related systems. When at full V3 maturity, this SPR-INTEROP/OSED Part 1 document will provide the requirements specification, covering functional, non-functional and interface requirements related to SESAR Solution PJ.01-06.

2.2 Scope

This is the SPR-INTEROP/OSED for Solution PJ.01-06 for the V3 phase, addressing Operational Improvement AOM-0104 B.

The requirements contained herein will cover safety, performance, operational aspects as well as the interoperability aspects related to specific technology to support the SESAR Solution PJ.01-06 Enhanced Rotorcraft and GA operations in the TMA.

2.3 Intended readership

The members of solutions within PJ.01 EAD - Enhanced Arrival & Departures.

The members of the following solutions within S2020:

PJ.02-05	Independent Rotorcraft operations at the airport

2.4 Background

Within SESAR 1, the project 04.10 was focused on contributing mainly to the Operational Focus Area (OFA) 02.01.01 “Optimised 2D/3D Routes” and reports its results concerning the “Standard PinS” concept. In fact, in the framework of Sesar 1 project P04.10, all the validation activities have covered the Standard PinS concept with straight segments based on RNP APCH specifications (DOC 8168 requirements) being also connected and consistent with the following projects:

- 05.06.03: Approach Procedure with Vertical Guidance (APV)
- 09.09: RNP Transition to xLS (x=G, I or M)
- 09.10: Approach with Vertical Guidance APV
- 09.49: Batch 1, 2 & 3 - Consolidated functional airborne architecture

The P04.10 activities have achieved fully V3 maturity level for the "Standard PinS" only. The development of "Advanced PinS" concept (e.g. curved procedures in the initial, intermediate, and missed approach segments) using possible new enablers such as SVS, EVS, etc, have been addressed in these SESAR 2020 activities.

2.5 Structure of the document

The document follows the following structure:

- **Section 1 Executive Summary:** provides a summary of the key information and elements contained in the document.
- **Section 2 Introduction:** presents the purpose and scope of the document, the intended audience, the structure of the document and the main acronyms and terminology used throughout the document.
- **Section 3 Operational Service and Environment Definition:** provides the summary of the solution validated by PJ.01-06, the Detailed Operational Environment which reports the operational characteristics, the roles and responsibilities of the actors and constraints, and also the Detailed Operating Method which contains the previous operating method, the new operating method and the difference between them.
- **Section 4 Safety, Performance and Interoperability Requirements (SPR-INTEROP):** lists the SPR and INTEROP requirements, which are covering safety, performance, operational aspects as well as the interoperability aspects related to a specific technology to support this SESAR Solution.
- **Section 5 References and Applicable Documents:** lists applicable and reference documents.
- **Appendix A Cost and Benefit Mechanisms:** contains the Benefit and cost Mechanisms, showing how the SESAR Solution elements contribute (positively or negatively) to the delivery of performance benefits and the costs.

2.6 Glossary of terms

Term	Definition	Source of the definition
ADS-B Application	A means by which aircraft, can automatically transmit and/or receive data such as identification, position and additional data, as appropriate, in a broadcast mode via a data link.	ICAO Documentation
Airspace Management	Airspace Management is the process by which airspace options are selected and applied to meet the needs of the ATM community.	ICAO 9854
	Airspace Management is integrated with Demand and Capacity Balancing activities and aims to define, in an inclusive, synchronised and flexible way, an optimised airspace configuration that is	P07.02 P04.02

	relevant for local, sub-regional and regional level activity to meet users requirements in line with relevant performance metrics. Airspace Management primary objective is to optimise the use of available airspace, in response to the users demands, by dynamic time-sharing and, at times, by the segregation of airspace among various airspace users on the basis of short-term needs. It aims at defining and refining, in a synchronised and a flexible way, the most optimum airspace configuration at local, sub-regional and regional levels in a given airspace volume and within a particular timeframe, to meet users requirements while ensuring the most performance of the European Network and avoiding as much as possible any disruption. Airspace Management in conjunction with AFUA is an enabler to improve civil-military co-operation and to increase capacity for the benefit of all users.	
Airspace Configuration:	Is a pre-defined and coordinated organisation of ATS routes of the ARN and /or terminal routes and their associated airspace structures, including airspace reservations/restrictions (ARES), if appropriate, and ATC sectorisation.	OSED 07.05.02 AFUA Step 1 V3 for V4
Airspace Restriction	A defined volume of airspace within which, variously, activities dangerous to the flight of aircraft may be conducted at specified times (a "danger area"); or such airspace situated above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions (a restricted area); or airspace situated above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited (a prohibited area).	OSED 07.05.02 Step 1 V" for V4
Airspace Structure	A specific volume of airspace designed to ensure the safe and optimal operation of aircraft.	OSED 07.05.02 Step 1 AFUA V3 for V4
Area navigation (RNAV)	Method of navigation which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained	ICAO Doc 9613 PBN Manual

	aids, or a combination of these. Note.— Area navigation includes performance-based navigation as well as other RNAV operations that do not meet the definition of performance-based navigation	
Approach procedure with vertical guidance (APV)	An instrument procedure which utilizes lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations. These procedures are enabled by GNSS and Baro VNAV or by SBAS. (PBN).	ICAO Documentation
APV Baro-VNAV	RNP APCH down to LNAV/VNAV minima.	ICAO Documentation
APV SBAS	RNP APCH down to LPV minima.	ICAO Documentation
Baro-VNAV	Barometric vertical navigation (Baro-VNAV) is a navigation system that presents to the pilot computed vertical guidance referenced to a specified vertical path angle (VPA), nominally 3°. The computer-resolved vertical guidance is based on barometric altitude and is specified as a VPA from reference datum height (RDH). (PANS OPS).	ICAO Documentation
CDFA – Continuous Descent Final Approach	Continuous Descent Final Approach is a technique for flying the final approach segment of an NPA as a continuous descent. The technique is consistent with stabilized approach procedures and has no level-off. A CDFA starts from an altitude/height at or above the FAF and proceeds to an altitude/height approximately 50 feet (15 meters) above the landing runway threshold or to a point where the flare manoeuvre should begin for the type of aircraft being flown. This definition is harmonized with the ICAO and the European Aviation Safety Agency (EASA).	ICAO Documentation
Flight intent	The future aircraft trajectory expressed as a 4-D profile up to the destination (taking into account of aircraft performance, weather, terrain, and ATM service constraints). It is calculated and “owned” by the aircraft flight management system, and agreed by the Pilot.	ICAO Doc 9854
	In the SESAR Context, Flight Intent corresponds to the "agreed data of RB/MT” : the waypoints of the routes and associated altitude, possible time	WP B04.02 CONOPS Step 1

	and/or speed constraints agreed between ATM actors.	
Final Approach Point/Fix (FAP/FAF)	In PANS-OPS ICAO Doc 8168 VOL I, FAF is described as the beginning of the final approach segment of an Non-Precision Approach, and FAP is described as the beginning of the final approach segment of a Precision Approach. Moreover, PANS-OPS ICAO Doc 8168 VOL II states that the APV segment of an APV SBAS procedure starts at the Final Approach Point. So, within this document, since only APV SBAS procedures are considered, the beginning of the final approach segment is called the FAP	PANS-OPS ICAO Doc 8168 VOL I
Final Approach Segment (FAS) Data Block	The APV database for SBAS includes a FAS Data Block. The FAS Data Block information is protected with high integrity using a cyclic redundancy check (CRC).	PANS OPS
GNSS – Global Navigation Satellite System	A worldwide position and time determination system that includes one or more satellite constellations, aircraft receivers and system integrity monitoring, augmented as necessary to support the required navigation performance for the intended operation.	ICAO Annex 10
Low Level IFR Routes	Low Level IFR Routes dedicated to Rotorcraft integration in dense / constrained airspace. Rotorcraft altitude (2000-4000 ft.) specific Low Level IFR routes are designed and optimised based on route network using RNP-1 / RNP-0.3. The integration in dense and constraint airspace TMA is due to rotorcraft peculiar flight characteristics and type of operation conducted, such as: • Helicopters not pressurised: the Maximum allowed altitude: FL100 (e.g 3000 m) • Most helicopters have no de-icing capability • Risk of encountering icing conditions increases with altitude. Typically standard IFR FL are often too high • Health of on-board patients during medical flights • Recommended altitude for patients in critical condition: not more than 3000 ft.	ICAO Documentation

	AGL • Safety and environment • Visual flight at very low height (500 ft. or sometimes less) to stay below clouds in marginal weather conditions is frequent accident cause and impacts environment (e.g noise footprint)	
LNAV, LNAV/VNAV, LPV	Are different levels of approach service and are used to distinguish the various minima lines on the RNAV (GNSS) chart. The minima line to be used depends on the aircraft capability and approval.	ICAO Documentation
LNAV/VNAV	The minima line based on Baro-VNAV system performances that can be used by aircraft approved according to AMC 20-27 or equivalent. LNAV/VNAV minima can also be used by SBAS capable aircraft according to CM-AS-002 Issue 2.	ICAO Documentation
LPV (Localiser Performance with Vertical Guidance)	The minima-line based on SBAS performances that can be used by aircraft approved according to AMC 20-28 or equivalent	ICAO Documentation
MAPt	Missed Approach Point	ICAO Documentation
Navigation specification	A navigation specification is a set of aircraft and aircrew requirements needed to support a navigation application within a defined airspace concept. The navigation specification: • defines the performance required by the navigation system, • prescribes the performance requirements in terms of accuracy, integrity, continuity and availability for proposed operations in a particular Airspace, • also describes how these performance requirements are to be achieved i.e. which navigation functionalities are required to achieve the prescribed performance and associated requirements related to pilot knowledge and training and operational approval. A Performance-Based Navigation Specification is	ICAO Doc 9613 and WP B04.02 CONOPS Step 1

	either a RNAV specification or a RNP specification. RNAV specifies a required accuracy whilst RNP specifies, in addition to a required accuracy, an aircraft system alert in case of deviation, with the pilot responsible to remain the aircraft within the RNP accuracy; it allows reducing ATC buffer with the controller still responsible for the separation against traffic.	
Network Management	Network Management is an integrated activity with the aim of ensuring optimised Network Operations and ATM service provision meeting the Network performance targets., The Network Management Function is executed at all levels (Regional, Sub-regional and Local) throughout all planning and execution phases, involving, as appropriate, the adequate actors (NM, FM, LTM…)	P07.02 P04.02
Performance-Based Navigation (PBN)	Area navigation based on performance requirements for aircraft operating along an ATS route, on an instrument approach procedure or in a designated airspace. *Note.— Performance requirements are expressed in navigation specifications in terms of accuracy, integrity,* *continuity, availability and functionality needed for the proposed operation in the context of a particular airspace concept*	ICAO DOC 9613 PBN Manual
PinS	Point in Space is an RNP approach procedure designed for helicopters only that includes both a visual and an instrument segment Two types of PinS are defined in this document. These terms are not listed in ICAO PANS-OPS. - standard PinS: straight in PinS RNP APCH down to LPV or LNAV minima - advanced PinS: PinS RNP APCH down to LPV or LNAV minima with a course change at the FAF or a RF-leg ending at the FAF	ICAO PANS OPS 8168
RNAV specification	See Navigation specification	ICAO PBN Manual

		9613
RNP specification	See Navigation specification	ICAO PBN Manual 9613
RNP operations	Aircraft operations using an RNP system for RNP navigation applications	ICAO Doc 9613 PBN Manual
RNP route	An ATS route established for the use of aircraft adhering to a prescribed RNP navigation specification	ICAO Doc 9613 PBN Manual
RF – Radius to Fix path terminator	– An ARINC 424 specification that defines a specific fixed-radius curved path in a terminal procedure. An RF leg is defined by the arc centre fix, the arc initial fix, the arc ending fix and the turn direction.	ICAO Doc 9613
RNAV Approach	This is a generic name for any kind of approach that is designed to be flown using the on-board area navigation system. It uses waypoints to describe the path to be flown instead of headings and radials to/from ground-based navigation aids. RNP APCH navigation specification is synonym of the RNAV approach.	ICAO Doc 9613
RNP APCH – RNP approach	The RNP navigation specification that applies to approach applications based on GNSS. As illustrated in figure 2 below, there are four types of RNP APCH that are flown to different minima lines published on the same RNAV(GNSS) approach chart.	ICAO Doc 9613
SBAS – Satellite-Based Augmentation System	A wide coverage augmentation system in which the user receives augmentation information from a satellite-based transmitter. (ICAO Annex 10). The European SBAS is called EGNOS, the US version is called WAAS and there are also other SBASs in different regions of the World such as GAGAN in India and MSAS in Japan	ICAO Doc 9613

Table 1: Glossary of terms

2.7 List of Acronyms

Acronym	Definition
AGL	Above Ground Level

APCH	Approach
APP	Approach
APV	Approach Procedure with Vertical Guidance
ATM	Air Traffic Management
CNS	Communication Navigation and Surveillance
CONOPS	Concept of Operations
CR	Change Request
DPIFR	Dual Pilot IFR
EATMA	European ATM Architecture
E-ATMS	European Air Traffic Management System
FATO	Final Approach and Takeoff
FL	Flight Level
FND	Flight and Navigation Display
GBAS	Ground Based Augmentation System
GND	Ground
HDD	Head Down Display
HUD	Head Up Display
HPAR	Human Performance Assessment Report
ICAO	International Civil Aviation Organization
IDF	Initial Departure Fix
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
ILS	Instrument Landing System
INTEROP	Interoperability Requirements
KPA	Key Performance Area
MCA	Minimum Crossing Altitude
OFA	Operational Focus Area
OI	Operational Improvement
OPAR	Operational Performance Assessment Report
OSED	Operational Service and Environment Definition
PAR	Performance Assessment Report
PIRM	Programme Information Reference Model

QoS	Quality of Service
RF	Radius to Fix
RNP	Required Navigation Performance
SAC	Safety Criteria
SAR	Safety Assessment Report
SecAR	Security Assessment Report
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SPIFR	Single Pilot IFR
SPR	Safety and Performance Requirements
SWIM	System Wide Information Model
TLOF	Touchdown and Liftoff Area
TS	Technical Specification
VAPP	Vertical Approach
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

Table 2: List of acronyms

3 Operational Service and Environment Definition

3.1 SESAR Solution PJ01-06: a summary

SESAR Solution ID	SESAR Solution Title	OI Steps ID ref. (coming from EATMA)	OI Steps Title (coming from EATMA)	OI Step Coverage
PJ01-06	Enhanced Rotorcraft and GA operations in the TMA	AOM-0104-B	Advanced Point-in-Space RNP approaches and departures	**Fully**

Table 3: SESAR Solution PJ.01-06 Scope and related OI steps

High Level CONOPS Requirement ID	High Level CONOPS Requirement	Reference to relevant CONOPS Sections e.g. Operational Scenario applicable to the SESAR Solution
S01-06-HLOR-01	Design of rotorcraft procedures to allow increased access (under IFR) to/from VFR FATOs, based on new procedure design requirements (e.g. curved segments, lower RNP) and SBAS guided Point-in-Space (PinS) approaches and departures	Section 4.2.2. of Transition ConOps SESAR 2020 document

Table 4: Link to CONOPS

AOM-0104-B Advanced Point-in-Space RNP approaches and departures

Description:

Advanced (e.g. curved) SBAS/GBAS guided Point-in-Space RNP approaches towards landing locations and Point-in-Space departures from landing locations are created with connections to/from Low Level IFR route network. The curved segment of the advanced PinS can be placed in the initial, intermediate or missed approach segment.

SBAS and its associated procedures like LPV providing approved vertical guidance or LNAV supported by SBAS providing advisory vertical guidance is, together with LNAV based purely on GNSS, considered the prime technological enablers in Solution PJ.01-06. On the one hand the Solution focuses on the use of a HMD to facilitate both curves in approach and departure procedures as well as the transition from instrument flying to aviating and navigating via external visual cues. On the other hand the solution verifies that autopilot systems are capable to perform advanced PinS procedures. In case a three-dimensional path that the pilot has to follow (or to be more precise, a corridor in which the pilot has to stay) is displayed in the HMD, such a three-dimensional path has to give both lateral and vertical guidance, of course. Continuous vertical guidance in a three-dimensional corridor can only be achieved via Baro-VNAV, SBAS, GBAS or ILS. GBAS and ILS only for final, straight in approaches. Only a few rotorcraft are equipped with Baro-VNAV and to the knowledge of the consortium no rotorcraft at all is currently equipped with GBAS, whereas ILS and SBAS are more common. ILSs are usually found at runways, where they are used by fixed-wing aircraft as well. As Solution PJ.01-06 focuses on FATOs, only SBAS remains as a well-established technology that is found aboard many rotorcraft and does not need any ground infrastructure, hence can be implemented at FATOs at much lower costs than ILS, if a three-dimensional corridor is required. For other applications of an HMD, GNSS alone is a sufficient technological enabler that still provides continuous two-dimensional guidance for arbitrary designable routes. SBAS can also provide vertical guidance outside the final approach segment.

Rationale:

Rotorcraft procedures are designed to allow IFR access to VFR FATOs, in particular when weather conditions are adverse. The advanced PinS procedures can contribute to a reduced noise footprint and improved access to VFR FATOs. There is also a contribution to safety (fewer VFR approaches in marginal VMC, IFR approaches with vertical guidance). This also enables the implementation of SNI operations at VFR FATOs located at airports (AO-0316). Head Mounted Display provides “eyes-out” information that can be used to facilitate safe flying along the PinS procedure (take-off and approach), facilitating the transition from IFR instrument phase to visual phase (for “proceed visually” PinS) or from IFR to VFR (for “proceed VFR” PinS) and vice-versa, and reducing pilot workload.

The following required and optional enablers are currently linked to PJ.01-06 (Dataset 19)

Required Enablers:

- A/C-01 Enhanced positioning for LPV/RNP based on Single Frequency SBAS
- A/C-04 Flight management and guidance for improved lateral navigation in approach via RNP
- A/C-04a Flight management and guidance for Advanced RNP
- A/C-04b Flight management and guidance for RNP 0.3 (Category H(rotorcraft)) in all phases of flight, except final approach and initial missed approach
- A/C-06 Flight management and guidance for LPV approach based on SBAS
- A/C-07 Flight management and guidance for RNP transition to ILS/GLS/LPV
- PRO-250 Rotorcraft procedures for IFR access to VFR FATOs

Optional Enablers:

- A/C-02a Enhanced positioning using GBAS single frequency
- A/C-05a APV Barometric VNAV
- A/C-23a Synthetic vision in low visibility conditions
- A/C-83 Head Mounted Display for PinS procedures

- BTNAV-0502 Update of Minimum Performance Standard for Enhanced Vision (EV)
- BTNAV-0503 New ARP standard for Transport Category Airplane HUD/SVS systems
- BTNAV-0504 Update of Minimum Performance Standard for Airborne Synthetic Vision (SV)
- CTE-N07a GBAS Cat I based on Single-Constellation / Single-Frequency GNSS (GPS L1)
- STD-067 DO-253D "GBAS MOPS" & DO-246E "GBAS ICD"
- STD-043 EN 303 084, Ground Based Augmentation System (GBAS) VHF ground-air Data Broadcast (VDB)
- STD-025 Harmonisation Specifications on Ground Based Augmentation System Ground Equipment to Support Category I Operations
- REG-0009 AMC for Curved Approaches
- REG-HNA-03 AMC for LPV approach based on SBAS
- REG-HNA-04 AMC for RNP transition to ILS/GLS/LPV

The following Change Requests related to required and optional enablers have been initiated:

- A/C-04 Flight management and guidance for improved lateral navigation in approach via RNP → removed
- A/C-04a Flight management and guidance for Advanced RNP → removed
- A/C-05a APV Barometric VNAV → changed to a required enabler
- PRO-251 ATC Procedure to handle SNI IFR rotorcraft operations using PinS → new optional enabler

3.1.1 Deviations with respect to the SESAR Solution(s) definition

No deviations.

3.2 Detailed Operational Environment

3.2.1 Operational Characteristics

3.2.1.1 Airspace characteristics

The operations considered have been conducted within controlled and uncontrolled airspaces.

Two kinds of operations have been considered within PJ01-06: take-off and approach.

In controlled airspace:

- For take-off, the operations started in the CTR airspace and end in the TMA airspace.
- For the approach, the operations started in TMA airspace and continued into the CTR airspace until the landing.

In uncontrolled airspace (airspace class F and airspace class G):

- For take-off, the operations started in uncontrolled airspace and ended in controlled airspace.

- For the approach, the operations started in controlled airspace and ended in uncontrolled airspace until the landing.

Most of today's VFR FATOs, hospitals, helipads are situated in uncontrolled airspace.

Performance Based Navigation (PBN) procedures RNP APCH and RNP 0.3 are used to systemise/optimise route structures and procedures, and specifically using RNP 0.3 specification dedicated for helicopters and slow moving aircraft, associated to the LP/LPV landing minima capabilities.

RNP 0.3 specification is applicable for all phases of flight, including en-route, terminal, departure, arrival, and offshore rotorcraft operations, except for the final approach segment. According to AC 20-138D, SBAS services (EGNOS, WAAS…) capable equipage must be on board the IFR certified helicopter to perform RNP 0.3 operations. It is not acceptable to use non augmented GPS or DME/DME or IRU for rotorcraft ENROUTE RNP 0.3 operations. This capability, as RNP APCH, does not require any ground infrastructure, allowing on board Positioning, Monitoring and Alerting, thus reducing traffic control in the nominal cases.

Performance Based Navigation (PBN) procedures RNP APCH and RNP 0.3 allows ANSP to design a low level IFR network (departure, route, approach) dedicated for helicopter and non-interfering with the aircraft with a reduced air traffic management.

The helicopter community identified a need for a specification that would enable some operations like:

a) Reduced protected areas, potentially enabling separation from fixed wing traffic to allow simultaneous non-interfering operations in dense terminal airspace;
b) Low-level routes in obstacle-rich environments reducing exposure to icing environments;
c) Seamless transition from en-route to terminal route;
d) More efficient terminal routing in an obstacle-rich or noise-sensitive terminal environment, specifically in consideration of helicopter emergency service IFR operations between hospitals;
e) Transitions to helicopter point-in-space approaches and for helicopter departures; and
f) Helicopter en-route operations are limited by range and speed

The impact on the fleet is limited because a large majority of IFR helicopters are already equipped with advanced systems required for IFR certification. Then the gap to introduce the large use of this new specification is mainly a training issue for operators and the network design for the NATS.

3.2.1.1.1 Point in Space Approach Flight Operational Procedure

A PinS Approach is an instrument procedure based on the RNP navigation specification (ICAO Doc 9613, Ed 4), flown to a "point in space" (the Missed Approach Point). It may be published with LNAV minima or LPV minima, as documented in PANS OPS ICAO doc 8168. The PinS approach procedure includes either a "proceed visually" instruction or a "proceed VFR" instruction from the MAPt to the heliport or landing location. Any visual flight manoeuvre beyond the MAPt (i.e. in the visual segment) has to be assumed with adequate visual conditions to see and avoid obstacles by pilots.

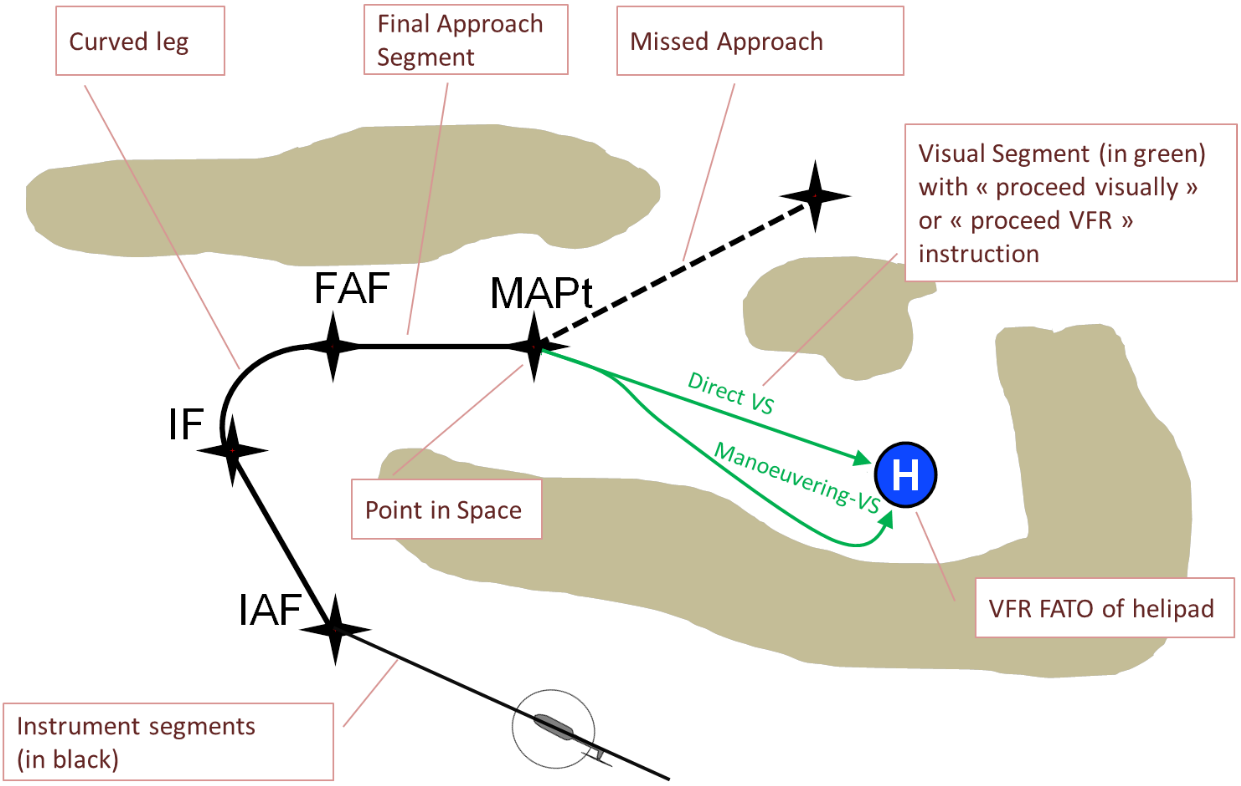


Figure 1: Advanced PinS approach example

PinS IFR approaches are adapted to helicopter operations (i.e. limited airspeed down to 70kts, high descent and climb gradient capabilities). PinS IFR approaches may be developed for heliports that do not support the design standards as defined by ICAO Annex 14 for an IFR heliport. These approaches may require some design flexibility, like: a turn at FAF, an RF leg, a turning missed approach. According to ICAP PANS-OPS 8168 Vol 2 the SBAS approach procedure can contain a RF leg ending at the FAF.
These instrument procedures are RNP APCH type, as defined in ICAO PBN Doc 9613 Ed4, and do not necessitate an “Authorization Required”.

The following description is extracted from ICAO PANS OPS Doc 8168 Ed 6 dated 13/11/2014, Vol 1, Part I, Section 8, Chapter 5.

- **PinS approach procedure with “Proceed Visually” instruction**

A PinS approach with a “proceed visually” instruction is an instrument approach procedure developed for a heliport or a landing location. The PinS instrument approach segment delivers the helicopter to a MAPt. A visual segment connects the MAPt to the heliport or landing location. If the heliport or landing location or visual references associated with it can be acquired visually prior to the MAPt, the pilot proceed visually to the heliport or landing location otherwise a missed approach shall be executed.

IFR obstacle clearance areas are not applied to the visual segment of the approach and missed approach protection is not provided between the MAPt and the heliport or landing location.

ICAO requires the length of a “Proceed Visually” segment to not exceed 3 Km (1.62 NM).

The visual segment can be a direct visual segment or a manoeuvring visual segment:

- Direct-VS (Direct Visual Segment): Once the pilot has visually acquired the landing location references (before the MAPt), he flies straight to the landing zone.
- Manoeuvring-VS (Manoeuvring Visual Segment): For some approach procedures, because of obstacles or to align on the centre line of the approach surface, a visual manoeuvring is necessary. In this case, airspeed shall be lower than 50 kts.

➢ **PinS approach procedure with a "proceed VFR" instruction**

A PinS approach with a "proceed VFR" instruction is an instrument approach procedure developed for heliport or landing locations where VFR FATOs do not meet ICAO Annex 14 criteria or where PinS "proceed visually" criteria cannot be met. The PinS instrument approach delivers the helicopter to a MAPt. Prior to or at the MAPt, the pilot determines whether the published minimum visibility or the visibility required by State regulations (whichever is higher), is available to safely transition from IFR to VFR flight and decides to proceed VFR or to execute a missed approach. The pilot shall be in VMC conditions before or at MAPt and then fly under VFR beyond this point. The pilot is responsible to see and avoid obstacles, and shall cancel IFR at the MAPt.

No protection from the PinS to the FATO is defined: the pilot is responsible to see and avoid obstacles.

Within PJ01-06 project, we focussed on PinS approach procedures containing a curved leg (RF leg) on the initial or intermediate segment. These PinS procedures are called "Advanced PinS procedure", as opposed to "Standard PinS procedures" which contain a straight leg of minimum 2NM before the FAF.

3.2.1.1.2 Point-in-space Departure Flight Operational Procedure

The PinS departure consists of a visual segment followed by an instrument segment. The visual phase of flight starts from the heliport or landing location and ends at the initial departure fix (IDF) at or above the IDF minimum crossing altitude (MCA). Flight manoeuvre from the heliport or landing location to the IDF, where the helicopter transitions from the visual segment to the instrument segment flight, assumes adequate visual conditions for the pilot to see and avoid obstacles.
A PinS departure procedure includes either a "proceed VFR" or "proceed visually" instruction from the heliport or landing location to the IDF.

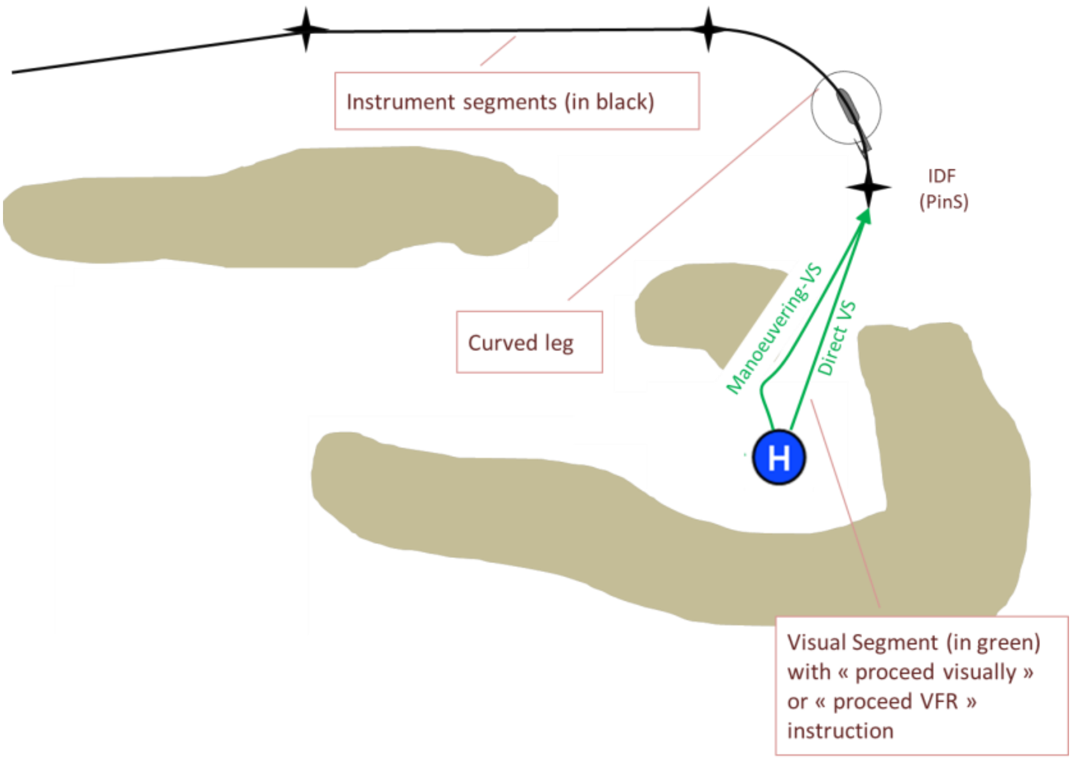


Figure 2: Advanced PinS departure example

The following description is extracted from ICAO PANS OPS Doc 8168 Ed 6 dated 13/11/2014, Vol 1, Part I, Section 8, Chapter 4.

- **For PinS departure with a "proceed VFR" instruction**

  The pilot shall remain in VFR conditions to see and avoid obstacles until crossing the IDF. PinS departures with a "proceed VFR" instruction can serve multiple heliports or landing locations. The visual segment of the PinS departure with a "proceed VFR" instruction is based on state regulatory requirements for VFR operations. Before the IDF, IFR clearance shall be obtained. After the IDF (the Point-in-Space), the pilots has to transition to IFR regime and fly the procedure.

- **For PinS departure with a "proceed visually" instruction**

  A direct visual segment or visual manoeuvring segment is identified from a single heliport or landing location to the IDF. The pilot shall navigate with a visibility that needs to be sufficient to see and avoid obstacles, with an IFR clearance from the heliport or landing location.

The visual segment for a PinS departure with a "proceed visually" instruction can be either a direct visual segment (Direct-VS) or a manoeuvring visual segment (Manoeuvring-VS).
After passing the IDF, instrument departure criteria provide obstacle protection. The instrument segment is based on the RNP navigation specification (RNP 0.3) defined in the PBN document (ICAO Doc 9613, Ed 4). The instrument phase consists of one or more segments and continues until the last waypoint of the departure procedure is reached.
Within PJ01-06 project, we focussed on PinS departures with a curved leg (RF leg).

3.2.1.1.3 IFR PinS Approaches Design

As described in ICAO PANS OPS Doc 8168 Ed 6 dated 13/11/2014, Vol 2, Part IV, Chapters 2 and 3, PinS IFR approaches can be of two types:

- Down to LNAV minima; in this case, there is lateral guidance provided to the pilot. Dependant of the type of RNP system installed on the aircraft, advisory vertical guidance can be provided to the crew to fly down the LNAV minima line.
- Down to LPV minima; in this case, lateral and vertical guidance on the Final Approach Segment (FAS) is provided, thanks to the SBAS augmentation (EGNOS in Europe).

On the approach plate the PinS IFR approaches are labelled RNP APCH with their respective minima line either LPV or LNAV or both.

To allow vertical and horizontal separation, the following construction guidelines are considered:

- In the horizontal plane, the trajectories are selected in order to avoid populated and/or obstacle-rich areas around the selected landing zone;
- In the vertical plane, the altitudes of the initial and intermediate segments are set according to the surrounding obstacle clearance analysis (OCA/OCH).

We provided for each segment of the approach the main geometric construction constraints that apply:

<u>Initial approach main constraints: From IAF to IF</u>

- Type of leg used : RF (Radius to Fix) or TF (Track to Fix)
- Length: should not exceed 10MN, unless operational requirements make a longer segment necessary
- Velocity : 120kt IAS maximum, and locally to cope with some environment constraints a slower velocity of 90kt IAS could be set
- Optimum descent is supposed to be 6.5% but it could be set up to 13.2% if required, provided the speed is restricted to a maximum of 90kt IAS and the gradient used is depicted on the approach chart
- Obstacle clearance in the primary area is 1000ft (300m).

<u>Intermediate approach main constraints: From IF to FAF</u>

- Type of leg used : RF or TF
- Length: The optimum length is 3NM. It shall not be less than 2NM, and shall not exceed 10NM
- Velocity: 120kt IAS maximum and to cope with some environment a slower velocity of 90kt IAS could be set
- The turn at IF shall not exceed 120°

- Optimum descent is supposed to be 6.5% but it could be set up to 13.2% if required, provided the speed is restricted to a maximum of 90kt IAS and the gradient used is depicted on the approach chart
- Obstacle clearance in the primary area is 492ft (150m).
- For non-precision approach procedure with a LNAV minima line:
  - The track change angle at the FAF shall not exceed 60° (ICAP PANS-OPS 8168 Vol 2, Par III, Section 3, Chapter 2, §2.4.1.1.
  - *Note: The FAF is always defined by a fly-by waypoint, even if there is no turn over the FAF.*
- For precision approach procedure with a LPV minima line:
  - The intermediate segment should be aligned with the final approach segment. Fly-by and fly-over turns at the FAF/FAP are not permitted.
  - If the intermediate segment contains an RF segment that ends at the FAF, the following criteria apply:
    - the track angle change of the RF leg shall not exceed 45°; and
    - the minimum radius shall be 4 723 m (2.55 NM)
    - *Note: The RNP system will enter approach mode, when the FAWP is the active waypoint and the bearing to FAWP is within 45° of the desired track of the final approach segment as specified in RTCA DO-229D § 2.2.1.7.*

<u>Final approach main constraints: From FAF to MAPt</u>

- Type of leg used : TF or FAS for LP/LPV minima
- Length: The optimum length is 3.2NM. The minimum length is governed by the magnitude of the turn required at the FAF, and no maximum are required
- Velocity: Procedures are normally designed for helicopters flying the approach up to 70kt IAS; for specific cases, the final segment may be designed to accommodate speeds up to 90kts IAS
- For non-precision approach procedure with a LNAV minima line:
  - Optimum descent gradient is supposed to be 6.5%, but it could be set up to 13.2% gpa=7.5°), if required; in that case, turn at FAF is limited to 30°; speed is restricted to a maximum of 70kt IAS, and the gradient used shall be depicted on the approach chart.
- For precision approach procedure with a LPV minima line:
  - The descent gradient is limited to 11% (gpa=6.3°), in case appendix to chapter 5 of ICAO DOC 8168 Vol 2 is applied.
- Obstacle clearance in primary area if 246fts (175m).

<u>Missed approach main constraints: From MAPt to MAHF</u>

- Type of leg used : RF or TF
- Velocity: 90kt IAS maximum and to cope with some environment constraints a slower velocity up to 70kt IAS could be set
- The normal climb gradient is supposed to be 4.2% but it could be set higher with operational approval.
  Note: Operational approval shall be limited at maximum because it's a constraint for the traffic management and then a traffic limitation.
- The turn at MAPt shall not exceed 120°.

The figure below provides the construction criteria followed for both the RNP 0.3 and RNP APCH procedures, where XTT is the cross-track tolerance, and TSE is the Total System Error.

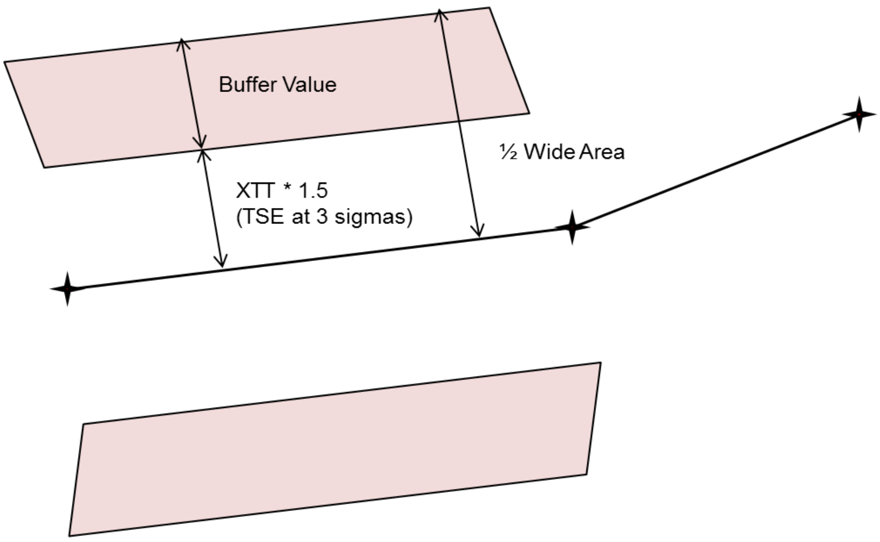


Figure 3: Construction criteria for RNP 0.3 and RNP APCH procedures

Width area for RNP 0.3:

En-route/STAR/SID (>30 NM ARP)			*STAR/SID/IF/IAF/Missed Approach (≤30 NM ARP)*			*SID/Missed Approach (<15 NM ARP)*		
XTT	*ATT*	*½ A/W*	*XTT*	*ATT*	*½ A/W*	*XTT*	*ATT*	*½ A/W*
0.30	0.24	1.45	0.30	0.24	1.15	0.30	0.24	0.80

Width area for RNP APCH (CAT H):

IF/IAF/missed approach (<30 NM ARP)			*FAF*			*MAPt/Initial Straight Missed Approach (LP/LPV only)*			*Missed approach (<15 NM ARP)*		
XTT	*ATT*	*½ A/W*	*XTT*	*ATT*	*½ A/W*	*XTT*	*ATT*	*½ A/W*	*XTT*	*ATT*	*½ A/W*
1.00	0.80	2.20	0.30	0.24	1.15	0.30	0.24	0.80	1.00	0.80	1.85

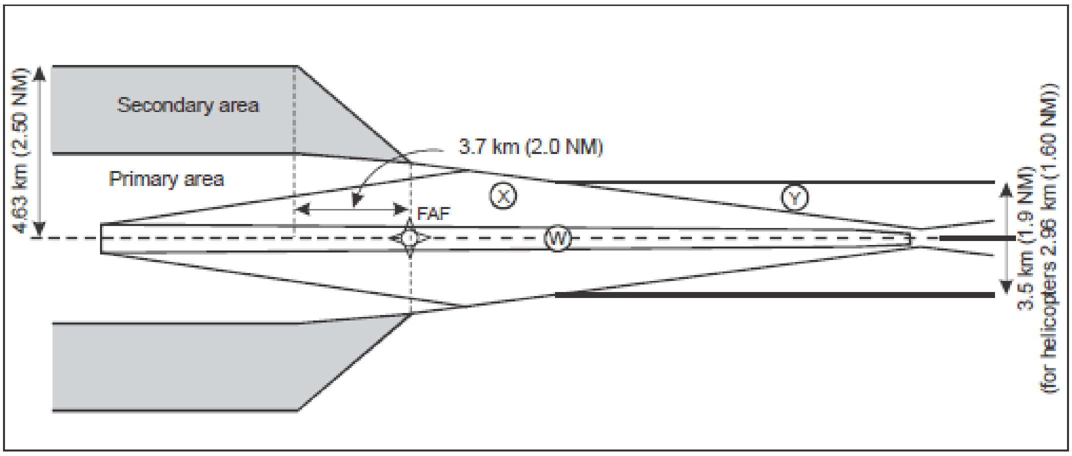


Figure 4: Intermediate approach area (fully based on SBAS). FAF far away from the threshold (X surface width more than 3.7 km (2.0 NM) at the FAF)

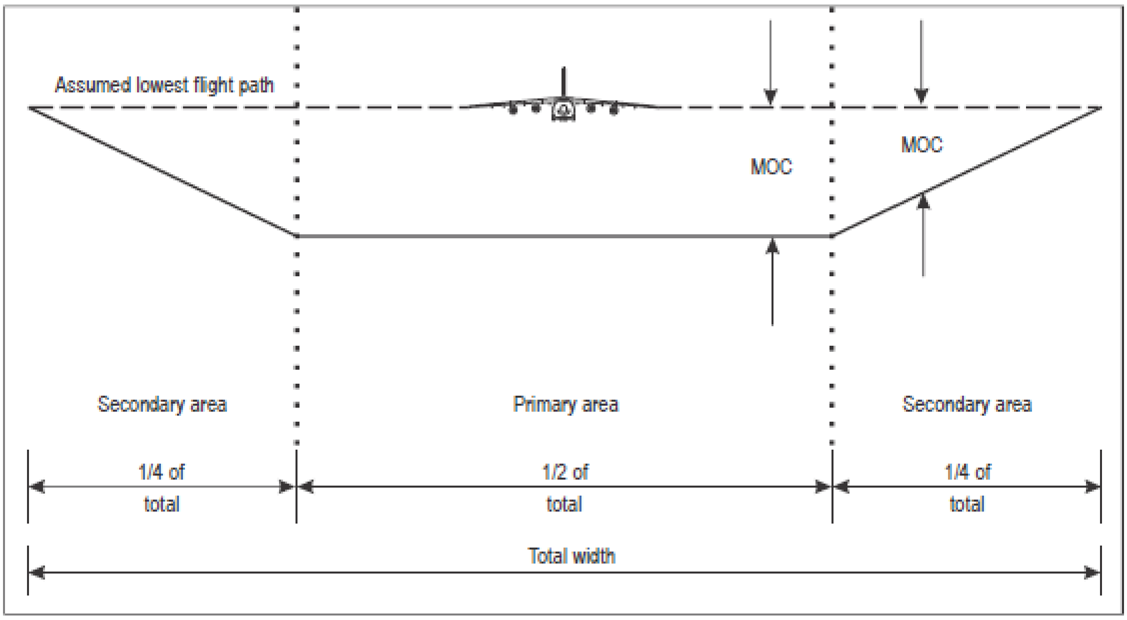


Figure 5: Cross section of straight segment area showing primary and secondary areas

Obstacle clearance is provided within the entire primary area. In the secondary area obstacle clearance is reduced linearly from the full clearance at the inner edge to zero at the outer edge.

Conlcusion for RNP 0.3 connected to Pins LPV:

RNP 0.3: FAF 1/2 A/W = 1.15NM
Transition to short final LPV: FAF FAF 1/2 A/W = 0.8 NM

The area semi-width is slightly reduced at the FAF.

RNP 0.3 route segments do have compared to RNP 0.1 or RNP 0.2 a relative large area semi-width, since a buffer value must be applied. The buffer value is based upon aircraft characteristics and is for RNP 0.3 the significant factor. RNP AR which is required for RNP 0.1 and RNP 0.2 operations which do not require a buffer value and therefore allow a much smaller area semi-width.

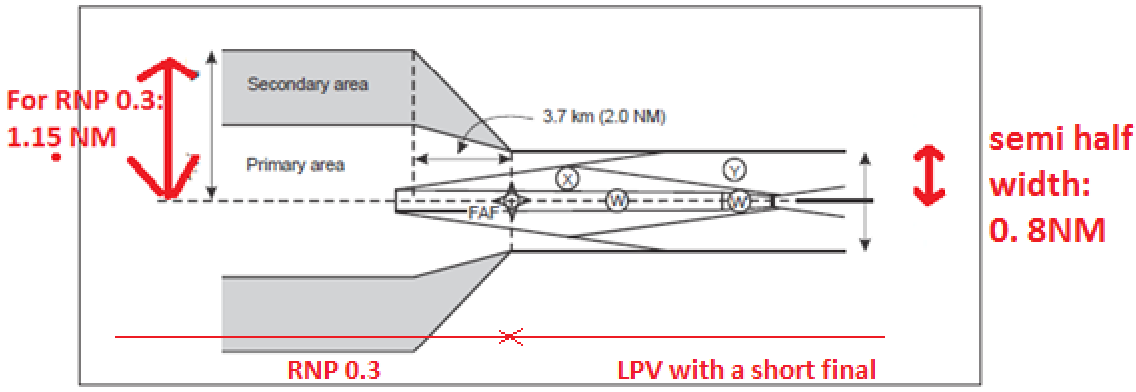


Figure 6: Transition area semi-width RNP 0.3 to RNP APCH LPV

Connecting RNP 0.3 LLR segments with PinS LPV approaches provides a seamless transition of the area semi-width defining the obstacle clearance area.

From procedure design perspective applying RNP 0.1 or RNP 0.2 criteria for the terminal area with a lower area semi-width and thus reduced obstacle clearance protection area, connected to PinS LPV approach, will not bring added value, since when entering the PinS LPV approach the obstacle clearance area would need to increase.

3.2.1.1.4 IFR PinS Departures Design

PANS OPS 8168 Vol2 defines the departure criteria for the IFR PinS departure from a heliport or landing location. As well as the IFR PinS approach, the IFR PinS departure procedure consists of two parts. It starts with a visual segment followed by an instrument segment. The first part is flown visually from the heliport or landing location to the IDF (PinS) at or above the IDF Minimum Crossing Altitude. No entry in IMC is allowed before reaching the IDF. The second part beyond the IDF may be continued in IMC.
If the criteria of PANS OPS 8168 Vol 2 Part IV Chapter 1 for the visual segment can be met, the PinS departure procedure is annotated with a “proceed visually” instruction. Otherwise the procedure is annotated with a “proceed VFR” instruction. PinS depature procedures with a “proceed VFR”

instruction do not provide obstacle protection in the visual segment. After passing the IDF the obstacle protection is granted.
Navigation information based on GNSS may be used during the visual segment as an aid to facilitate flying towards the IDF.

The proceed visually segment can be either a:

- direct visual segment (flown directly from the heliport or landing location to the IDF) or
- a manoeuvring visual segment (initial take-off in a direction other than directly to the IDF)

The instrument segment consists of one or more legs (TF or RF) and continues until the minimum en-route altitude is reached.

Design criteria for PinS departure with a “proceed visually” instruction and direct visual segment:

- The maximum track change at the IDF shall not exceed 30°.
- The visual segment design gradient (VSDG) shall not be less than 5 %. It may exceed 5% in case of obstacle penetration of the visual or IFR obstacle identification surfaces (OIS).
- The visual segment length, measured from the outer edge of the heliport or landing location safety area to the IDF, shall not be less than 0.80NM.
- The maximum visual segment length shall be dependant of the track change at the IDF.
    - 0° track change : 7.50 NM
    - 0°<track change <= 10° : 6.40 NM
    - 10°<track change <= 20°: 5.00 NM
    - 20°<track change <= 30°: 3.50NM
- The visual segment shall be protected by the visual segment obstacle identification surface (OIS). If operational possible any OIS penetrating obstacles should be avoided by increasing the VSDG.
- The instrument segment shall protected by the IFR obstacle identification surface (OIS). In case of obstacle penetration of the IFR OIS the IDF MCA should be increased or as preferred solution a turn initiated.

Design criteria for PinS departure with a “proceed visually” instruction and manoeuvring visual segment:

- A manoeuvring visual segment is protected by pilot taking off a direction other than directly to the IDF and then visually manoeuvres to join the initial instrument segment at the IDF.
- The minimum crossing height (MCH) of the IDF shall not be less than 90m above heliport landing location elevation.
- The manoeuvring visual segment length from the heliport reference point (HRP) to the IDF shall be not less than 0.8 NM.
- The maximum track change at the IDF shall not exceed 30°.

Design criteria for PinS departures are defined more in detail in PANS OPS 8168 Vol2.

3.2.1.2 Separation standards

The separation minima are the current standards used in the airspace considered.

The controller has the responsibility for separation. There is no difference in the controller activity otherwise to consider the rotorcraft specific performances and flight altitude.

3.2.1.3 Traffic Characteristics

The proposed PinS will work for all forms of traffic; dense or light, mixed or segregate, dependent or independent.

3.2.1.4 CNS equipment

3.2.1.4.1 Ground

Communication means	VHF Radio communication
Surveillance means	Radar / ADS-B surveillance
Navigation means	No "classic" ground structure needed at the FATO, but GNSS and SBAS needed.

Table 5 Ground equipment

The controller is provided with the traffic surveillance data.

The following aspects of today's operations are assumed:

- Radar separation Minima (usually 5-3 NM in Terminal Airspace) and
- Minima imposed by Wake Turbulence on the final approach segment.
- It will still be possible to use conventional separation modes although there will be less tactical intervention.

3.2.1.4.2 Airborne

Communication means	- VHF Radio communication - VHF Radio Navigation
Navigation means	Required as minimum - RNP capability, down to RNP0.3 - LPV capability - GNSS/ SBAS receiver - RNP APCH down to LPV minima - FMS supporting all PBN elements (including LPV and Radius-to-Fix legs) - Multi-Function Display (head-down) presenting FMS elements Optional - Head Worn Display presenting symbology to help the pilot to fly the Point In Space procedures

	- APV baro-VNAV capability - GBAS Cat I receiver - RNP transition to GLS/LPV - Synthetic Vision System - Enhanced Vision System
Surveillance means	- ADS-B out solution - Cockpit Display of Traffic Information (CDTI)

Table 6 Airborne equipment

3.2.2 Roles and Responsibilities

3.2.2.1 ATCO

The ATCOs are responsible for preventing collisions and expediting and maintaining the orderly flow of traffic. To prevent collisions, the ATC units issue the clearances and traffic information depending on the service provided which is function of the type of flight (i.e. IFR or VFR) and the class of airspace.

Taking into consideration PinS approaches and departure procedures, the integration of this kind of specific tailored rotorcraft procedures do NOT introduce change of responsibilities or change of practices in the Air traffic controllers duties.

3.2.2.2 Flight Crew

There is no change to the responsibilities of the Flight Crew regarding the safe conduct of the flight during PinS procedures. Flight crews are still responsible for the safe and efficient control and navigation of their individual aircraft in all airspaces. However, procedures will now include flight crews' use of the advanced on board avionics technologies, improving the decision-making process for the safe and efficient management of the flight.

3.2.3 Technical Characteristics

3.2.3.1 Procedure design

- Included a curved segment (i.e. "advanced PinS")
- RNP values were lower than 0.3 on the final and lower than 1.0 on the initial and intermediate segments
- Procedure Design was based on current provisions for PinS and A-RNP (ICAO Doc 8168 PANS-OPS)

3.2.3.2 On-board operation

The advanced PinS procedures have been flown in SPIFR and DPIFR configuration.

3.2.3.3 Visibility conditions

External visibility conditions (due to the weather and/or the night) have an impact on the operations considered in this project since a part of the Point In Space procedure is done visually by the crew (either on the “Proceed VFR” or the “Proceed Visually” procedure). Therefore, solution PJ.01-06 shall consider operations:

- by day
- in VMC or IMC on the instrument segment.

3.2.4 Applicable standards and regulations

For deployment of the advanced PinS solution, guidelines and standards are quoted below and statements about validity (or gaps) are provided.

- ICAO
  - Procedures for Air Navigation Services — Aircraft Operations, Volumes II (PANS-OPS) (Doc 8168, 6th edition 2 - 2014)
    - Part IV of this document is devoted to construction of helicopter point in space procedures based on PBN concept. It includes PinS departures, PinS approach (RNP APCH to LNAV and LPV minima). These sections do not explicitly mention RF leg applicability to helicopters, and this may be considered in a future evolution of this document.
    - As shown in the validation results, IFR-certified rotorcraft with autopilot coupling of the flight route are able to maintain very low cross-track errors. Therefore, the proposal is to consider relaxation of obstacle clearance criteria in this document in order to further ease rotorcraft access in obstacle-rich and mountainous terrain.
  - Performance-Based Navigation Manual, (Doc 9613, 4th edition)
    - RNP 0.3 for all phases of helicopter flight and all airspaces (controlled/uncontrolled) is defined in this document. It includes functional requirements (e.g. display display, monitoring, autopilot, etc.) for the aircraft, and implementation guidelines. Appendix 1 to Part C includes guidelines on RF leg part terminator with applicability to RNP 0.3, RNP 1 and RNP APCH which are those applicable to helicopter operations.
  - Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM) (Doc 4444)
    - This document provides ATM guidelines in order for ATS to take rotorcraft specific performances into account in managing air traffic. No specific gaps or improvements are required here.

- RTCA
  - Minimum operational performance standards for global positioning system/wide area augmentation system airborne equipment, DO-229D

- EASA
  - Airworthiness Approval and Operational Criteria related to Area Navigation for Globald Navigation Satellite System approach operation to Localizer Performance with vertical guidance minima using satellite bases augmentation system, AMC 20-28

- FAA
    - Airworthiness Approval of Positioning and Navigation Systems, AC 20-138D
    - Airworthiness Approval of Enhanced Vision System, Synthetic Vision System, Combined Vision System, and Enhanced Flight Vision System Equipment, AC 20-167A
    - Airborne Navigation Sensors using the GPS Augmented by SBAS, TSO C145c
    - Area Navigation Equipment using Multi-Sensor Inputs, TSO C115c
    - Stand-Alone Airborne Navigation Equipment Using the Global Positioning System Augmented by the Satellite Based Augmentation System (SBAS), TSO-C146d
        - RTCA, FAA and EASA documentation, in particular AC 20-138D provide guidelines to aircraft manufacturers regarding airworthiness approval of positioning and navigation equipment including rotorcraft enroute, terminal and offshore RNP 0.3 including RF leg capability.
        - However, the use of enhanced vision systems (including HMD solution) for gaining operational benefits in advanced PinS procedure should be considered in future evolutions of airworthiness guidelines.

- ARINC
    - ARINC 424-21 (2016) Navigation System Database Specification
        - This document specifies procedure encoding standard for hosting navigation database in an airborne navigation system. This specification already includes guidelines for PinS procedure encoding including the definition of RF legs in the terminal segments. No additional changes are considered necessary.

Based on the documents surveyed, it is found that airworthiness and ICAO guidelines adequate to support advanced PinS in terms of rotorcraft performance (PBN specification), required airborne equipment (FAA and EASA circulars) and database coding standards (ARINC).

To improvements are identified:

1) An improvement to ICAO Doc 8168 may be considered in order to explicit RF leg capability in the procedure construction and to ease obstacle clearance criteria for rotorcraft with autopilot coupling.
2) Evolution (or new definition) of airworthiness regulations that give due credit to enhanced vision systems in advanced PinS procedures.

3.3 Detailed Operating Method

3.3.1 Previous Operating Method

Today, rotorcraft reach their best operational performances, when flying unconstrained in VFR flight rules, an operating mode really dependent upon weather conditions and visibility. During winter months this way to operate can be adversely affected, by foggy and cloudy weather conditions which can prevent rotorcraft to proceed VFR or make them subject to delays when operating to/from a controlled airspace (i.e: CTR) in a dense medium complexity ATM airspace

At present, there are many helicopters which are IFR certified and characterized by advanced avionic standards. Already today many helicopters are SBAS equipped and certified for RNP APCH operation down to LPV minima, which enables them to fly PinS LPV approaches. When these rotorcraft are flying in IFR mode, due to the lack of rotorcraft specific procedures, they are used to fly the same instrument flight procedures designed for aircraft.

Most of today procedures, being specifically designed for fixed-wing A/C, are constraining for rotorcraft implying important limitation on their operations as they have flight profiles which are not optimised for this category of operations. In particular rotorcraft categories have different needs and possibility in terms of descent rate and speed profile in order to optimise their performances.

Forcing them along the same SID/STAR (designed for fixed wing) can delay their operations to/from airports, and impact negatively the operations of commercial fixed-wing A/C, increasing also Air Traffic Controller workload.

In current operations arriving helicopters aiming for an instrument approach procedure are directed toward the instrument flight procedures available for runway (IFR landing location in an airport environment) often experiencing delay in order to avoid penalty to commercial IFR aircraft, since no tailored approach is available taking into account the different performances achievable by helicopters with respect to aircraft.

The current operating method offers the principle of the Point in Space (PinS) concept relying on the pilot's capability to perform an IFR approach toward a Point in Space and not directly to the FATO. Once the PinS has been reached, the pilot shall acquire visual references to proceed visually (or VFR) and land on the helipad (HP). If visual references cannot be acquired, a missed approach shall be executed. The main difference of PinS down to LNAV minima with direct CAT H criteria is the maximum glide path angle on the final IFR segment of the approach (from FAF to PinS), shall be up to 7.5° (13.2%) with a limitation of 90kt IAS on the initial and intermediate segment and 70 kt IAS on the final segment provided the course change at the FAF is less than or equal to 30°.With the new edition of PANS OPS from 2014, LPV final approaches for PinS procedures are allowed. To create the FAS datablock for PinS procedures, a fictitious heliport (FHP) is required. This FHP is located 800m from the PinS at the same height as the real heliport. All requirements for the FAS datablock are described in PANS OPS, 6th Edition of 2014, Volume 2, Section 2, Chapter 6

According PANS-OPS Pins LPV are currently allowed only when the intermediate segment is aligned with the final approach segment. Pins LPV can be designed with a glide path angle up to 6.3°

FAA AC20-138D defines the acceptable means to obtain airworthiness approval for RNP APCH down to LPV minima.

Availability of Low Level IFR routes and IFR access to helipads, thanks to Point-in-Space departure/approach procedures, should reduce VFR flights undertaken in marginal visibility conditions and make rotorcraft operations less dependent on the weather.

3.3.2 New SESAR Operating Method

The rationale of the new operating Method is the coherent involvement in SESAR project of the need to properly consider all the possible air platform requirements in the development of the new ATM system allowing the correct integration of the rotorcraft element in the Single European Sky.

Tailored rotorcraft flightpath offers a vision of the benefits and challenges faced by European aviation community in meeting the future need of a sustainable mobility system. A future safe and efficient Air Traffic System (ATS) that respects the SESAR pillars of paramount importance in this field, allowing “smarter” flight operations than today: precise navigation and on-board systems not only will deliver benefits to commercial air transport, but also offer all-weather, 24/7 capacity to rotorcraft and aircraft capable of door-to-door operation with limited infrastructure. In this scenario, all types of rotorcraft are expected in the next future to perform simultaneous, non-interfering approach and departures to/from airports as part of international networks including VFR FATOs inside congested and densely populated areas but also secondary, remote infrastructure, complying with local noise regulations and operative constraints.

In the near future, satellite-based instrumental flight procedures will radically change the way Rotorcraft are operated, improving transportation inter-modality and both ATM and flight efficiency. The goal is a synchronised and predictable European ATM system, where partners and stakeholders are aware of the business and operational situations and collaborate to optimise the network. This first step initiates arrival time prioritisation together with wide use of data-link and the deployment of initial trajectory based operations, reflected in optimizing 2D/3D routes, moving then to 4D trajectory management.

The introduction of RNP will optimise route structures and automation. The Rotorcraft characteristic/needs and Airspace management needs can be matched by developing PBN based advanced PinS procedures and applying SNI concept at busy airports.

In this scenario the concept has addressed a new OI taking into consideration the existing rotorcraft needs in order to fulfil the SESAR gap into rotorcraft operations.

The incorporation of rotorcraft optimised 2D/3D routes (i.e.: low level IFR routes) operations in a medium dense airspace reflected the necessity to insert a dedicated operational Improvement for the rotorcraft approaches procedures:

- Enhanced Rotorcraft Operations at VFR FATOs with specific Point-in-Space RNP procedures using satellite augmentation.

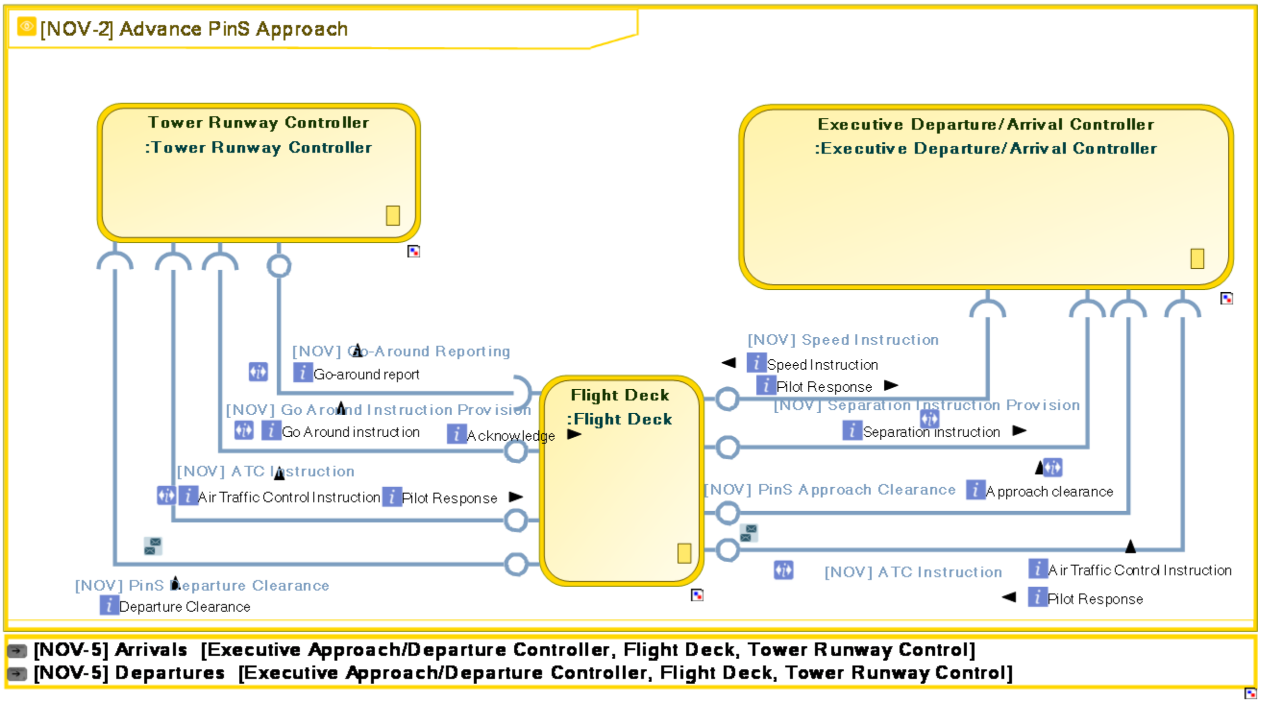
This rotorcraft operational improvement has facilitated the ability of the SESAR project to meet its stated aims like:

- To increase safety operational level
- To improve efficiency
- To reduce costs (due to shorter routing)
- To increase Airport/Heliport and Airspace capacity
- To improve access to Airport / Heliport
- To reduce the environmental impact of noise and pollution (i.e.: reduce fuel burn, reducing flight and holding time)

A-RNP (also included in the new edition of PANS OPS from 2014) gives provisions for including RF legs in the initial and intermediate segments of an approach procedure. They are currently not specified for PinS-procedures specially tailored for helicopter operations. Their main advantage is a smoother transition onto the final segment where a turn at the FAF is needed which can be handy for obstacle avoidance and that they provide a non-varying segment length which facilitates continuous descent (thus smoother) approaches. They are defined by a radius to be flown and start and end points, thus unambiguously defining a turn, compared to a fly-by-turn at a single given waypoint.

3.3.2.1 Use Cases

This Node View summarizes the Use Cases 1 and 2 of normal operations



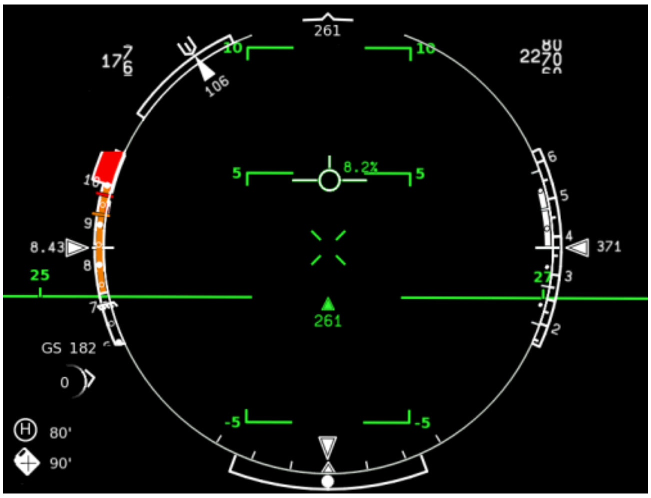
3.3.2.1.1 Advanced PinS procedures using HMD

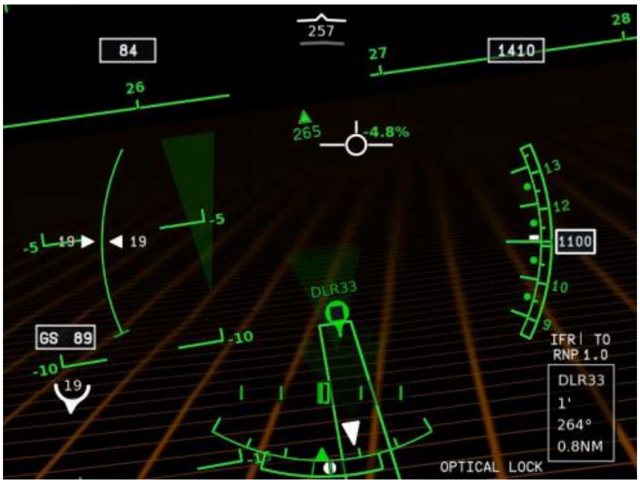
The use cases that are considered here cover Point in Space procedures for departure and approach containing a curved segment and have been conducted using an HMD as a *complementary display*.

Complementary display shall be understood as follows: we considered a rotorcraft that has been certified to operate in the civil airspace using its head-down avionics instrumentation; this certification does not include the advanced PinS operations. An HMD has been added to the avionics system, providing a *complementary* display to the head-down certified displays. At any time, when using the HMD, the pilot was able to also look inside the cockpit to read its head-down instrumentation; this could be done either by an eye pupil movement (head posture remains "eye-out" oriented and only the pupil is looking down) or by a head movement downwards (in that case the HMD symbology was automatically removed, or remained displayed if the head-down can be correctly seen through the HMD symbology: this has been investigated during the PJ01-06 exercise). One of the objectives of PJ01-06 activity was to determine what information needs to be displayed on the HMD to perform this operation, and what information could remain displayed only on the HDD, and to define the visual circuit the pilot had to follow between HMD and HDD.

Different situations have been considered: the nominal situation (all systems work properly, no failure); the situation in case of GNSS loss; the situation in case of HMD failure.

An example of symbology that was presented on the HMD is given below:



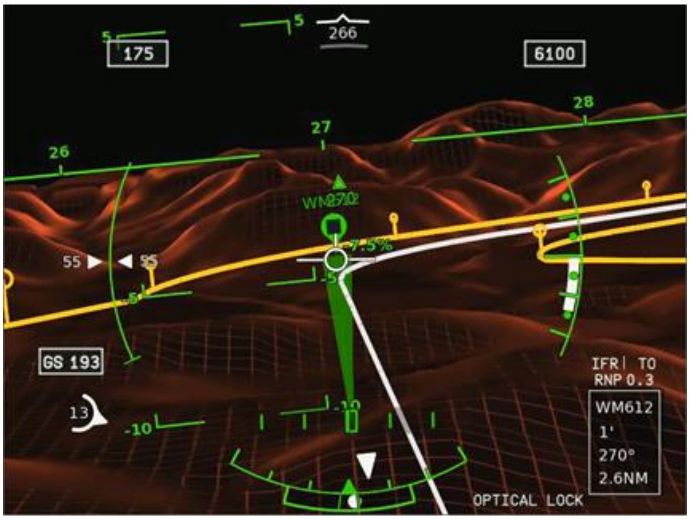


Classical piloting information was presented, including Integrated Air Speed, Altitude, Heading, Attitude, Radio Height, Ground Speed, Wind, engine limitations, synthetic runway, 3D waypoints conformal presentation, next waypoint navigation data, a Synthetic Vision System,

For the Advanced Point in Space procedure, two specific symbologies were added onto this piloting symbology; PJ01-06 team designed and evaluated such symbology, first on the Real Time Simulator, and then during the Flight Trials:

- The Flight Director solution, based on the display in the HMD of a fully conformal advanced Flight Director 2D symbol, including anticipation features specifically designed for advanced PinS procedures.

- The 3D Pathway solution, based on the display in the HMD of a fully conformal 3D view of the route to fly, including altitude constraints and lateral limits.



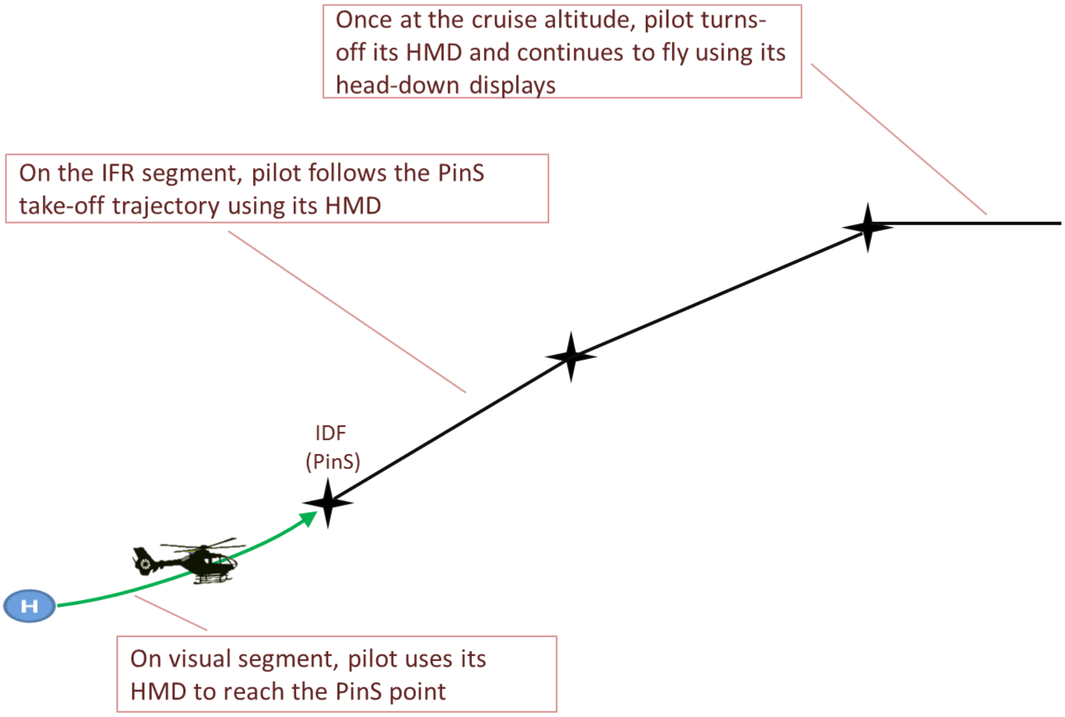
The objective of the HMD symbology was to provide the minimum information that is necessary to perform the operation without requiring too many “eyes-in” “eyes-out” movements. On the one hand, HMD symbology shall be reduced to the minimum in order not to alter the natural perception of the external environment. On the other hand, any information (see examples on the illustration above) that the pilot must control during the operation may be displayed on the HMD with benefits in order to perform safely the operation. But of course the head-down instrumentation remained available, and the pilot may need – through its HMD – to check some information presented head-down.

Regarding traffic information, ADS-B tracks were added as conformal symbols (superimposed to the real A/C). An example of HMD traffic symbology is provided below:

3.3.2.1.1.1 Nominal situation

3.3.2.1.1.1.1 Departure PinS procedure

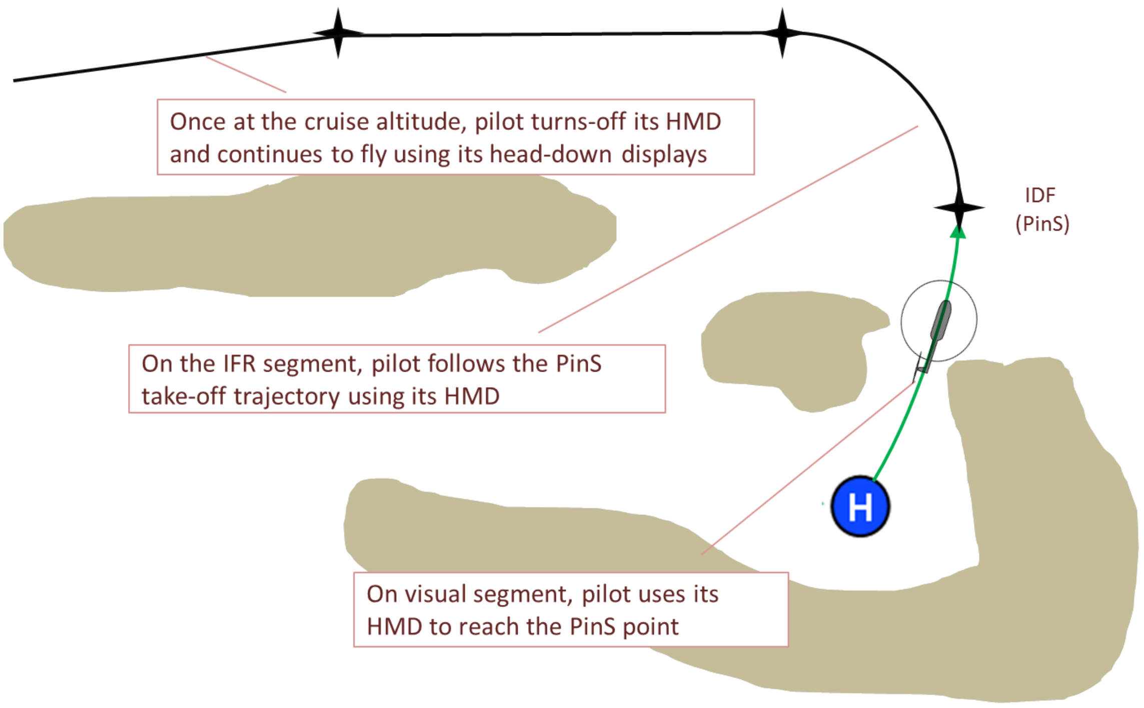
Flying a PinS departure procedure consists first – for the pilot – to fly visually to the first point of the instrument procedure, the IDF (Initial Departure Fix), which is a navigation waypoint defined by geographic coordinates and a Minimum Crossing Altitude (MCA). As during this phase the pilot is flying "eyes-out", meaning looking outside to control separation with other traffic and with terrain and obstacles, the HMD can help him to navigate towards the IDF while keeping an eye on its piloting parameters (altitude, heading, speeds…).



PinS departure using HMD – Vertical profile

Once on the IFR segment, the pilot can continue to use its HMD to take benefit from the HMD symbology, in particular when this procedure is flown manually. Indeed, this manoeuver combines longitudinal, lateral and vertical movements, in particular on the curved part of the departure procedure.

Once the cruise altitude has been reached, the pilot can turn-off its HMD and continue a normal instrument flight using its head-down displays.



PinS departure using HMD – Lateral profile

This View describes the Use Case for departing aircraft, further described in the V3 SPR-INTEROP/OSEDof the solution

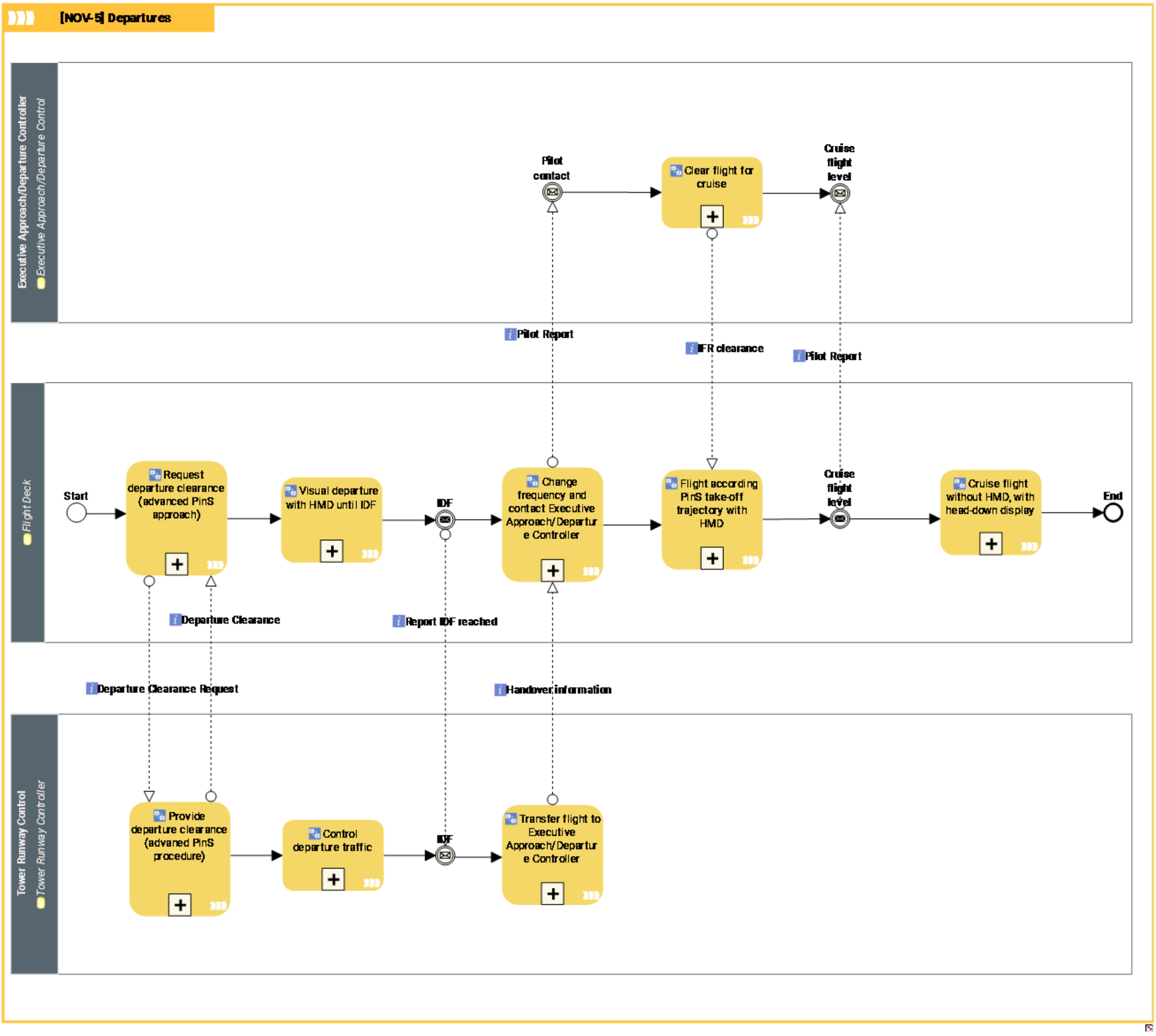


Figure 7: [NOV-5] Departure

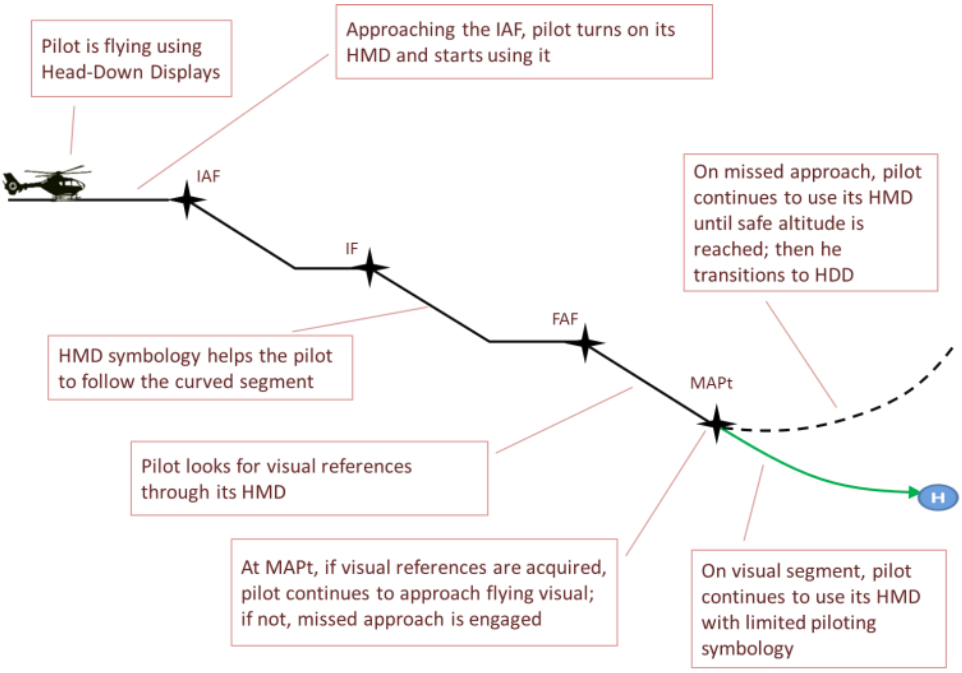
Activity	Description
Change frequency and contact Executive Approach/Departure Controller	After receiving handover information the pilot contacts the executive approach and departure controller
Clear flight for cruise	The executive approach and departure controller clears the rotorcraft for cruise flight level.
Control departure traffic	The TWR controller controls the departure traffic under his responsibility
Cruise flight without HMD, with head-down display	After reaching cruise flight level, the pilot flies without HMD and with head-down display
Flight according PinS take-off trajectory with HMD	After IFR clearance the rotorcraft flies PinS take-off trajectory with HMD until he reaches cruise flight level.

Provide departure clearance (advanced PinS procedure)	The TWR controller provides departure clearance with advanced PinS
Request departure clearance (advanced PinS approach)	The Flight Crew requests departure clearance with advanced PinS
Transfer flight to Executive Approach/Departure Controller	After the rotorcraft reaches IDF the TWR controller provides handover information to the rotorcraft crew
Visual departure with HMD until IDF	The pilot flies visual departure with HMD until he reaches IDF

Issuer	Info Exchange	Addressee	Info Element
Tower Runway Control	Transfer flight to Executive Approach/Departure Controller o--> Change frequency and contact Executive Approach/Departure Controller	Flight Deck	Handover information
Executive Approach/Departure Controller	Clear flight for cruise o--> Flight according PinS take-off trajectory with HMD	Flight Deck	IFR clearance
Flight Deck	IDF o--> IDF	Tower Runway Control	Report IDF reached
Flight Deck	Change frequency and contact Executive Approach/Departure Controller o--> Pilot contact	Executive Approach/Departure Controller	Pilot Report
Tower Runway Control	Provide departure clearance (advanced PinS procedure) o--> Request departure clearance (advanced PinS approach)	Flight Deck	Departure Clearance
Flight Deck	Cruise flight level o--> Cruise flight level	Executive Approach/Departure Controller	Pilot Report
Tower Runway Control	Transfer flight to Executive Approach/Departure Controller o--> Change frequency and contact Executive Approach/Departure Controller	Flight Deck	Handover information
Flight Deck	Request departure clearance (advanced PinS approach) o--> Provide departure clearance (advanced PinS procedure)	Tower Runway Control	Departure Clearance Request
Flight Deck	Request departure clearance (advanced PinS approach) o--> Provide departure clearance (advanced PinS procedure)	Tower Runway Control	Departure Clearance Request

3.3.2.1.1.1.2 Approach PinS procedure

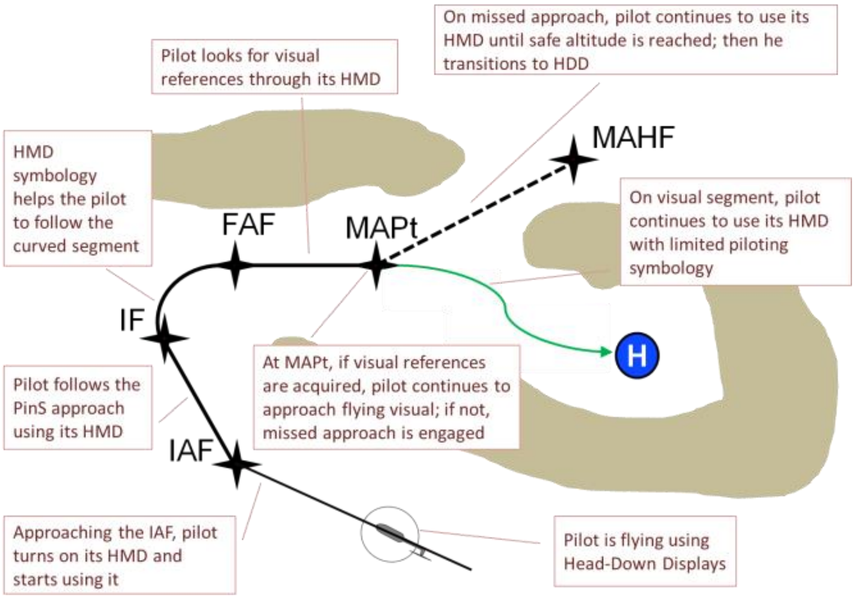
The helicopter is flying IFR on a route that can be any kind of RNP/RNAV route, including low-level RNP0.3 route specific to helicopter operations. At some distance from the first point of the PinS instrument approach, the IAF (Initial Approach Fix), the pilot turned ON his HMD. Once on the descent phase, the HMD symbology helped the pilot to control laterally and vertically the trajectory, as well as the flight parameters (speed, altitude, velocity vector…); a first recognition of the external scene was then possible (if weather conditions allow it); during the curved segment (between the IF – Intermediate Fix – and the FAF – the Final Approach Fix), which combines longitudinal, lateral and vertical movements, the HMD brings to the pilot means to control its trajectory while keeping an eye on the external scene.



PinS approach using HMD – Vertical profile

When approaching the MAPt (Missed Approach Point), at which a decision shall be taken by the pilot to continue or abort the approach, this is where the HMD was particularly helpful, allowing the pilot to acquire the necessary visual references defined by the approach chart while controlling the flight parameters and keeping the helicopter on the final approach segment.

During the final approach segment (ie. from FAF to MAPt), if the PinS approach was an LPV (Localizer Performance with Vertical guidance) approach, the HMD was used to display the lateral and vertical deviations compared to the Final Approach Segment (FAS).



PinS approach using HMD – Lateral profile

At the MAPt,

- if the visual references have been acquired visually (through the HMD), then the pilot continued to fly towards the landing zone (LZ), either under VFR regime (in case of a "Proceed VFR" procedure) or "visually" under IFR regime (in case of a "Proceed Visually" procedure. During this visual segment, the pilot continued (if he considered this display as helpful) to use the HMD to navigate towards the LZ, controlling in particular its airspeed, heading and height above ground).
- if the minimum visual references have not been acquired visually, then the pilot initiated a "go-around", and continued to use the HMD to fly the missed-approach procedure. When the safety altitude has been reached, the pilot can choose to fly to an alternate destination or to perform a second round of the approach. In the first case, depending on the distance to the alternate destination, the pilot may decide to turn OFF its HMD and fly "head-down", or continued to fly "eyes-out" with its HMD; in the last case, he preferred to continue to use the HMD since the return to the approach path is relatively short.

This following view describes the Use Case for arriving rotorcraft:

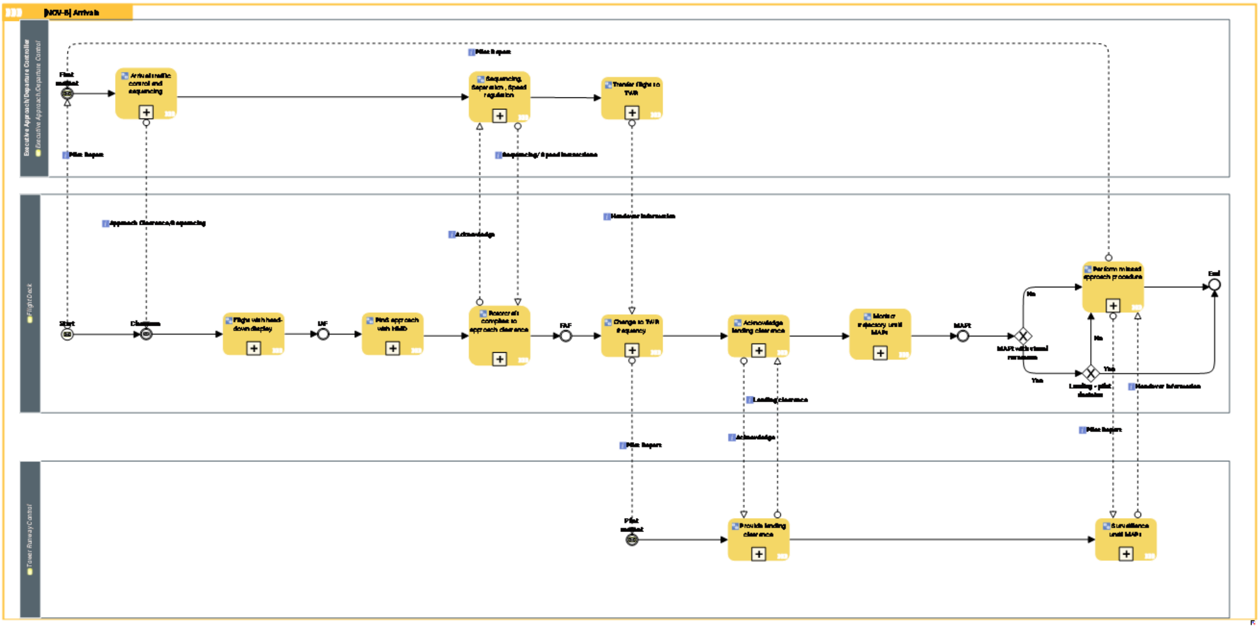


Figure 8: [NOV-5] Arrivals

Activity	Description
Acknowledge landing clearance	The rotorcraft pilot receives the landing clearance and confirms this with a read back
Arrival traffic control and sequencing	The executive approach and departure controller is responsible for the arrival traffic including sequencing.
Change to TWR frequency	After receiving handover information the rotorcraft pilot switches his frequency to the TWR controller
Flight with head-down display	The pilot flies with head-down display until he reaches IAF
Monitor trajectory until MAPt	The pilot monitors the trajectory until he reaches MAPt
Perform missed approach procedure	If no visual reference is available at MAPt or the pilot decides not to land, the rotorcraft performs a missed approach procedure
PinS approach with HMD	After reaching IAF the pilot flies a PinS approach with HMD
Provide landing clearance	The TWR controller provides a landing clearance to the rotorcraft crew
Rotorcraft complies to approach clearance	the rotorcraft complies to the given approach clearance
Sequencing, Separation , Speed regulation	The executive approach and departure controller is responsible for sequencing, separation and speed regulation as long as the rotorcraft is under his responsibility
Surveillance until MAPt	If the rotorcraft flies a missed approach procedure the TWR controller provides the handover information to the crew
Transfer flight to TWR	After reaching FAF the controller provides handover information to the rotorcraft crew

Issuer	Info Exchange	Addressee	Info Element
Tower Runway Control	Provide landing clearance o--> Acknowledge landing clearance	Flight Deck	Landing clearance
Tower Runway Control	Surveillance until MAPt o--> Perform missed approach procedure	Flight Deck	Handover information
Flight Deck	Rotorcraft complies to approach clearance o--> Sequencing, Separation , Speed regulation	Executive Approach/Departure Controller	Acknowledge
Executive Approach/Departure Controller	Sequencing, Separation , Speed regulation o--> Rotorcraft complies to approach clearance	Flight Deck	Sequencing/ Speed Instructions
Executive Approach/Departure Controller	Transfer flight to TWR o--> Change to TWR frequency	Flight Deck	Handover information
Flight Deck	Clearance o--> Arrival traffic control and sequencing	Executive Approach/Departure Controller	Approach Clearance/Sequencing
Flight Deck	Start o--> First contact	Executive Approach/Departure Controller	Pilot Report
Flight Deck	Change to TWR frequency o--> Pilot contact	Tower Runway Control	Pilot Report
Flight Deck	Perform missed approach procedure o--> Surveillance until MAPt	Tower Runway Control	Pilot Report
Flight Deck	Acknowledge landing clearance o--> Provide landing clearance	Tower Runway Control	Acknowledge
Executive Approach/Departure Controller	Arrival traffic control and sequencing o--> Clearance	Flight Deck	Approach Clearance/Sequencing
Flight Deck	Perform missed approach procedure o--> First contact	Executive Approach/Departure Controller	Pilot Report

3.3.2.1.1.2 Loss of GNSS signal during the PinS operation

3.3.2.1.1.2.1 Departure PinS procedure

This use case consists in considering a loss of the GNSS signal-in-space during the instrument segment of the departure procedure, for instance during the curved segment.

The effect of the loss of the GNSS signal-in-space is a loss of the RNP capability if no other RNP capable navigation system is installed. The navigation system on-board shall automatically revert to radio-navigation means such as VOR, DME or ADF means (depending on the emitters available in the airspace where the operation is performed). From the HMD perspective, the only effect will be the loss of the RNP symbology; a message shall then be displayed to the pilot (on the HMD) to warn him that RNP capability is lost. Even if the RNP capability is lost, the avionic system will remain in RNAV mode in order to provide horizontal display guidance to the pilot avoiding any discontinuity in the navigation management and reducing the crew work load. After this failure management on-board, the Air Traffic Control operator shall be informed by the pilot, to take into account this problem. Vertical Guidance based on SBAS is no longer provided.

The exercise performed by PJ01-06 team has evaluated the impact on the pilot's workload of such a failure, and assessed the acceptability of this operation.

3.3.2.1.1.2.2 Approach PinS procedure

This use case consists in considering a loss of the GNSS signal-in-space during the instrument segment of the approach procedure, for instance during the curved segment.

Again, the effect of the loss of the GNSS signal-in-space is a loss of the RNP capability. The navigation system on-board shall automatically revert to radio-navigation means such as VOR, DME or ADF means (depending on the emitters available in the airspace where the operation is performed). From the HMD perspective, the effect will be the loss of the RNP symbology, as well as the LPV guidance symbology (in case of a LPV approach); a message shall then be displayed to the pilot (on the HMD) to warn him that RNP capability is lost. The pilot shall then engage a Go-Around procedure, to climb to a safe altitude, in order to re-engage a conventional approach if possible or to go to an alternate helipad. Even if the RNP capability is lost, the avionic system will remain in RNAV mode in order to provide horizontal display guidance to the pilot, avoiding any discontinuity in the navigation management and reducing the crew work load. After this failure management on-board, the Air Traffic Control operator shall be informed by the pilot, to take into account this problem.

The exercise performed by PJ01-06 team has evaluated the impact on the pilot's workload of such a failure, and assessed the acceptability of this operation.

3.3.2.1.1.3 HMD failure during the PinS operation

3.3.2.1.1.3.1 Departure PinS procedure

This use case consists in considering a failure of the HMD during the instrument segment of the departure procedure, for instance during the curved segment. As an example, we propose to consider a freeze of the HMD display.

This failure shall be automatically detected by the HMD itself; the effect shall be the complete loss of all the HMD symbology; the pilot procedure in that case shall then be to turn OFF its HMD and transition to the head-down displays and continue the departure procedure.

The exercise performed by PJ01-06 team has evaluated the impact on the pilot's workload of such a failure, and assessed the acceptability of this operation.

3.3.2.1.1.3.2 Approach PinS procedure

This use case consists in considering a failure of the HMD during the instrument segment of the approach procedure, for instance during the curved segment. As an example, we proposed to consider a freeze of the HMD display.

This failure shall be automatically detected by the HMD itself; the effect shall be the complete loss of all the HMD symbology; the pilot procedure in that case shall then be to turn OFF its HMD and transition to the head-down displays and continue the approach procedure.

The exercise performed by PJ01-06 team evaluated the impact on the pilot's workload of such a failure, and assessed the acceptability of this operation.

3.3.2.1.2 Advanced PinS procedures using HDD

The scope of these use cases is to validate an advanced PinS procedures using HDD. The new procedures have been validated in nominal and abnormal conditions with and without autopilot coupling.

A serial HC equipped with Helionix display suite has been used for the flight trails. The MFD will display for all RNAV approach types the following data:

- Data from the guidance source (GNSS receiver or FMS):
    - LOS
    - CDI
    - VDI
- Data from FMS:
    - DTK
    - Active waypoint identifier
    - Distance to Go (to next waypoint)
    - Time to Go
    - Active Flight Plan

Figure 9: Example of FND page in Sector mode

In case a RF leg type is part of the active flight plan the depiction on the MFD is the following:

Figure 10: Example of FND page in Sector mode with RF leg

Standard and advanced PinS LPV are RNP APCH procedures flown down to LPV and / or LNAV minima line.

Compared to Standard PinS LPV approaches advanced PinS LPV allow to use:

- A curved intermediate segment (RF leg type) connected to the FAF or a straight segment (TF leg type) to the FAF with a course change of up to 45deg. When using a RF leg directly before starting the final approach phase, the FAF will be a fly-over waypoint. Standard PinS LPV require a straight intermediate segment followed by the FAF as a fly-by waypoint.

- An altitude change in the initial and intermediate segment to prepare the descent. Whereas standard PinS LPV require a level/flat portion of the intermediate segment to intercept the glide path.
- A curved segment (RF leg type) in the final missed approach segment.

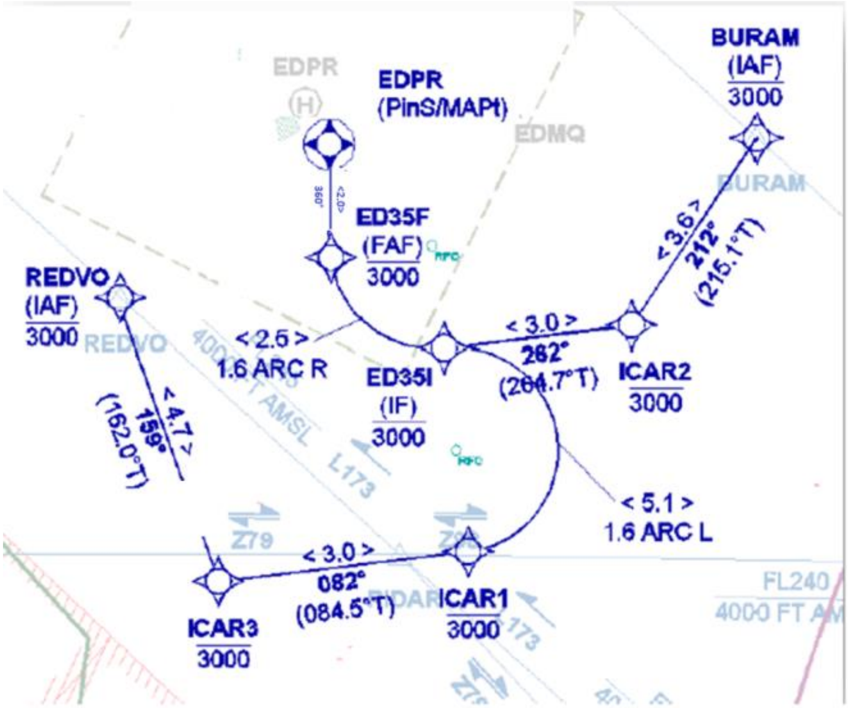


Figure 11: Example of an advanced PinS LPV approach

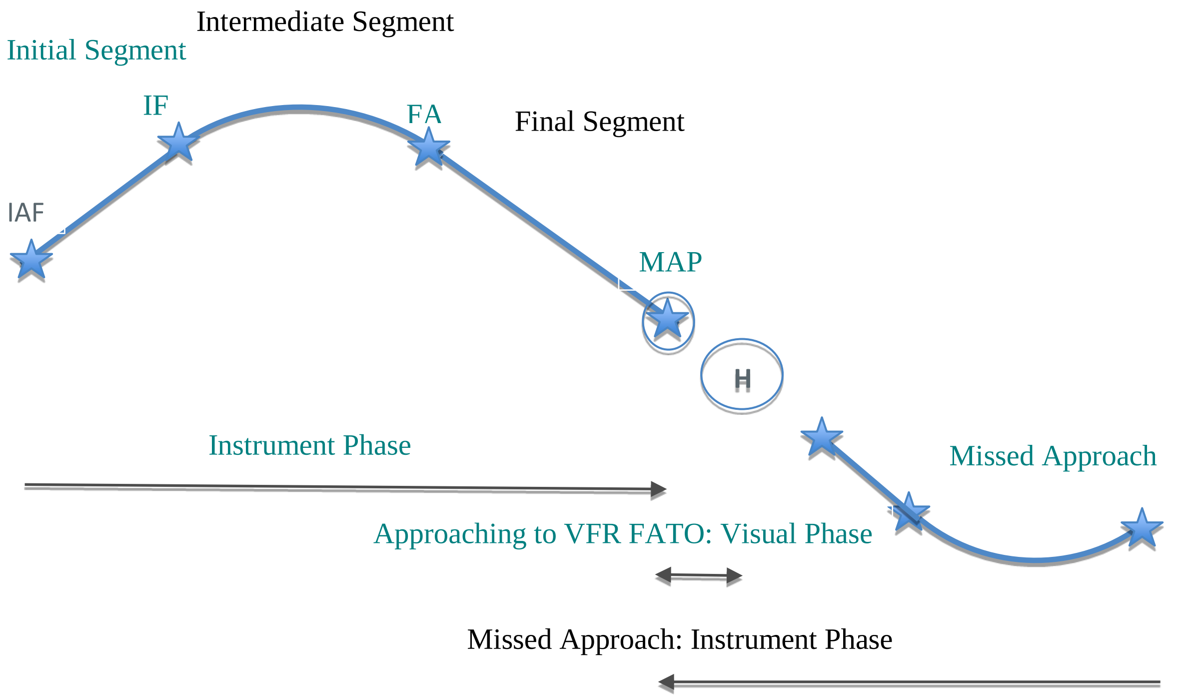


Figure 12: Schematic lateral view of an advanced PinS LPV approach

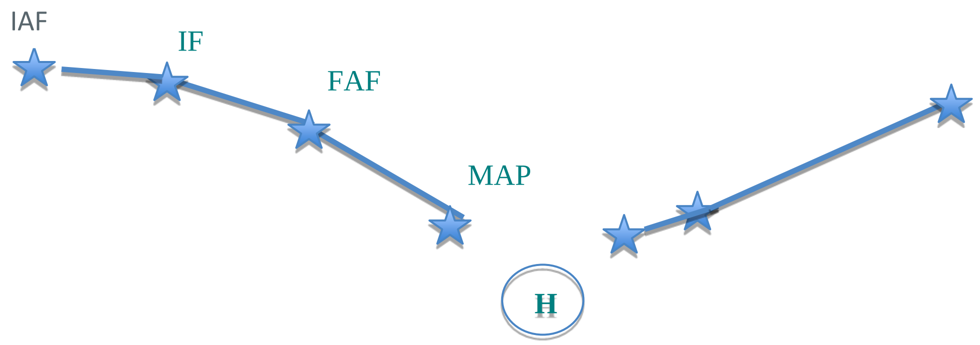


Figure 13: Schematic vertical view of an advanced PinS LPV approach

Expected Benefits

The following potential benefits have been anticipated:

Novelty 1: Applying RNP 0.3 on initial and intermediate approach segment and RF leg to the FAF:

- Reduces track miles, resulting in less fuel consumption and less CO2 emission, through the combined use RF and TF legs with RNP values from 1 down to 0.3. This composition can allow the construction of shorter trajectories, e.g. when noise sensitive and obstacle-rich areas are to be considered. This allows shorter paths, especially for traffic arriving from opposite directions than the runway orientation compared to standard PinS LPV that require a straight aligned segment to FAF.
- Because of the increased adherence to horizontal nominal paths through the use of RF and TF legs with RNP values from 1 down to 0.3:
  - increases ground track predictability and repeatability for Air Traffic Controllers and pilots;
  - Concentrates noise distribution to specific non-sensitive areas when applicable. In case the VFR FATO is not noise-sensitive, full focus on optimised routing (fuel/CO2) should be prioritised, because a RF turn defines a fixed turn trajectory, whereas TF/TF fly-by and fly-over transitions do not, and;
- Increases the VFR FATO accessibility, because a RNP 0.3 procedure with RF leg to the FAF and TF leg to the MAPt allows to construct LPV FAS to a VFR FATO where a standard PinS LPV cannot be constructed due to surrounding terrain.

Novelty 2: Applying RNP 0.3 and RF leg in the final phase of the missed approach:

- Increase the airport accessibility, because with the use of RF turns can make it possible to reduce the LPV minima where the missed approach must confront terrain obstacles.
- Through the better adherence to horizontal nominal paths with the use of RF and TF legs:
  - Increase ground track predictability and repeatability for air traffic controllers and pilot.
  - Concentrate noise distribution to specific non-sensitive areas when applicable. In case the VFR FATO is not noise-sensitive, full focus on optimised routing (fuel/CO2)

3.3.2.1.2.1 Reference *Scenario*

The following reference scenario have been used for the validation of the advanced PinS LPV procedures.

- Low density/Low complexity airspace around Donauwörth heliport EDPR
- EDPR is located in an uncontrolled airspace G reaching from GND to 1000 ft AGL and controlled airspace E from 1000 ft AGL to FL 100
- No ATC but EUROCOPTER INFO available
- No radar surveillance was available along the procedure due to uncontrolled airspace
- Communication coverage was available along the procedure
- EDPR Instrument heliport in accordance to ICAO Annex 14
- VFR operation in VMC will be used to simulate IFR operation but not in IMC itself
- Several IAFs to the approach procedure
- One procedure to and from the heliport

- RF connected to short final LPV segment and a missed approach with RF in the final missed approach segment
- Variety of wind conditions
- Non mountainous terrain

3.3.2.1.2.2 Nominal condition

3.3.2.1.2.2.1 Advanced PinS departure procedure

The crew flew manually using visual references from the FATO to a PinS called the IDF (Initial Departure Fix). The instrument flight phase started once the pilot has passed the IDF at the Minimum Crossing Altitude (MCA). Upon passing the IDF the crew engaged the autopilot NAV mode to fly coupled the curved segment. The autopilot was onlycoupled to lateral guidance but not vertically.

3.3.2.1.2.2.2 Advanced PinS approach procedure

Preparation

At flight preparation, the crew checked that no NOTAM has been published for the VFR FATO and PinS LPV approach. If flying under SBAS coverage, the crew checked that no NOTAM has been published for the SBAS system. If flying outside SBAS coverage, the crew performed a P-RAIM check.

Flight plan loading / execution

At flight plan loading, the crew selected on FMS the approach. The FMS extracted from its database the waypoints sequence with their position and constraints, such as speed or altitude constraints. The FMS extracted also the published minima for the approach and presented them to the crew. The crew was able to select the lowest requested minima (for instance an advanced PinS approach with LPV could be forced to LNAV for training purpose).

The crew checked the flight plan for consistency with the official approach chart. The crew had to ensure the plausibility of the approach by checking the distance and track between the legs. The crew executed lastly the approach on FMS. At flight plan execution, the FMS used for data entry cross-talked to the other FMS the approach selection (in case of dual FMS installation).

Establishment of level of service at Intermediate Fix

Arriving at the IF, the FMS selected the best minima in accordance with the minima requested by the crew and the current integrity performance. The FMS transmitted this minima to the MFD and switched to approach mode. The FMS provided guidance to the active leg and the GPS computed deviation with respect to the final approach segment.

Transition

The lateral transition from FMS to GPS guidance occurred for:

- Straight-in standard PinS LPV approaches at the IF
- Curved or respectively turn at the FAF advanced PinS LPV approaches at the FAF

Upon toggling from FMS to GPS guidance, all data needed for guiding the helicopter along the final approach segment was provided to the crew.

The vertical deviation from GPS or FMS, depending on the minima, was provided to the crew as soon as it was valid. There was no transition from one source to the other.

Autopilot Modes

The crew flew the advanced PinS procedure coupled with NAV mode engaged for lateral coupling up to the IF. The autopilot was not coupled for vertical guidance to the flight plan. Once the IF was passed, the AFCS armed its APP and VAPP upper modes, for lateral and vertical guidance. Using the 4th axis of the AFCS, the crew could select a desired airspeed using the IAS mode, in parallel to the APP/VAPP mode. When the helicopter was within the transition criteria for toggling from FMS guidance to GPS guidance for the final approach segment, the AFCS engaged the APP and later VAPP modes and guides the helicopter down to the DH.

Upon crossing the DH the crew either manually continued the approach in case required visual conditions were met otherwise performed a missed approach using the autopilot GA mode. The visual segment independent of its type either “Proceed VFR” or “Proceed IFR” have been flown manually.

3.3.2.1.2.3 Abnormal condition

3.3.2.1.2.3.1 Advanced PinS departure procedure

The procedure has been validated considering the following abnormal conditions:

- Loss of GNSS before reaching the IDF
- Loss of GNSS upon passing the IDF on the curved segment
- Discrepancy of the lateral guidance upon passing the IDF on the curved segment

3.3.2.1.2.3.2 Advanced PinS approach procedure

The procedure has been validated considering the following abnormal conditions:

- LOS downgrade from LPV to LNAV before the FAF
- LOS downgrade from LPV to LNAV after the FAF
- Loss of GNSS before the FAF on the curved intermediate segment
- Loss of GNSS after the FAF on final approach segment
- Discrepancy of the lateral guidance before the FAF on the curved intermediate segment

3.3.3 Differences between new and previous Operating Methods

The project intended to prove the use of dedicated PinS RNP APCH procedures based on satellite navigation as a means of navigation, exploiting its performances to provide efficient solutions for rotorcraft operations. Such types of rotorcraft are in fact characterized by different constraints, requirements and operating methods, which are not always compatible with the current ATM air-system. In addition it should be considered also the trend within SESAR Programme, which foresees a strong increase of IFR rotorcraft operations with a move of current VFR operations (of IFR certified rotorcraft) into the IFR ones when this is possible.

Today, Rotorcraft reach their best operational performances, when flying unconstrained in VFR flight rules, an operating mode really dependent upon weather conditions and visibility. During winter months this way to operate can be adversely affected, by foggy, cloudy and icing weather conditions which can prevent Rotorcraft to proceed VFR or make them subject to delays when operating to/from a controlled airspace (i.e.: CTR) in a dense medium complexity ATM airspace. At present, when in IFR operations, since there are only very few dedicated rotorcraft procedures, they are used to fly the same instrument flight procedures and routes developed for fixed wing, where altitude constraints permits this kind of operations. Additionally, mixing such different craft along the same procedures or routes can delay rotorcraft operations to/from airports and related VFR FATOs, and impact negatively both the operations of fixed-wing and rotorcrafts.

In this respect GNSS based PinS procedures may represent a valid solution, since they provide a reliable and accurate mean of navigation for IFR operations which allow to develop dedicated and tailored approach instrument flight procedures to/from airport, completely decoupled from the traditional navigation aids (e.g. NDBs, VORs, ILS) and from aircraft procedures, thus avoiding interference (SNI concept) with fixed wing operations. The ability of rotorcrafts to be integrated successfully into the SESAR environment will be subject to the availability of appropriate equipment, both on the ground and in the air. Proportionality considerations include the cost, weight and power requirements of available CNS equipment, and their certification standards. Whilst high-end commercial operations will in many cases be fully compliant and capable, many aircraft operators will wish to or have no option but to continue to fly with minimal additional equipment levels. This reduced capability may result in some constraints to their planned flight especially in busy managed airspace and airports.

Moreover, the ability to operate R/C under IFR increases their utility and safety in ATM environment, extending their safe utilization also in adverse weather conditions. Rotorcraft IFR operators will have an excellent safety record due to the investment in rotorcraft-specific IFR procedures and IFR trained flight crews.

Additionally, for rotorcraft dedicated Instrument Flight Procedures, PinS approach with LPV-LNAV/VNAV minima (SBAS-BaroVNAV augmented) and with LNAV minima (GPS only), can represent a valid mean to guarantee access to VFR FATOs landing locations (not aerodrome located) where conventional flight procedure cannot be developed; and moreover can provide an alternative IFR capabilities to small airport where the installation of traditional navigation aids is not financially viable or unfeasible due to other specific constraints.

Today rotorcraft traffic has hard difficulties in order to operate in airports where rotorcraft and aircraft traffic need to be segregated to optimize the airport capacity. The actual instrument approach procedures developed for airport operations are optimized for fixed-wing aircraft and not well adapted to rotorcraft flight characteristics. As a consequence rotorcraft is forced to fly either the fixed-wing IFR procedures that are not adapted to their capabilities or to fly in VFR, provided that the weather and visual conditions are compatible with such operating mode. The result is that rotorcraft operations are discouraged (even rejected) at busy airports.

In this airport environment satellite navigation availability without local ground installation is well adapted to Rotorcraft IFR operations. The rotorcraft instrument approach procedures which are included in the ICAO regulations in the following years are the most suitable solution to deal with the requirements for such kind of operations. The implementation of rotorcraft specific approach procedures relying on GNSS/SBAS guidance and allowing SNI operations will improve the airport capacity, the operational efficiency and will contribute to reduce both costs and the environmental impact.

Moreover, the ability to operate rotorcraft under IFR increases their utility and safety, extending their safe utilisation also in adverse weather, IMC conditions.

These procedures are specific in a sense that their geometry and speed profile are adapted to helicopter capabilities and are customized for respective airports FATOs. The approach followed was to take into account the rotorcraft performance in terms of speed, climb and descent gradient, to analyse the current Standards to be used for the design and then to tailor the procedures for the specific environment.

Rotorcraft capabilities (e.g. steep descent slopes) allow approaches to be designed that are minimising noise nuisance and also, where possible, that can be flown without interfering with fixed-wing on-runway traffic. The main characteristic is the possibility to perform flexible track that allows to fly on areas with low density of population. This is allowed also because these procedures are based on the RNAV navigation method that permits aircraft operation on any desired flight path within the coverage of ground satellite used to compute the aircraft lateral and vertical deviations for the final approach segment.

As far as aircraft operations are concerned, this kind of on board technologies in addition to available approach design criteria and en-route optimization can offer a strong contribution in terms of runway / VFR FATOs usage, ATM airspace optimization and improvement especially for the following situations:

1. Airports or FATOs VFR characterized by terrain or airspace constraints preventing the possibility to develop conventional approach procedures;
2. Airports when only one navaid is available for landing and no suitable back-up approach procedure exists, or for those runways where no precision approach procedure exists.
3. Not only aerodrome (airports and heliports). We also have to consider any suitable landing locations (FATOs) for RC operations (...helidecks, Hospital operating site, etc.) where PinS procedure could allow a smooth and better integration in a rich obstacle environment and congested urban area, within a busy ATM airspace.

The PinS operational concept can be summarised as:

In the near future, satellite-based instrumental flight procedures will radically change the way Rotorcraft are operated, improving transportation inter-modality and efficiency. The specific rotorcraft capabilities of tight turns, steep climb and descent, combined to dedicated IFR procedures with curved segments based on GNSS will allow to avoid noise sensitive populated areas, interact with the conventional air traffic without interfering, and operate in optimal ways in obstacle-rich urban environments, increasing availability and safety even at night and in low visibility conditions. It is then expected that, more and more PinS procedures will be studied, approved and published for a number of airports, to exploit the utilisation of rotorcraft, as well as to increase landing capacity (granting better access on several landing location) with no significant economic impact due to the installation of traditional landing navigation means in at smaller or regional airports. New operating methods, will maintain and improve the level of safety.

Activities (in EATMA) that are impacted by the SESAR Solution	Current Operating Method	New Operating Method
Acknowledge landing clearance	The rotorcraft pilot receives the landing clearance and confirms this with a read back	
Arrival traffic control and sequencing	The executive approach and departure controller is responsible for the arrival traffic including sequencing.	
Change frequency and contact Executive Approach/Departure Controller	After receiving handover information the pilot contacts the executive approach and departure controller	
Change to TWR frequency	After receiving handover information the rotorcraft pilot switches his frequency to the TWR controller	
Clear flight for cruise	The executive approach and departure controller clears the rotorcraft for cruise flight level.	
Control departure traffic	The TWR controller controls the departure traffic under his responsibility	
Cruise flight without HMD, with head-down display	N/A	After reaching cruise flight level, the pilot flies without HMD and with head-down display
Flight according PinS take-off trajectory with HMI	N/A	After IFR clearance the rotorcraft flies PinS take-off trajectory with HMD until he reaches cruise flight level.
Flight with head-down display	N/A	The pilot flies with head-down display until he reaches IAF
Monitor trajectory until MAPt	The pilot monitors the trajectory until he reaches MAPt	
Preform missed approach procedure	If no visual reference is available at MAPt or the pilot decides not to land, the rotorcraft performs a missed approach procedure	

PinS approach with HMD	N/A	After reaching IAF the pilot flies a PinS approach with HMD
Provide departure clearance (advanced PinS procedure)	N/A	The TWR controller provides departure clearance with advanced PinS
Provide landing clearance (advanced PinS procedure)	N/A	The TWR controller provides a landing clearance to the rotorcraft crew
Request departure clearance (advanced PinS approach)	N/A	The Flight Crew requests departure clearance with advanced PinS
Rotorcraft complies to approach clearance	The rotorcraft complies to the given approach clearance	
Sequencing, Separation, Speed regulation	The executive approach and departure controller is responsible for sequencing, separation and speed regulation as long as the rotorcraft is under his responsibility	
Surveillance until MAPt	If the rotorcraft flies a missed approach procedure the TWR controller provides the handover information to the crew	
Transfer flight to TWR	After reaching FAF the controller provides handover information to the rotorcraft crew	
Transfer flight to Executive Approach/Departure Controller	After the rotorcraft reaches IDF the TWR controller provides handover information to the rotorcraft crew	
Visual departure with HMD until IDF	N/A	The pilot flies visual departure with HMD until he reaches IDF

Table 7: Difference between new and previous Operating Method

4 Safety, Performance and Interoperability Requirements (SPR-INTEROP)

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0001
Title	Navigation Data Display
Requirement	The rotorcraft pilot shall have access to a Navigation Data Display as primary flight indicator.
Status	<validated>
Rationale	A continuous navigation data display as primary flight indicator is necessary in order to provide indication to pilots with possible failure, actual status, integrity, lateral deviation (cross track deviation), helicopter position relative to the desired approach path. Furthermore the pilot needs access to the actual navigation sources used, the active waypoint, velocity, time, distance and bearing to the active waypoint (IAF, IF, FAF) during PinS APCH procedure.
Category	<HMI>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-0003 REQ-PJ.01.06-TS-IRS-0004 REQ-PJ.01.06-TS-IRS-0005

		REQ-PJ.01.06-TS-IRS-0006 REQ-PJ.01.06-TS-IRS-0011 REQ-PJ.01.06-TS-IRS-PERF-0001 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	PinS approach with HMD Flight according PinS take-off trajectory with HMI

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0002
Title	Navigation Data Base
Requirement	The rotorcraft pilot shall have access to the current Navigation Data Base
Status	<validated>
Rationale	A navigation data base stored on the helicopter navigation systems which includes functions and capabilities to execute desired RNP considering terminal procedure is necessary to execute advanced PinS operation manoeuvres.
Category	<HMI>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	Flight according PinS take-off trajectory with HMI PinS approach with HMD

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0003
Title	Path Terminator Transition
Requirement	The rotorcraft pilot shall have the possibility to execute Path Terminator Transition
Status	<validated>
Rationale	A helicopter navigation system which includes functions and capabilities to execute path terminator transition is necessary to execute advanced PinS operation manoeuvres.
Category	<HMI>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-0003 REQ-PJ.01.06-TS-IRS-0007 REQ-PJ.01.06-TS-IRS-0009 REQ-PJ.01.06-TS-IRS-0011 REQ-PJ.01.06-TS-IRS-0012 REQ-PJ.01.06-TS-IRS-0013 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	Flight according PinS take-off trajectory with HMI PinS approach with HMD

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0004
Title	Selection of desired Advanced PinS procedure
Requirement	The rotorcraft pilot shall have the possibility to select the desired Advanced Pins procedure on the HMI.
Status	<validated>
Rationale	To comply with the desired PinS APCH procedure, functions and capabilities are necessary to enable a selection from the navigation database.
Category	<HMI>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	Flight according PinS take-off trajectory with HMI PinS approach with HMD Request departure clearance (advanced PinS approach)

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0005
Title	Helicopter Performance Monitoring
Requirement	The rotorcraft pilot shall receive the Helicopter Performance Monitoring on the HMI.
Status	<validated>

Rationale	Display navigations systems accuracy, integrity, availability and continuity including helicopter performance monitoring are necessary information for the pilots during approach phase.
Category	<HMI>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-0003 REQ-PJ.01.06-TS-IRS-0004 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	Flight according PinS take-off trajectory with HMI

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0006
Title	performing CDFA during approach
Requirement	The rotorcraft pilot shall have the possibility to perform CDFA during approach.
Status	<validated>
Rationale	During last phases of the instrument approach the capability to perform a CDFA is necessary.
Category	<HMI>

[REQ Trace]

Relationship	Linked Element Type	Identifier

<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0002
<ALLOCATED_TO>	<EATMA Activity>	PinS approach with HMD

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0007
Title	Information about Approach procedure Engagement Status before FAP
Requirement	The rotorcraft pilot shall receive information about Approach procedure Engagement Status before FAP on the HMI.
Status	<validated>
Rationale	RNAV-GNSS approach procedure (with LNAV, LNAV/VNAV or LPV minima) engagement status before FAP is an important information for the crew.
Category	<HMI> , <Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-0007 REQ-PJ.01.06-TS-IRS-0009 REQ-PJ.01.06-TS-IRS-0011 REQ-PJ.01.06-TS-IRS-0012

		REQ-PJ.01.06-TS-IRS-0013 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	Rotorcraft complies to approach clearance

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0008
Title	Feedback of Approach procedure selection
Requirement	The rotorcraft pilot shall receive feedback of approach procedure selection on the HMI.
Status	<validated>
Rationale	A visual feedback that RNAV GNSS approach procedure (with LNAV or LPV minima) has been properly selected and validated is an important information for the crew.
Category	<Operational> , <HMI>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-0007 REQ-PJ.01.06-TS-IRS-0009 REQ-PJ.01.06-TS-IRS-0011 REQ-PJ.01.06-TS-IRS-0012 REQ-PJ.01.06-TS-IRS-0013 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	Rotorcraft complies to approach clearance

		PinS approach with HMD

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0009
Title	Distance to MAPt
Requirement	The rotorcraft pilot shall receive current distance to MAPt on the HMI.
Status	<validated>
Rationale	The current distance to MAPt is an important information for the crew.
Category	<Operational> , <HMI>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	PinS approach with HMD Surveillance until MAPt Rotorcraft complies to approach clearance Monitor trajectory until MAPt

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0010
Title	Display lateral and vertical angular scales

Requirement	The rotorcraft pilot shall receive lateral and vertical angular scales on the HMI.
Status	<validated>
Rationale	When performing an RNAV-GNSS approach (with LPV minima), the lateral and vertical angular scales are important information for the pilot.
Category	<HMI> , <Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-0007 REQ-PJ.01.06-TS-IRS-0009 REQ-PJ.01.06-TS-IRS-0011 REQ-PJ.01.06-TS-IRS-0012 REQ-PJ.01.06-TS-IRS-0013
<ALLOCATED_TO>	<EATMA Activity>	Flight according PinS take-off trajectory with HMI PinS approach with HMD

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0011
Title	Display course to final LPV Approach segment
Requirement	The rotorcraft pilot shall receive the course to final LPV Approach segment on the HMI.
Status	<validated>

Rationale	During a RNAV-GNSS approach (with LNAV or LPV minima) the course to the final LPV approach segment is an important information for the pilot.
Category	<Operational> , <HMI>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-0007 REQ-PJ.01.06-TS-IRS-0009 REQ-PJ.01.06-TS-IRS-0011 REQ-PJ.01.06-TS-IRS-0012 REQ-PJ.01.06-TS-IRS-0013
<ALLOCATED_TO>	<EATMA Activity>	PinS approach with HMD

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0012
Title	Lateral Deviation Display
Requirement	The rotorcraft pilot shall have access to a Lateral Deviation Display.
Status	<validated>
Rationale	A lateral deviation display with the full scale deflection equal to the RNP1 value (1NM) for the initial, intermediate and missed approach segments of RNP APCH approach is necessary to operate advance PinS approach.
Category	<Operational> , <HMI>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	PinS approach with HMD

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0013
Title	Display loss of Integrity/Navigation
Requirement	The rotorcraft pilot shall receive information about loss of Integrity/Navigation on the HMI.
Status	<validated>
Rationale	When an RNAV-GNSS approach (with LNAV or LPV minima) is selected in the flight plan, the pilot must be informed visually about any loss of integrity/navigation of the LNAV or LPV capability during the TERMINAL and APPROACH flight phase to perform a safe advanced PinS approach.
Category	<Operational> , <HMI>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-0002

		REQ-PJ.01.06-TS-IRS-0007 REQ-PJ.01.06-TS-IRS-0009 REQ-PJ.01.06-TS-IRS-0011 REQ-PJ.01.06-TS-IRS-0012 REQ-PJ.01.06-TS-IRS-0013 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	PinS approach with HMD

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0014
Title	Selection of RNAV-GNSS Approach procedure
Requirement	The rotorcraft pilot shall have the possibility to select the RNAV-GNSS Approach procedure.
Status	<validated>
Rationale	A function for selection of the RNAV-GNSS approach procedure (with LNAV, LNAV/VNAV or LPV minima) must be available.
Category	<Operational> , <HMI>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	PinS approach with HMD Rotorcraft complies to approach clearance

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0015
Title	Initiating Missed Approach
Requirement	The RF leg shall be kept as the active leg when a missed approach is initiated by the rotorcraft pilot.
Status	<validated>
Rationale	When initiating the missed approach while on a RF leg, the FMS shall keep the RF leg as the active leg.
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-0003 REQ-PJ.01.06-TS-IRS-0006 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	Preform missed approach procedure

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0016
Title	RNAV procedure with LPV minima
Requirement	When flying RNAV procedure with LPV minima, vertical guidance shall be based on vertical deviations computed by the GNSS.
Status	<validated>
Rationale	A calculation of vertical deviations is necessary to operate RNAV procedure with LPV minima safely.

Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-0006
<ALLOCATED_TO>	<EATMA Activity>	PinS approach with HMD Rotorcraft complies to approach clearance

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0017
Title	Performance
Requirement	The lateral cross track error shall be within RNP 0.3 value for at least 95 percent of the total flight time.
Status	<validated>
Rationale	Cross track error is essential for RNP performing.
Category	<Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001

		REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-0003 REQ-PJ.01.06-TS-IRS-0004 REQ-PJ.01.06-TS-IRS-0005 REQ-PJ.01.06-TS-IRS-0006 REQ-PJ.01.06-TS-IRS-PERF-0001 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	PinS approach with HMD Rotorcraft complies to approach clearance

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0018
Title	FCS in LNAV mode when initiating missed approach
Requirement	The rotorcraft pilot shall have the possibility to activate LNAV mode manually.
Status	<validated>
Rationale	When initiating the missed approach, the FCS shall remain in LNAV mode or automatically engage the LNAV mode; if the LNAV mode is not kept or automatically engaged, the FCS shall allow the engagement of LNAV mode.
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-0006 REQ-PJ.01.06-TS-IRS-PERF-0002

<ALLOCATED_TO>	<EATMA Activity>	Preform missed approach procedure

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0019
Title	Concept Integration
Requirement	The integration of the concept shall be possible with the related OI steps and enablers at the current level of maturity
Status	<validated>
Rationale	It must be checked whether the new concept is possible with the linked OI-steps and enablers in EATMA.
Category	<Interoperability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0001 REQ-PJ.01.06-TS-IRS-0002 REQ-PJ.01.06-TS-IRS-0003 REQ-PJ.01.06-TS-IRS-0004 REQ-PJ.01.06-TS-IRS-0005 REQ-PJ.01.06-TS-IRS-PERF-0001 REQ-PJ.01.06-TS-IRS-PERF-0002
<ALLOCATED_TO>	<EATMA Activity>	Flight according PinS take-off trajectory with HMI PinS approach with HMD

[REQ]

Identifier	REQ-PJ.01.06-SPRINTEROP-0020
Title	Linear Deviation
Requirement	The rotorcraft pilot shall get an indication about linear deviation
Status	<validated>
Rationale	Information about linear deviations are necessary to perform an RNAV-GNSS approach and RNP en-route
Category	<Operational>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA
<ALLOCATED_TO>	<TS/IRS Requirement>	REQ-PJ.01.06-TS-IRS-0008 REQ-PJ.01.06-TS-IRS-00010
<ALLOCATED_TO>	<EATMA Activity>	Flight according PinS take-off trajectory with HMI PinS approach with HMD

[REQ]

Identifier	REQ-PJ.01.06-SEC-MSSC-C8.3-0001
Title	Software design - Detection, prevention and recovery controls
Requirement	Software design and operation shall provide detection, prevention, and recovery controls to protect A/C software against malicious code.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01.06-SEC-MSSC-C8.3-0002
Title	Loss of software function or the unauthorised replay.
Requirement	The loss of software function or the unauthorised replay of sensitive data has a potentially high impact on Operational Safety, Performance (Delay, Environment) and/or Cost of Operation. Malicious software may stop operations, manipulate data to the detriment of operations, or provide unauthorized access to data or operations. Malicious software may be introduced in design or production coding, via operational updates or through the use of viruses.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01.06-SEC-PR1-C8.3-0001

Title	Detection and removement of malicious software
Requirement	The software development and production process shall detect and remove malicious software prior to the in-service date.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-PR2-C8.3-0002
Title	Software management process - removed on detection.
Requirement	The software management process shall ensure that all detected malicious software is removed on detection.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-PR3-C8.3-0003
Title	Immediate user information
Requirement	Once detected users shall be immediately informed of the event and as soon as possible provided with detailed of any effects.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-PR4-C8.3-0004
Title	Software Installation
Requirement	The software shall only be installed from verified media.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport

		TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-PR5-C8.3-0005
Title	Validated and verificated software installation
Requirement	Only software which has been the subject of documented validation and verification testing shall be installed.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-PR7-C8.3-0006
Title	Software development, operations, maintenance and management staff
Requirement	Software development, operations, maintenance and management staff shall be proved with periodic training on type of malicious software.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-TR1-C8.3-0001
Title	Detection and removal system - periodical scan
Requirement	The detection and removal system shall scan all software before installation, all data items that are input to the system, all data and software on access and scan all system software in every 28 day period.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-TR2-C8.3-0002
Title	Protection against detected malicious software achievement
Requirement	For operational systems, protection against detected malicious software shall be achieved within 10 minutes of detection. If cessation of operations is necessary, this shall be done as soon as operationally safe to do so.

Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-TR3-C8.3-0003
Title	Signature databases
Requirement	In response to information about a new form of malicious software development and operation software shall be reviewed for presence. The detection software shall utilise signature databases from a reputable security source; systems connected to the Internet shall update their detection databases within 12 hours of the availability of new signatures, or within 72 hours if the system has no Internet connection.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-TR5-C8.3-0004
Title	Security and Software Management processes alert
Requirement	The System shall alert the Security and Software Management processes within 5 minutes of detecting malicious software.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-TR6-C8.3-0005
Title	Verified media definition
Requirement	Verified media shall be defined within the Software Management process
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier

<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-TR7-C8.3-0006
Title	Validation and verification processes - industry standards
Requirement	Validation and verification processes to be used shall be based on industry standards e.g. ISO or Def Standards and industry best practices.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-TR8-C8.3-0007
Title	Staff training
Requirement	Training to staff shall ensure that all users understand and practice processes for handling media, are aware of the risks resulting from malicious software and the mechanisms by which such software may be inadvertently introduced into the system, and understand general security requirements and good practice for the protection of security tokens such as passwords and access controls. Users shall demonstrate current knowledge of these issues at intervals of no less than 1 year.

Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SEC-TR9-C8.3-0008
Title	Security and Software management processes - up to date listing of trained staff
Requirement	The Security and Software management processes shall maintain an up to date listing of those who have been trained and shall restrict access to operational software to those who have been trained and are current.
Status	<validated>
Rationale	High level cyber security requirement based on a self-assessment of the project members of Solution PJ.01-06.
Category	<Security>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SAF-0001
Title	Clearance Input - Dedicated Interface
Requirement	The Air Traffic Controller shall input any clearance given to an rotorcraft on a dedicated interface
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-SAF-0002
Title	NAVAID cross-check
Requirement	The Flight Crew shall check adherence of selected NAVAIDS to given clearances.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-SAF-0003
Title	Flight trajectory cross-check by Crew
Requirement	The Flight Crew shall check adherence of flight trajectories to given clearances.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-SAF-0004
Title	Terrain Database independent of the MSAW.
Requirement	The Air Traffic Controller shall have access to a Terrain Database independent of the MSAW.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-SAF-0005
Title	Flight trajectories cross-check by ATCO
Requirement	The Air Traffic Controller shall check adherence of flight trajectories to given clearances.
Status	<deleted>
Rationale	Safety requirement deleted as discussed during V3 Maturity Gate
Category	<Safety>

[REQ]

Identifier	REQ-PJ.01-06-SAF-1001
Title	Lateral route deviation greater than 0.3Nm
Requirement	FCRW shall be able to detect lateral route deviation greater than 0.3Nm including during RF leg using HDD or HMD.
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report

Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SAF-1002
Title	Lateral and vertical route deviation during final LPV approach
Requirement	FCRW shall be able to detect lateral and vertical route deviation during final LPV approach using HDD or HMD.
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	TMA Airport

[REQ]

Identifier	REQ-PJ.01-06-SAF-1008
Title	Contingency procedure - loss of GNSS/SBAS

Requirement	Helicopter operator shall define contingency procedure in case of loss of GNSS and/or SBAS during A-PinS operations and considering local environment .
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SAF-1009
Title	Respect contingency procedure - loss of GNSS/SBAS
Requirement	In case of loss of GNSS and/or SBAS during PinS operation, FCRW shall respect helicopter operator's contingency procedures (e,g, conventional navigation or dead reckoning)
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport

		TMA

[REQ]

Identifier	REQ-PJ.01-06-SAF-1012
Title	Contingency procedure - loss of HMD
Requirement	Helicopter operator shall define contingency procedure in case of loss of HMD during A-PinS operations and considering local environment
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	TMA Airport

[REQ]

Identifier	REQ-PJ.01-06-SAF-1013
Title	Respect contingency procedure - loss of HMD
Requirement	In case of loss of HMD during PinS operation, FCRW shall respect helicopter operator's contingency procedures
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SAF-1015
Title	Contingency procedure - loss of AP
Requirement	Helicopter operator shall define contingency procedure in case of loss of AP during A-PinS operations and considering local environment
Status	<validated>
Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	Airport TMA

[REQ]

Identifier	REQ-PJ.01-06-SAF-1016
Title	Respect contingency procedure - loss of AP
Requirement	In case of loss of AP during PinS operation, FCRW shall respect helicopter operator’s contingency procedures
Status	<validated>

Rationale	Safety Requirement based on PJ.01-06 Safety Assessment Report
Category	<Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.01-06
<ALLOCATED_TO>	<Role>	Flight Crew
<ALLOCATED_TO>	<Sub-Operating Environment>	TMA Airport

5 References and Applicable Documents

5.1 Applicable Documents

Content Integration

[1] B.04.01 D138 EATMA Guidance Material

[2] EATMA Community pages

[3] SESAR ATM Lexicon

Content Development

[4] B4.2 D106 Transition Concept of Operations SESAR 2020

System and Service Development

[5] 08.01.01 D52: SWIM Foundation v2

[6] 08.01.01 D49: SWIM Compliance Criteria

[7] 08.01.03 D47: AIRM v4.1.0

[8] 08.03.10 D45: ISRM Foundation v00.08.00

[9] B.04.03 D102 SESAR Working Method on Services

[10]B.04.03 D128 ADD SESAR1

[11]B.04.05 Common Service Foundation Method

Performance Management

[12]B.04.01 D108 SESAR 2020 Transition Performance Framework

[13]B.04.01 D42 SESAR2020 Transition Validation

[14]B.05 D86 Guidance on KPIs and Data Collection support to SESAR 2020 transition.

[15]16.06.06-D68 Part 1 –SESAR Cost Benefit Analysis – Integrated Model

[16]16.06.06-D51-SESAR_1 Business Case Consolidated_Deliverable-00.01.00 and CBA

[17]Method to assess cost of European ATM improvements and technologies, EUROCONTROL (2014)

[18]ATM Cost Breakdown Structure_ed02_2014

[19]Standard Inputs for EUROCONTROL Cost Benefit Analyses

[20]16.06.06_D26-08 ATM CBA Quality Checklist

[21]16.06.06_D26_04_Guidelines_for_Producing_Benefit_and_Impact_Mechanisms

Validation

[22]03.00 D16 WP3 Engineering methodology

[23]Transition VALS SESAR 2020 - Consolidated deliverable with contribution from Operational Federating Projects

[24]European Operational Concept Validation Methodology (E-OCVM) - 3.0 [February 2010]

System Engineering

[25]SESAR 2020 Requirements and Validation Guidelines

Safety

[26]SESAR, Safety Reference Material, Edition 4.0, April 2016

[27]SESAR, Guidance to Apply the Safety Reference Material, Edition 3.0, April 2016

[28]SESAR, Final Guidance Material to Execute Proof of Concept, Ed00.04.00, August 2015

[29]SESAR, Resilience Engineering Guidance, May 2016

Human Performance

[30]16.06.05 D 27 HP Reference Material D27

[31]16.04.02 D04 e-HP Repository - Release note

Environment Assessment

[32]SESAR, Environment Reference Material, alias, “Environmental impact assessment as part of the global SESAR validation”, Project 16.06.03, Deliverable D26, 2014.

[33]ICAO CAEP – “Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes” document, Doc 10031.

Security

[34]16.06.02 D103 SESAR Security Ref Material Level

[35]16.06.02 D137 Minimum Set of Security Controls (MSSCs).

[36]16.06.02 D131 Security Database Application (CTRL_S)

5.2 Reference Documents

[37]ED-78A GUIDELINES FOR APPROVAL OF THE PROVISION AND USE OF AIR TRAFFIC SERVICES SUPPORTED BY DATA COMMUNICATIONS.[1]

Appendix A Cost and Benefit Mechanisms

A.1 Stakeholders identification and Expectations

Stakeholder	Involvement	Why it matters to stakeholder
ANSP	No involvement	Improve the easiness approach design due to the enablers capabilities
Airport Operators	No involvement	Improve the traffic due to separated traffic in airport (SNI) and in TMA also Increased operator workload due to the management of interference between traffic
Airspace users	No involvement	Decreased operator workload due to the piloting symbology and increased the situation awareness providing a wide field of view (head motion). Decreased operator workload due to the autopilot pilot and decrease the human error

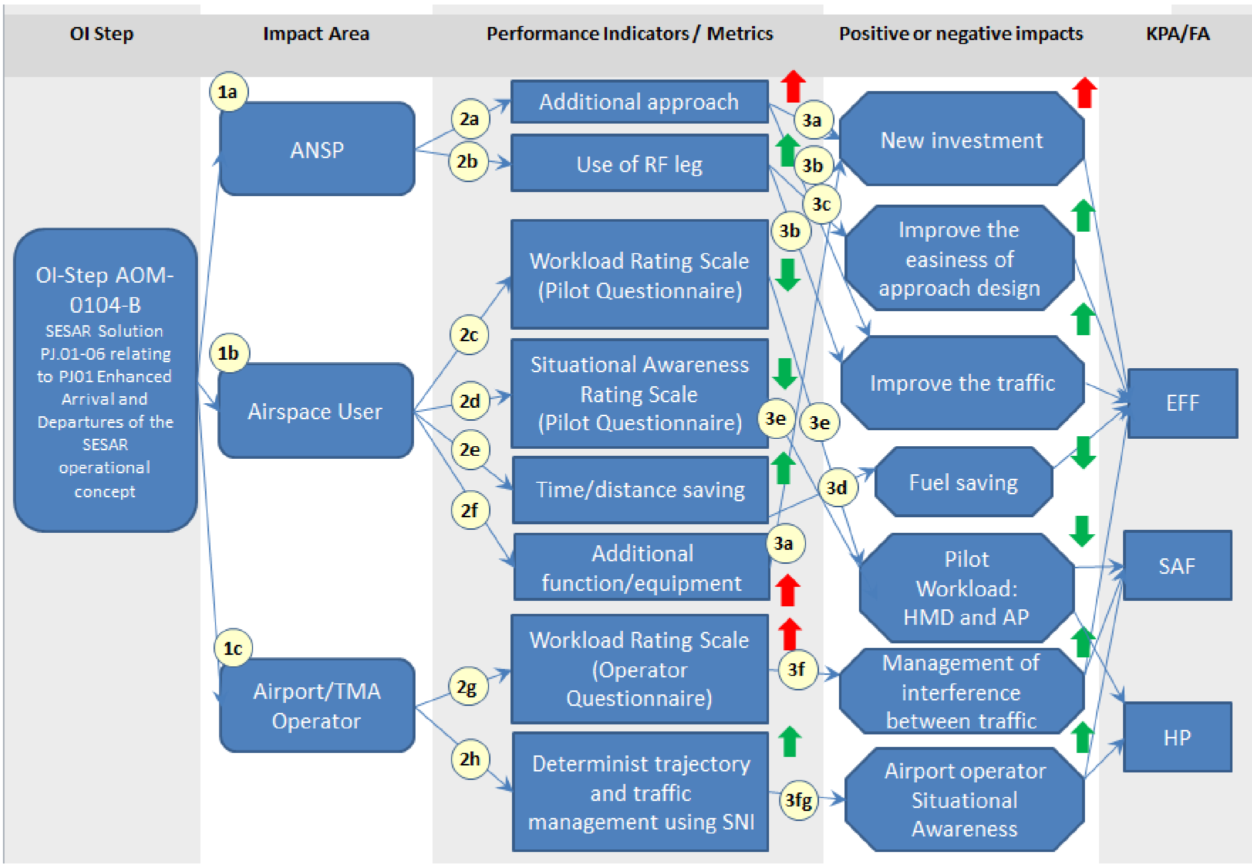
Table 8: Stakeholder's expectations

A.2 Benefits mechanisms

Positive Impact	Primary or Secondary	Rank (1 = most important)	Order of Magnitude
ANSP : Improve the easiness approach design due to the enablers capabilities	Primary	1	>
Airport operator : Improve the traffic due to separated traffic in airport (SNI) and in TMA also	Primary	2	>
Approach : Reduce number of delayed and increase the predictability due to the traffic management using SNI or reducing the time of interference	Primary	3	≈

Approach : Reduce the length of the approach regarding a A/C approach Determinist trajectory	Primary	4	>
Approach : Lower Fuel Consumption for Conflict Resolution	Primary	5	≈
Airspace user ; Auto pilote : Decreases operator workload due to the autopilot pilot and decrease the human error	Secondary	6	>
Airspace user : HMD Decreases operator workload due to the piloting symbology and increased the situation awareness providing a wide field of view (head motion)	Secondary	7	>

Negative Impact	**Primary or Secondary**	**Rank** (1 = most important)	**Order of Magnitude**
ANSP : Require investment for approach design	Primary	1	>
Airspace user : Require investment for rotorcraft upgrade	Primary	2	>
Airport Operators : Increased operator workload due to the management of interference between traffic	Primary	3	>



(1a)	More approach using RF leg and easy to implement
(1b)	New functionality and capability to take-off and land
(1c)	Management of different kind of traffic (rotorcraft and A/C simultaneously), new way of separation
(2a)	New approach implementation
(2b)	RF leg capability
(2c)	Pilot work load measure
(2d)	Time and distance saving during the approach
(2e)	Additional piloting functionality on-bard of the rotorcraft
(2f)	Pilot situational awareness measure
(2g)	Airport/TMA Operator work load measure
(2h)	Airport/TMA situational awareness measure
(3a)	New investment

(3b)	Improvement of the traffic
(3c)	Improvement of the procedure design
(3d)	Fuel saving
(3e)	Decrease the pilot workload
(3f)	Easy interference traffic management
(3g)	Increase the Airport/TMA situational awareness

A.3 Costs mechanisms

The implementation of the new concept is expected to induce implementation costs

- for procedure implementation
- for ATCO training
- for adaptation of standards & regulations

It is expected that the concept will reduce costs for Airspace Users because of reduced fuel.