International Civil Aviation Organization

MIDANPIRG/22 & RASG-MID/12 Meetings

(Doha, Qatar, 4 – 8 May 2025)

Agenda Item 5.3: ANS (AIM, PBN, AGA-AOP, ATM-SAR, CNS and MET)

OUTCOME OF THE PBN SG/9 MEETING

(Presented by the Secretariat)

SUMMARY

This paper presents the outcome of the PBN SG/9 meeting.

Action by the meeting is at paragraph 3.

REFERENCES

– PBN SG/9 Report

1. INTRODUCTION

1.1 The Ninth meeting of the Performance Based Navigation Sub-Group (PBN SG/9) was successfully held in Doha, Qatar, from 9 to 11 December 2024. The meeting was attended by a total of fifth-one (51) participants from ten (10) States (Egypt, Iran, Iraq, Jordan, Libya, Oman, Qatar, Saudi Arabia, Sudan, UAE and USA) and four (4) Organizations/Industries.

2. DISCUSSION

Global Developments Related to PBN

2.1 The PBN SG/9 meeting noted updates from several panels and groups, including the Flight Operations Panel (FLTOPSP), Instrument Flight Procedures Panel (IFPP), Navigation Systems Panel (NSP), Separation and Airspace Safety Panel (SASP), and ICAO's Transition to True North Advisory Group (TRUE-AG). Key outcomes from the ANC related to PBN were also highlighted, with a focus on two critical recommendations:

- Recommendation 2.2/2 – Enhancing strategies to address Global Navigation Satellite System (GNSS) interference and improve contingency planning.

- Recommendation 3.2/1 – Phasing out or optimizing legacy systems to align with modern aviation standards.

Magnetic to a True North Reference System

2.2 The PBN SG/9 meeting was apprised of the activities of the ICAO True North Advisory Group (TRUE-AG), an expert group established by the Air Navigation Commission (ANC) comprising representatives from states, international organizations, and industry. Key deliverables for the group include the creation of a Concept of Operations (CONOPS), a detailed transition plan, and strategic recommendations to guide ICAO's preparations for the 2027 Air Navigation Conference (AN-Conf/15) and the 2028 Assembly.

GNSS RFI Impact on Flight Operations

2.3 The use of GNSS in all phases of the flights has increased recently worldwide, being the main navigation sensor that supports the performance-based navigation (PBN) concept. The benefits that brings to aviation makes logical the massive deployment of its use. However, as any other system, it has some inherent vulnerabilities that could potentially impact the aviation that are needed to be minimized and mitigated.

2.4 The PBN SG/9 Meeting appreciated the informative presentations delivered by ICAO, EUROCONTROL, IATA, FAA, Qatar Airways, and Iraq on their recent activities on GNSS RFI. The PBN SG/9 Meeting recognized the value of sharing such experiences and best practices and encouraged all stakeholders to continue contributing by sharing their lessons learned and mitigation efforts during future Sub-Group meetings.

2.5 The PBN SG/9 Meeting emphasized the growing impact of GNSS Radio Frequency Interference (RFI), such as jamming and spoofing, on PBN routes and procedures. These RFI events have caused significant confusion for pilots navigating RNAV routes and procedures, especially in areas affected by such disruptions.

2.6 The PBN SG/9 meeting reiterated the importance of maintaining a robust network of conventional navigation aids, including VORs, DMEs, and ILS, to ensure continued operational safety and airspace capacity during periods of GNSS interference.

iPACK FOR MITIGATION OF GNSS RFI

2.7 The PBN SG/9 Meeting was informed that ICAO is in the process of developing an iPACK for the mitigation of GNSS RFI. This iPACK will leverage existing guidance materials from ICAO and other organizations, as well as best practices from various regions. Designed as a 5-day national workshop, the iPACK will undergo validation with a pilot State and is expected to be available by Q2 2025.

PBAOM

2.8 The meeting may wish to recall that MIDANPIRG/21, through Conclusion 21/6, requested that a Webinar on Performance-Based Aerodrome Operating Minima (PB-AOM) be organized in 2024 to provide a comprehensive understanding of the concept, its implications on aerodrome design and operations. Therefore, a dedicated session on PB-AOM was conducted, allowing for an in-depth discussion of these critical aspects, including practical considerations and challenges in the context of flight operations. The session outlined how PB-AOM enables operators of advanced aircraft to achieve reduced operating minima, particularly in low-visibility conditions, by leveraging enhanced onboard systems and existing aerodrome infrastructure. PBAOM offers significant benefits across the aviation ecosystem. Operators gain flexibility to conduct flights in poorer weather conditions, aerodromes optimize existing infrastructure without costly modifications, and CNS/ATM service providers benefit from streamlined operations that reflect modern aircraft capabilities.

PBN Manual DOC9613, 5TH Edition, Updates

2.9 Further to MIDANPIRG/20 Conclusion 20/23, which called for a webinar to highlight critical updates in the fifth edition of the Performance-Based Navigation (PBN) Manual (Doc 9613, ED5), a dedicated session was organized to facilitate an in-depth exploration of the revised document.

The session provided participants with a platform to analyze key amendments, including operational, technical, and regulatory changes. Notable updates include a restructured framework for improved clarity and accessibility, expanded guidance on Free Route Airspace to optimize airspace efficiency, modernized terminology aligned with current technological advancements, strengthened specifications for Required Navigation Performance Authorization Required (RNP AR) procedures and the integration of advanced technologies such as satellite-based navigation systems.

PBN SIDs and STARs Charting

2.10 The meeting may wish to recall that the MIDANPIRG/21 meeting identified discrepancies in PBN SID/STAR charts published in the Aeronautical Information Publications (AIPs) of MID States and PBN information is dispersed across various sections of SID/STAR charts, varying by country or airport, contrary to the specific promulgation principles outlined by ICAO. These discrepancies, included issues related to chart titles, chart identification, and the PBN Box. The need for a harmonized layout of the PBN SID/STAR charts was agreed, especially given the mandate by the MID Doc002 that necessitates the implementation of PBN SID/STAR at every instrument runway where these procedures are published. the MIDANPIRG/21 meeting, through Decision 21/8, resolved to establish a PBN SID and STAR Charting Ad Hoc Working Group. This Group was tasked with developing standardized guidance and specimen PBN SID and STAR charts to address these challenges and promote consistency across the MID region.

2.11 The PBN SG/9 Meeting reviewed the outcomes of the PBN SID and STAR Charting Ad Hoc Working Group and noted that following a virtual meeting with Eurocontrol, during which the work undertaken by the ICAO EUR/NAT Office and Eurocontrol was presented. To avoid duplication and foster interregional harmonization, the Ad-Hoc Working Group endorsed the PBN SID/STAR Charts Harmonised AIP Publication factsheet at ***Appendix A***, jointly developed by the ICAO EUR/NAT Office and Eurocontrol. This decision aimed to streamline practices, leveraging collaborative insights to enhance alignment in charting methodologies and ensure coherence with broader regional objectives.

2.12 It should be noted that the factsheet, tailored for specialists responsible for chart origination, provides illustrative examples and references to relevant ICAO provisions. This resource is intended to enhance understanding and to promote harmonization but does not seek to replace or override state regulations or ICAO requirements regarding AIP publication and charting. Furthermore and to ensure its effective implementation, complementary explanatory guidance as at ***Appendix B***, was developed to assist States in achieving higher levels of standardization.

2.13 Based on the above and with a view to streamlining efforts, promoting interregional harmonization, and aligning with ongoing initiatives, the PBN SG/9 Meeting agreed to the following draft Conclusion:

Why	To support standardisation and promote harmonization and consistency in the publication of PBN SID and STAR Charts
What	Adoption of ‘PBN SID/STAR charts Harmonised AIP Publication’ factsheet
Who	MIDANPIRG22
When	2025

DRAFT CONCLUSION 9/1: PBN SID/STAR CHARTS HARMONISED AIP PUBLICATION

That, ICAO MID Office:

a) *promotes the PBN SID and STAR Charting factsheet at* ***Appendix A*** *along with the complementary explanatory guidance as at* ***Appendix B*** *to enhance harmonization in the publication of these procedures across the MID Region, ensuring their widespread dissemination among member states; and*

b) *monitors the implementation status of PBN SID/STAR charts and the harmonized AIP publication and provides progress reports to the relevant subsidiary bodies of MIDANPIRG.*

GNSS RFI Mitigation and NOTAM GNSS

2.14 For reference, the meeting may recall that MIDANPIRG/20 endorsed a NOTAM template for GNSS interference through Conclusion 20/18. However, the Middle East region has recently observed an increase in GPS spoofing incidents. In light of these developments, MIDANPIRG/21, via Conclusion 21/30, requested ICAO and IATA, in coordination with the AIM SG, to develop a revised NOTAM template for GNSS interference (including jamming and spoofing).

2.15 The PBN SG/9 meeting reviewed and endorsed the proposed GNSS RFI NOTAM template at ***Appendix C***, pending the establishment of specific NOTAM codes for GNSS interference events. To advance this initiative, the Secretariat was tasked with coordinating the template's finalization and endorsement with the AIM Sub-Group. In parallel, work is currently underway to develop new NOTAM codes, as mandated by AN-Conf/14, to enhance reporting and mitigation of GNSS interference events, including jamming and spoofing. The finalized template will be implemented as soon as the new NOTAM codes become available, ensuring alignment with both regional needs and global developments.

GNSS reversion & contingency

2.16 The PBN SG/9 meeting noted that, just as controllers and pilots have clearly defined procedures for situations such as loss of surveillance, loss of communication, blocked runways, and adverse weather conditions, similar procedures are essential for the loss of navigation signals. It was emphasized that pilots and controllers require clear and straightforward procedures to handle situations when GNSS becomes unavailable.

2.17 It was highlighted that developing such contingency procedures will require each State and its service provider(s) to evaluate how they would manage air traffic in a degraded operational environment. A critical aspect of this process is the availability of reversionary infrastructure to support future operations, whether based on Performance-Based Navigation (PBN) or conventional navigation.

2.18 Considering the foregoing, the PBN SG/9 meeting strongly encouraged States to undertake an awareness campaign on GNSS contingency. Furthermore, the meeting encouraged States to develop Reversion Scenarios and associated Contingency Procedures in the event of GNSS being unusable.

2.19 Based on the above, the PBN SG/9 meeting agreed to the following Draft Conclusion:

Why	to develop Reversion Scenarios and associated Contingency Procedures in the event of GNSS being unusable

What	GNSS reversion & contingency procedures
Who	MID States
When	2025

DRAFT CONCLUSION 9/2: GNSS REVERSION & CONTINGENCY PROCEDURES

That:

a) States are strongly encouraged to raise awareness among Air Navigation Service Providers (ANSPs) and Aircraft Operators (AOs) on GNSS contingency planning to enhance preparedness and operational resilience; and

b) Air Navigation Service Providers (ANSPs) and Aircraft Operators (AOs) are urged to develop reversion scenarios and associated contingency procedures to maintain safe and efficient operations in the event of GNSS unavailability.

RNP APCH guidance material

2.20 The MID-RASP 2023-2025 framework aligns with the Global Aviation Safety Plan (GASP) and establishes six regional safety performance goals. Through the MID Region Safety Performance Measurement and Monitoring (SPMM) system, the RASG-MID tracks progress toward these goals by overseeing 24 Safety Enhancement Initiatives (SEIs) and 61 actionable steps. These address operational risks, organizational challenges, and emerging threats. G1-SEI-04A1 targets Controlled Flight into Terrain (CFIT) risks by advocating for the development of RNP Approach design guidance.

2.21 Building on the MID-RASP framework, the PBN SG/9 meeting highlighted that the ICAO EUR/NAT Office has developed comprehensive RNP Approach Guidance Material (EUR Doc 025, at **Appendix D**).

2.22 To streamline efforts, avoid duplication, and harmonize regional practices, the PBN SG/9 meeting endorsed a following Draft Conclusion:

Why	To promote the guidance material on RNP Approach (RNP APCH) outlined in EUR Doc 025
What	Adoption of the guidance material on RNP Approach (RNP APCH) outlined in EUR Doc 025
Who	MIDANPIRG22
When	2025

DRAFT CONCLUSION 9/3: GUIDANCE MATERIAL ON RNP APPROACH (RNP APCH)

*That, ICAO MID promotes the guidance material on RNP Approach (RNP APCH) outlined in EUR Doc 025, **at Appendix D**, and ensuring its widespread dissemination among MID States.*

Status of the APTA THREAD BLOCK 0 & 1 in MID Region

2.23 The PBN SG/9 meeting reviewed and updated the implementation status of APTA THREAD Blocks 0 and 1 in the MID Region, as summarized in the table below :

Element	**APTA B0/1**	**APTA B0/2**	**APTA B0/4**	**APTA B0/5**	**APTA B0/7**
Status of Impl in MID	75%	56.5%	65.2%	65.2%	86.6%

2.24 The PBN SG/9 meeting highlighted the following:

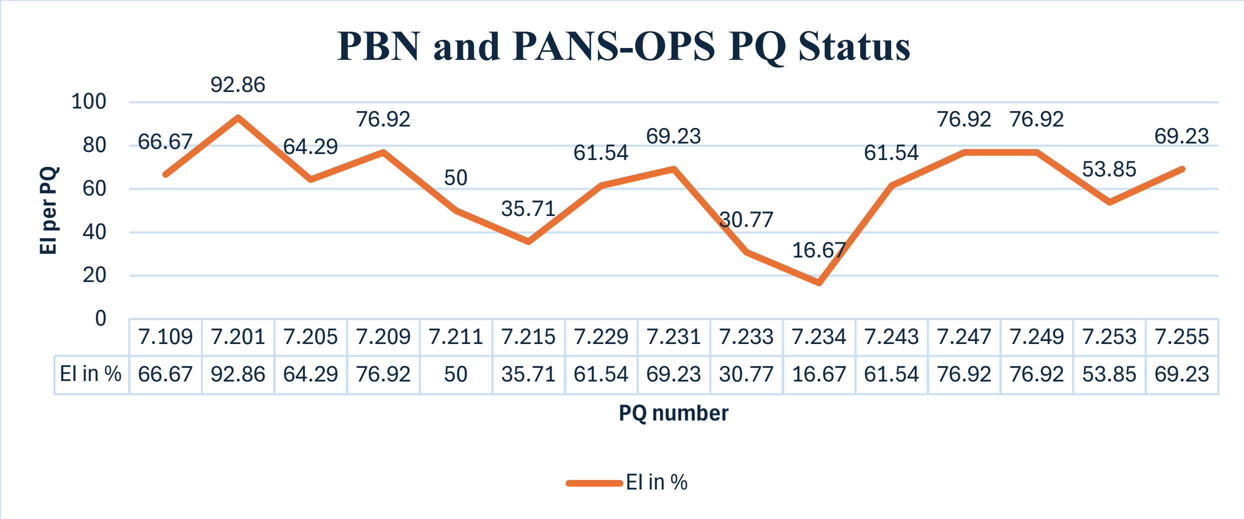
- The status of implementation of the APTA B0/1 related to PBN Approaches (with basic capabilities) reached 75% behind the regional target of 100% by Dec. 2018.
- The status of implementation of the APTA B0/2 related to PBN SID and STAR procedures (with basic capabilities) is 56.5% behind the regional target of 70% by Dec. 2022.
- The status of implementation of the APTA B0/4 and B0/5 reached 65.2%; each element is far behind the regional target of 100% by Dec. 2022.
- The status of implementation of the APTA B0/7 related to Performance based aerodrome operating minima – Advanced aircraft which reached 86.6% above the regional target of 80% by Dec. 2025.

2.25 The PBN SG/9 meeting urged those States behind Global and Regional targets to expedite implementation of PBN to achieve the global targets of the Assembly Resolution A37-11 and the regional targets of the MID Air Navigation Strategy.

IFP provisions and oversight capability in MID Region

2.26 The PBN SG/9 meeting noted the importance of the State Safety Oversight function, specifically the implementation of the eight critical elements (8 CEs), as a foundational framework for ensuring safety in aviation operations. Additionally, the PBN SG/9 meeting highlighted the role of service providers in establishing robust processes and procedures for Instrument Flight Procedure (IFP) development, including the creation of operational and quality manuals. Emphasis was placed on the provision of services, which encompasses designing and publishing procedures based on State-specific criteria, conducting periodic reviews, ensuring continuous maintenance, implementing quality assurance measures, providing comprehensive training and qualification programs, and integrating a Safety Management System (SMS) to uphold safety and efficiency standards.

2.27 The PBN SG/9 meeting noted also the following Chart illustrating the effective implementation of each Protocol Question (PQ) related to PBN and PANS-OPS within the Middle East (MID) Region.



	7.109	7.201	7.205	7.209	7.211	7.215	7.229	7.231	7.233	7.234	7.243	7.247	7.249	7.253	7.255
EI in %	66.67	92.86	64.29	76.92	50	35.71	61.54	69.23	30.77	16.67	61.54	76.92	76.92	53.85	69.23

2.28 Recognizing the importance of robust safety oversight and in view of several Significant Safety Concerns (SSCs) raised during the ICAO Universal Safety Oversight Audit Programme (USOAP) Continuous Monitoring Approach (CMA) Audit of some States in other Regions related to the regulatory oversight of Instrument Flight Procedures (IFP), the PBN SG/9 meeting encouraged States to prioritize building safety oversight capabilities for PBN and PANS-OPS operations. This includes allocating resources for training programs for PANS-OPS inspectors and procedure designers to align with global safety standards.

2.29 On the other hand, the PBN SG/9 meeting agreed to organize a regional workshop dedicated to PBN implementation, IFPD services, and safety oversight practices in IFP to strengthen and support Civil Aviation Authorities (CAAs) in establishing a robust oversight framework for Instrument Flight Procedures (IFP) and Performance-Based Navigation (PBN). States and stakeholders were encouraged to actively participate in the workshop, with the aim of exchanging experiences, addressing challenges, and promoting greater collaboration across the region. Therefore, the PBN SG/9 meeting agreed to the following Draft Conclusion:

Why	To strengthen and support Civil Aviation Authorities (CAAs) in establishing a robust oversight framework for IFP
What	Conduct a Workshop on IFP provisions and oversight
Who	ICAO
When	2025

DRAFT CONCLUSION 9/4: IFP SAFETY OVERSIGHT WORKSHOP

That,

a) IFP Safety Oversight Workshop be organized in 2025; and

b) States and stakeholders are encouraged to actively participate in the workshop to exchange experiences, address challenges, and foster collaboration.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note and discuss the outcomes of the PBN SG/9 meeting; and

b) endorse the proposed Draft Conclusions.

EUROCONTROL

PBN SID/STAR charts
Harmonised AIP Publication

v1.0
29 January 2024

SUPPORTING EUROPEAN AVIATION

CONSORTIUM COORDINATOR sesar DEPLOYMENT MANAGER

FOUNDING MEMBER sesar JOINT UNDERTAKING

NETWORK MANAGER

Introduction

EUROCONTROL monitors the implementation of Performance-Based Navigation (PBN) procedures in ECAC using the PBN Map tool, integrating data from national AIPs and implementation plans derived from PBN Transition plans produced by ATM/ANS providers.

Each AIRAC cycle prompts a thorough examination of national AIPs, with a specific focus on identifying new PBN procedures, particularly Standard Instrument Departures (SIDs) and Standard Instrument Arrivals (STARs).

It was identified that PBN information is dispersed across various sections of SID/STAR charts, varying by country or airport, contrary to the specific promulgation principles outlined by ICAO. This inconsistency prompted EUROCONTROL to address the lack of harmonization in European PBN SID/STAR charts in various stakeholder groups. The need for harmonization was agreed, with the support for creating a factsheet, especially given the mandate by the European PBN implementing regulation (EU 1048/2018) that necessitates the implementation of PBN SID/STAR at every instrument runway where these procedures are published.

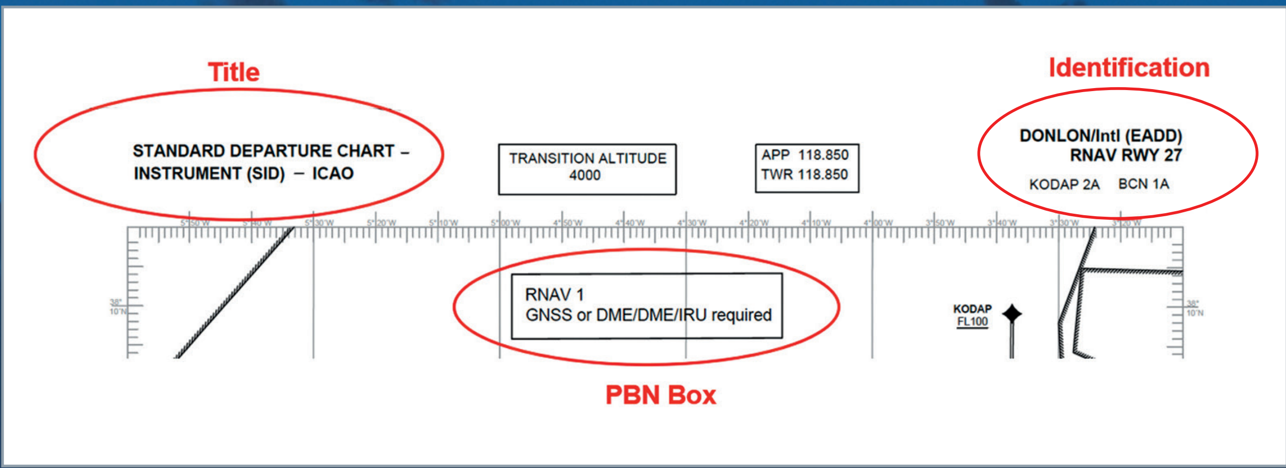
This factsheet, designed for specialists responsible for chart origination, includes illustrative examples and corresponding references to ICAO documentation. It is essential to note that this resource is intended to enhance understanding and promote harmonization but does not seek to replace or override state regulations or ICAO requirements regarding AIP publication and charting.

Objective

The development of this factsheet aims to heighten awareness regarding the charting of PBN SID/STAR in accordance with ICAO principles. The primary objective is to foster harmonization in the publication of these procedures across Europe, especially in anticipation of the increased number of PBN SID/STAR charts due to the PBN Implementing Regulation (EU 1048/2018).

Specifically, this factsheet concentrates solely on three key chart elements:

- Title
- Identification
- PBN box



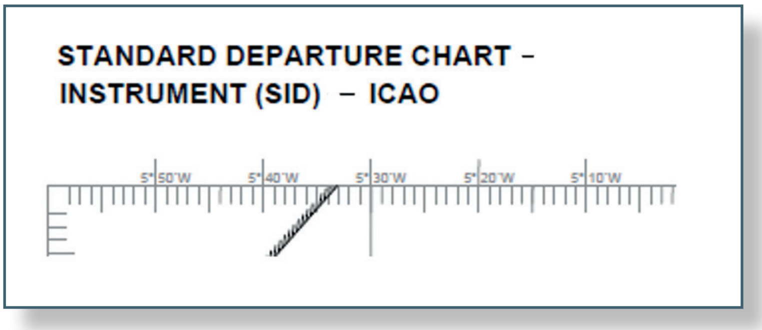
PBN SID/STAR - Chart Title

According to ICAO Doc 8697 Aeronautical Chart Manual, chapter 7.9 (SID):

Title

*"The title must be "**Standard Departure Chart - Instrument (SID) - ICAO**". Such title must not include "ICAO" unless the chart conforms with all Standards specified in Annex 4, Chapters 2 and 9. The chart title is placed at the top left corner of the chart in bold upper-case type".*

Example:

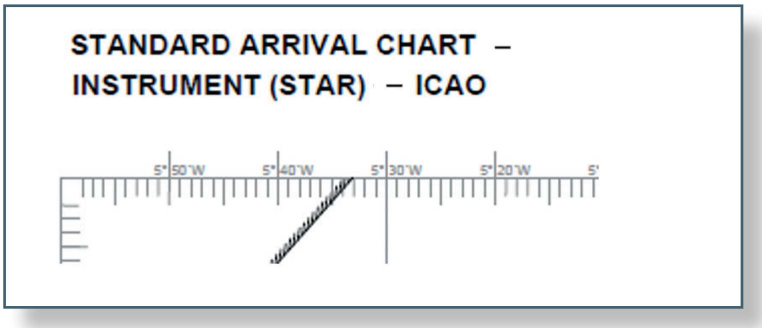


According to ICAO Doc 8697 Aeronautical Chart Manual, chapter 7.10 (STAR):

Title

*"The title must be "**Standard Arrival Chart - Instrument (STAR) - ICAO**". Such title must not include "ICAO" unless the chart conforms with all Standards specified in Annex 4, Chapters 2 and 10. The chart title is placed at the top left corner of the chart in bold upper-case type."*

Example:



PBN SID/STAR - Chart Identification

According to ICAO Doc 8168 PANS-OPS Vol II, Part III, Section 5, Chapter 1.3.2 “Chart Identification”:

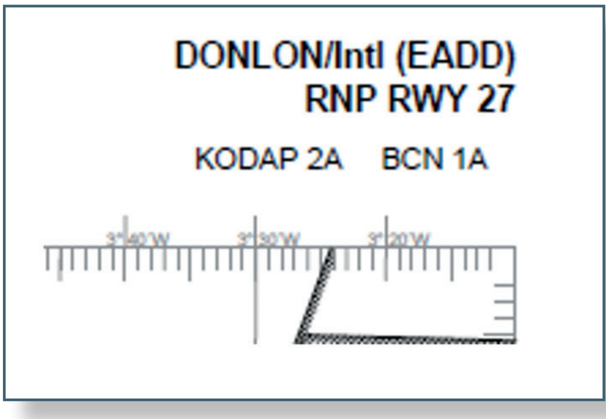
“The chart shall be identified in accordance with Annex 4, 9.5 for departures and 10.5 for arrivals and ***shall include the term RNAV or RNP, depending on the navigation specification****.”*

According to ICAO Doc 8697 Aeronautical Chart Manual, chapter 7.9 (SID) and 7.10 (STAR) “Identification”:

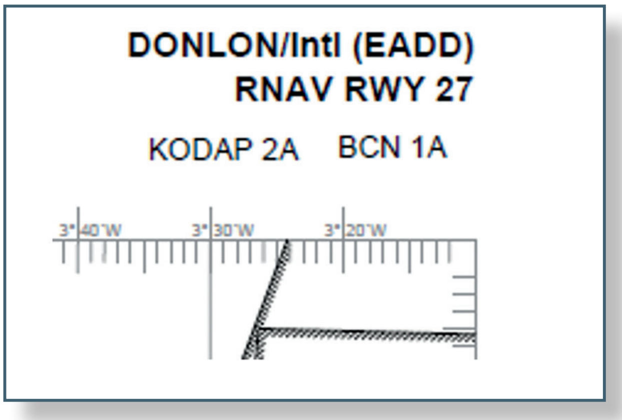
“The chart must be identified by the name of the city or town, or area, that the aerodrome serves, the name of the aerodrome, and the identification of the standard departure/arrival route(s) — instrument as established in accordance with the PANS-OPS, Volume II, Part I, Section 3. The identification of the standard departure/arrival route(s) — instrument is provided by the procedures specialist.

The ICAO location indicator may also be included with the name of the aerodrome. ***The chart identification is placed at the top right corner of the chart in bold upper-case type****.”*

Example for PBN SID/STAR based on RNP:



Example for PBN SID/STAR based on RNAV:



PBN SID/STAR - PBN BOX

According to ICAO Doc 8168 PANS-OPS Vol II, Part III, Section 5, Chapter 1.3.4 "Chart notes":

*"Additional procedure requirements shall be provided as chart notes. **PBN items shall be separated out and published in a PBN requirements box on the plan view of the chart** immediately below the chart identifier. **The PBN requirements box shall include the identification of the navigation specification used in the procedure design, any navigation sensor limitations (e.g. GNSS required, GNSS or DME/DME/IRU required), and any required functionalities (e.g. RF required)** that are described as options in the navigation specification, that is, not included in the core navigation specification."*

Examples of PBN boxes:

RNAV 1
GNSS or DME/DME/IRU required

RNP 1
RF required

RNAV 1
GNSS required

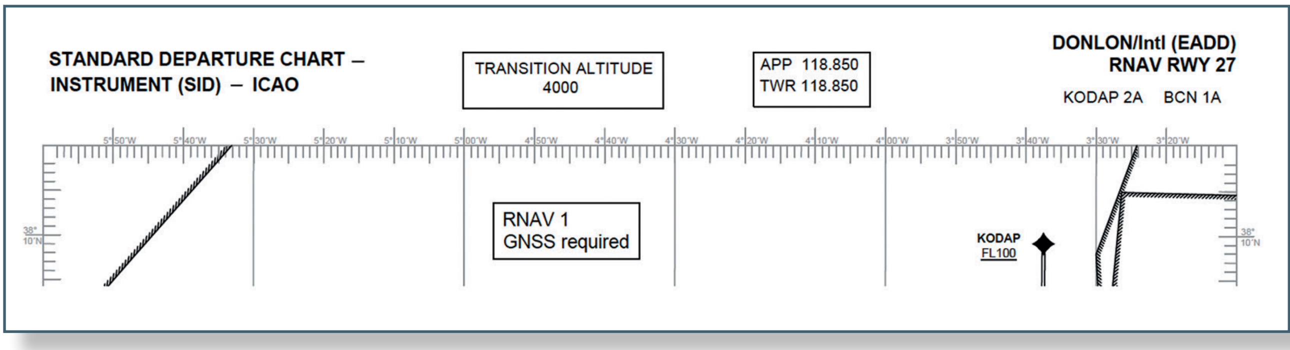
RNP 0.3

Advanced RNP

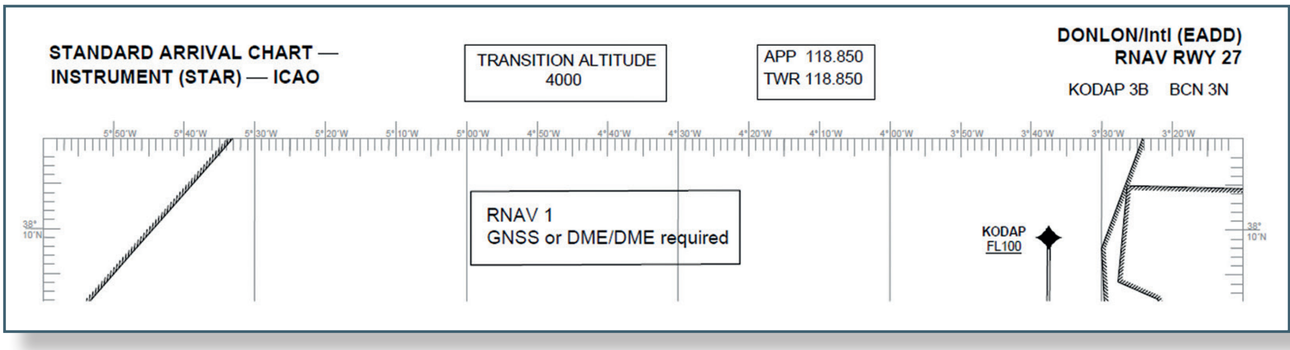
RNAV 5
GNSS or DME/DME required

PBN SID/STAR EXAMPLES

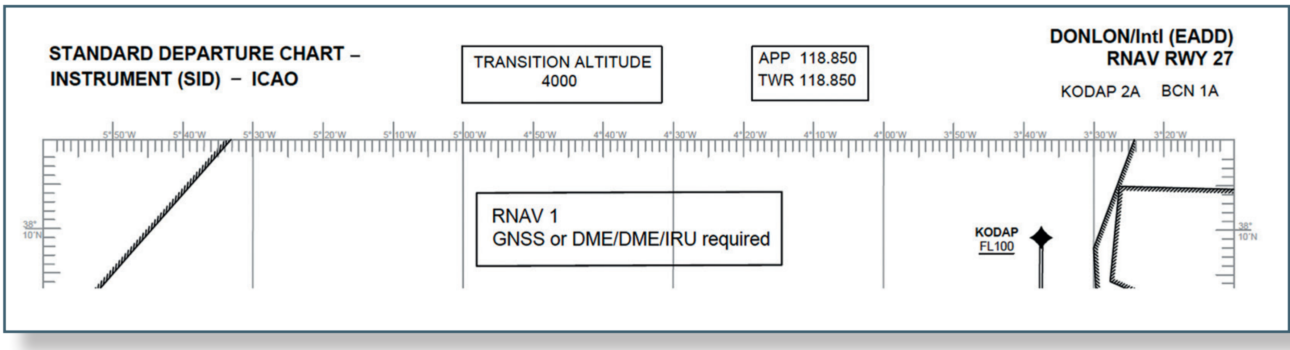
Navigation specification: ***RNAV 1***
Navigation sensor limitations: ***GNSS required*** *(DME/DME is not available)*
Functional requirement: ***None***



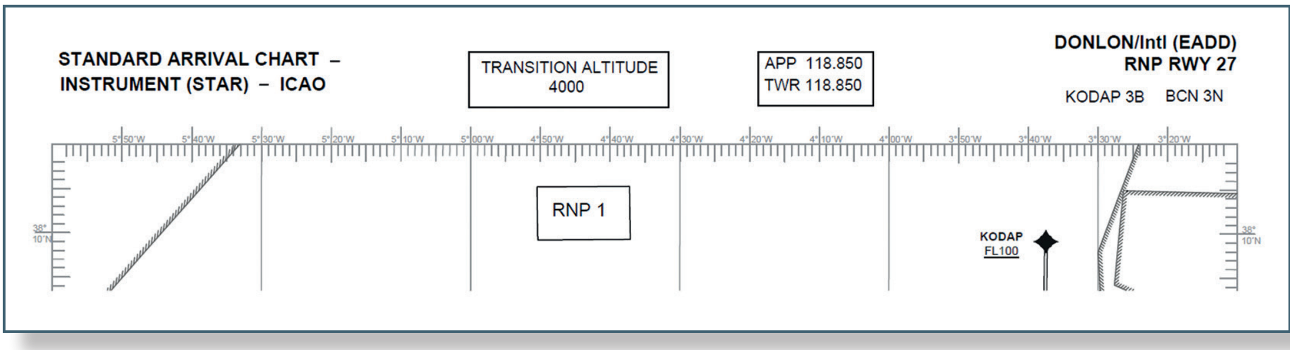
Navigation sensor limitations: **None** (GNSS and DME/DME are available)
Functional requirement: ***None***



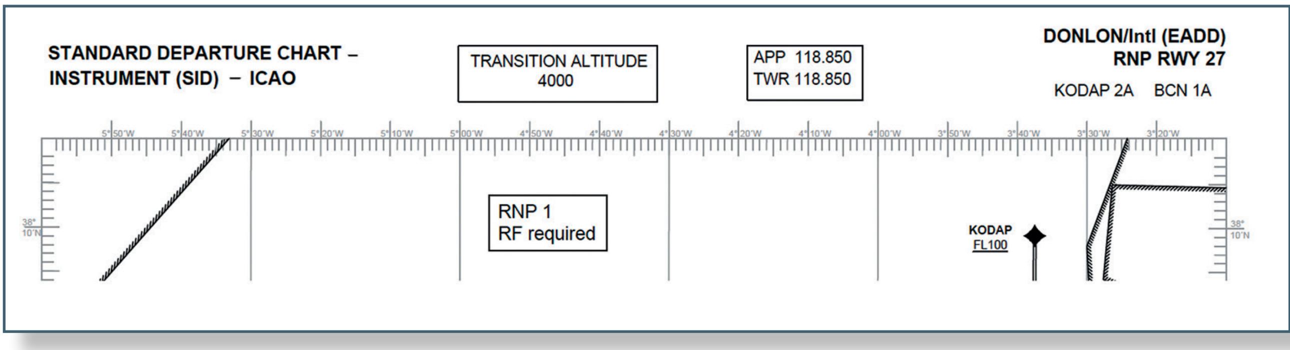
Navigation specification: ***RNAV 1***
Navigation sensor limitations: ***GNSS or DME/DME/<u>IRU</u> required****.*
Functional requirement: ***None***



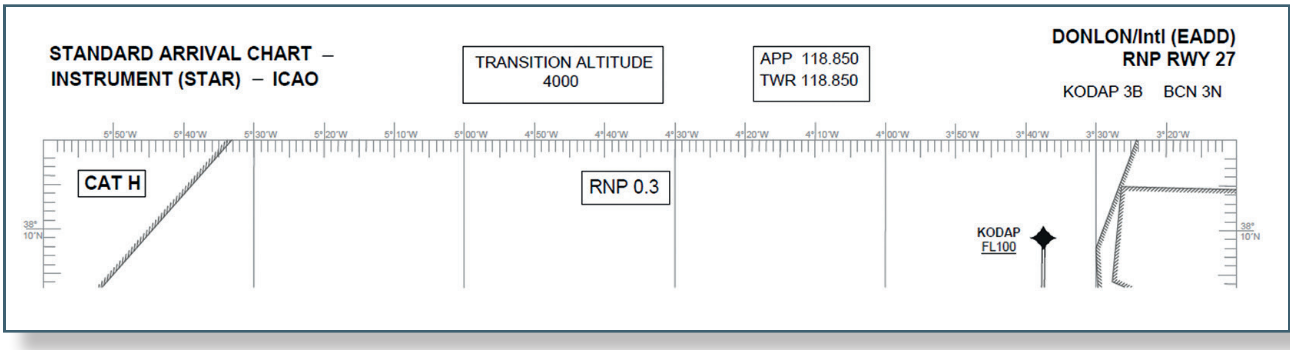
Navigation specification: ***RNP 1***
Navigation sensor limitations: ***None*** *(GNSS required)*
Functional requirement: **None**



Navigation specification: ***RNP 1***
Navigation sensor limitations: ***None*** *(GNSS required)*
Functional requirement: ***RF required***



Navigation specification: ***RNP 0.3*** *(CAT H)*
Navigation sensor limitations: ***None*** *(GNSS required)*
Functional requirement: **None**



Glossary

AIP	Aeronautical information publication
ANS	Air navigation services
ATM	Air traffic management
DME	Distance measuring equipment
GNSS	Global navigation satellite system
IRU	Inertial reference unit
PBN	Performance-based navigation
RF	Radius to fix
RNAV	Area navigation
RNP	Required navigation performance
SID	Standard instrument departure
STAR	Standard instrument arrival

Further Information

The EUROCONTROL Navigation Steering Group (NSG) coordinates the activities necessary for the implementation of PBN procedures in ECAC.

For more information, please contact the nav.user.support@eurocontrol.int or visit our website: https://www.eurocontrol.int/communications-navigation-and-surveillance

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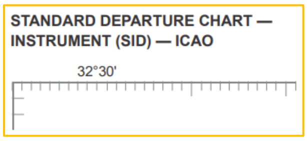
APPENDIX B

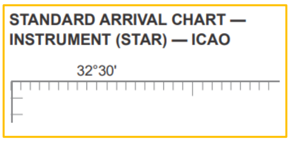
ICAO Charting Provisions

1. ICAO Provisions for Chart Titles:

References: ICAO Annex 4, Doc 8697 and Doc 8168 Vol. II

a. Chart shall be titled in accordance with Annex 4 specifications.
b. The chart title shall not include "ICAO" unless the chart conforms with all ICAO Standards mentioned in the Annex.
c. The title must be "Standard Departure Chart — Instrument (SID) — ICAO" for SID and "Standard Arrival Chart — Instrument (STAR) — ICAO" for STAR.
d. The chart title is placed at the top left corner of the chart in bold upper-case type.

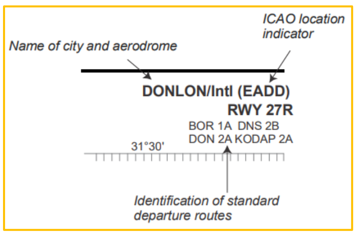


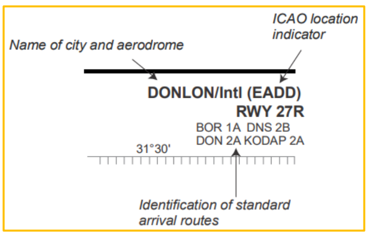


2. ICAO Provisions for Chart Identifications:

References: ICAO Annex 4, Doc 8697 and Doc 8168 Vol. II

a. The chart shall be identified in accordance with Annex 4 requirements and shall include the term RNAV or RNP, depending on the navigation specification.
b. The chart should include an identifier which is unique for that aerodrome and which may include reference to either a runway, fix or NAVAID.
c. The chart shall be identified by the name of the city or town or area which the aerodrome serves, the name of the aerodrome, and the identification of the SID or STAR.
d. The ICAO location indicator may also be included with the name of the aerodrome.
e. The chart identification is placed at the top right corner of the chart in bold upper-case type.





3. ICAO Provisions for PBN Requirement Boxes:

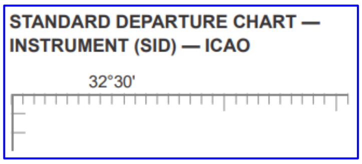
Reference: Doc 8168 Vol. II

a. The provision of PBN requirement boxes is missing in Annex 4 and Aeronautical Chart Manual and specification charts except for those in Doc 8168, Vol. II.
b. PBN items shall be published in a PBN requirements box.
c. The PBN requirements box shall include:
   - the identification of the navigation specification used in the procedure design, such as RNAV 5, RNAV 2, RNAV 1, A-RNP, RNP AR and RNP 1.
   - any navigation sensor limitations, such as GNSS required, DME/DME required.
   - any required functionalities that are described as options in the navigation specification, such as RF required.

<u>Guidance for Chart Harmonization:</u>

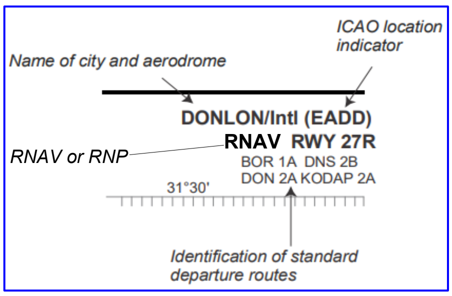
1. Standardizing Chart Titles:

a. Ensure all SID charts are titled as "Standard Departure Chart - Instrument (SID) - ICAO" and all STARs charts as "Standard Arrival Chart - Instrument (STAR) - ICAO".
b. The title should be placed at the top left corner of the chart in bold upper-case type.
c. Do not use ICAO in the chart title if the chart does not meet the Annex 4 charting criteria.
d. Do not use any other things, such as PBN, RNAV, RNP or DEP/ARR, in the chart titles.

Example: 

2. Consistent Chart Identification:

a. Identify charts by the name of the city or town, the aerodrome name, and the identification of the standard departure/arrival routes.
b. Include the ICAO location indicator with the name of the aerodrome.
c. The chart identification should be placed at the top right corner of the chart in bold upper-case type.
d. Use 'RNAV' or 'RNP' based on the navigation specification used in designing the SIDs or STARs. For example, use 'RNAV' for an RNAV1 SID or STAR, and use 'RNP' for an RNP1 SID or STAR, before the runway designation.

Example: 

3. Requirements for PBN Boxes:

a. Include PBN items in the PBN requirements box, preferably on the plan view of the chart, not obscuring the chart information. Do not use such information in any places other than PBN requirement box.
b. The PBN box should contain the navigation specification (e.g., RNAV 1, RNP 1 or A-RNP) that is used for the design of PBN SID or STAR.
c. Clearly specify any sensor limitations (e.g., GNSS required or DME/DME required) within the PBN box, as required.
d. Include any additional functional requirements (e.g., RF required) in the PBN requirement box, as applicable.

Example 1: With sensor limitations and functional requirement

Navigation Specification ------------------------> RNP 1
Sensor Limitations -------------> GNSS and DME/DME required
Functional Requirements -----------------> RF required

Example 2: No sensor limitations, but with a functional requirement for RF

A-RNP
RF required

Example 3: GNSS or DME/DME/IRU only allowed, with no functional requirements

RNAV 2
GNSS or DME/DME/IRU required

Example 4: GNSS only allowed, with no functional requirements

RNAV 1
GNSS required

Example 5: No sensor limitations and functional requirements

RNAV 5

APPENDIX C

NOTAM TEMPLATE FOR GNSS INTERFERENCE

Item Q – Qualifier: the following qualifiers shall be mentioned in item Q:

Qualifier FIR: This Item shall contain the ICAO location indicator of the FIR within which the flights may be impacted by the RFI. If more than one FIR of the same country is impacted, the ICAO nationality letters of that country (e.g. OE) should be followed by 'XX'.

Qualifier NOTAM CODE: the following NOTAM code qualifiers (second and third letter) shall be used as appropriate for GNSS RFI event notification in the case of:

TBD (additional NOTAM codes for GNSS interference events)

Qualifier TRAFFIC: the « IV » should be used as a traffic qualifier, indicating that both IFR and VFR traffic may be impacted by the RFI

Qualifier PURPOSE: the code NBO should be used to notify RFI events:

Qualifier SCOPE: Depending on the impacted area, one of the following codes should be used:

- A = if the event only impacts aerodrome(s) operations (used QGA)
- E = if the event only impacts en-route traffic (used QWA)
- AE = if the event impacts both Aerodrome and En-route traffic (used QWA)

Qualifier LOWER/UPPER: Depending on the jamming range and the traffic in the impacted area.

Qualifier GEOGRAPHICAL REFERENCE – Coordinates: this qualifier indicates the coordinates of the interference source or weighted centre point of the impacted area. For NOTAM with 'Scope' 'A' the Aerodrome Reference Point (ARP) coordinates should be inserted. For NOTAM with 'Scope' 'AE' or 'E' the centre of a circle whose radius encompasses the whole area of interference should be inserted.Qualifier 'GEOGRAPHICAL REFERENCE' – Radius*: The radius of the impacted area should be inserted in this field.

Item A – Location

All FIR location indicators affected by the information should be entered in Item A), each separated by a space. In the case of a single FIR, the Item A) entry must be identical to the 'FIR' qualifier entered in Item Q). When an aerodrome indicator is given in Item A), it must be an aerodrome/heliport situated in the FIR entered in Item Q).

Item B – Start of Activity

A ten-digit date-time group giving the year, month, day, hour and minutes, at which the NOTAM comes into force, should be mentioned in Item B).

Item C – End of Validity

A ten-digit date-time group giving the year, month, day, hour and minute, at which the NOTAM ceases to be in force and becomes invalid, should be mentioned in Item C). This date and time should be later than that given in Item B).

Item E – NOTAM Text

The following standard text should be used according to Q-code:

JAMMING :

GNSS JAMMING REPORTED. GNSS MAY BE UNUSABLE WITHIN …. INSTANCES OF GNSS JAMMING SHOULD IMMEDIATELY BE REPORTED TO ATC.

SPOOFING :

GNSS SPOOFING REPORTED. GNSS MAY BE MISLEADING WITHIN… INSTANCES OF GNSS SPOOFING SHOULD IMMEDIATELY BE REPORTED TO ATC.

GNSS INTERFERANCE

GNSS INTERFERENCES REPORTED. GNSS MAY BE UNUSABLE WITHIN …. INSTANCES OF GNSS INTERFERENCES SHOULD IMMEDIATELY BE REPORTED TO ATC.

WITHIN: specify route / geographical area (coordinates / waypoints)

INTERNATIONAL CIVIL AVIATION ORGANIZATION

European and North Atlantic Office

EUR Doc 025

EUR RNP APCH GUIDANCE MATERIAL

- *Second Edition* –
(V.2.0)
January 2021

EUROPEAN AND NORTH ATLANTIC OFFICE OF ICAO

International Civil Aviation Organization (ICAO)
European and North Atlantic (EUR/NAT) Office
3 bis, Villa Emile Bergerat
92522, Neuilly-sur-Seine CEDEX
FRANCE

e-mail	:	icaoeurnat@paris.icao.int
Tel	:	+33 1 46 41 85 85
Fax	:	+33 1 46 41 85 00
web:		http://www. icao.int/EURNAT

EXCLUSION OF LIABILITY

RECORD OF AMENDMENTS

Edition Number	Edition Date	Description	Pages Affected
1.0	December 2012	First Edition	All
2.0	January 2021	- Amendment prepared by EUROCONTROL NSG and approved by ICAO PBNC TF/3 ECTL NSG/30 - Endorsed by the EASPG through correspondence	All

TABLE OF CONTENTS

1. INTRODUCTION

1.1. ICAO is encouraging all States to implement RNP Approach procedures and requesting the publication of a PBN Implementation Plan through the ICAO Assembly Resolutions 36-23 and 37-11. A first version of this document was developed in 2012 in response to an increasing need for guidance on RNP Approach implementation that had been expressed in several forums.

1.2. In 2020, the landscape for RNP Approach implementation in Europe had evolved significantly and the need to update the document became evident. The second version of the Guidance Material accounts for instance for the declaration of the EGNOS LPV200 service in 2015, the publication of the PBN Implementing Regulation [1] and the availability of new EASA standards for PBN in 2019. It also benefits from lessons learned throughout the implementation of the many RNP Approach procedures already published on the EUR region.

1.3. This guidance is primarily intended for States in the ICAO European region who wish to implement RNP Approach operations. It describes the generic steps that an ANSP and/or Airport should undertake to introduce such operations together with the applicable standards and relevant documentation that is available. The guidance also addresses aircraft operators by including an overview of the available standards that can be used to obtain airworthiness certification and operational approval.

1.4. RNP AR Approach procedures and the use of PBN specifications different from RNP APCH for initial and intermediate segments are outside the scope of this document.

2. GLOSSARY OF MAIN TERMS

ABAS - Aircraft-based augmentation system. An augmentation system that augments and/or integrates the information obtained from GNSS elements with other information available on board the aircraft. [2]. RAIM is a form of ABAS which uses GNSS information exclusively.

APV – Approach Procedures with Vertical Guidance. See definition of Instrument approach procedure (IAP).

- **APV I –** Refers to a set of performance criteria for navigation systems that support RNP Approach down to LPV minima designed using the SBAS APV I procedures design criteria (see ICAO Annex 10 [2] Table 3.7.2.4-1 "Signal-in-space performance requirements"). In Europe, EGNOS provides an APV I Service level meeting these performance requirements.

- **APV Baro-VNAV –** RNP Approach down to LNAV/VNAV minima based on barometric vertical navigation.

- **SBAS APV –** RNP Approach down to LPV minima. ICAO now reserves this term for procedures designed according to APV I criteria (excluding those designed according to SBAS Cat I criteria).

Area Navigation. A method of navigation which permits aircraft operation on any desired flight path within the coverage of ground or space-based navigation aids or within the limits of the capability of self-contained aids, or a combination of these [4].

Area navigation system – There are two types of area navigation system: RNAV and RNP systems. Flying PBN applications requires such systems. An RNP system is required for an RNP APCH application.

Baro-VNAV – Barometric vertical navigation (Baro-VNAV) is a function of an area navigation system that presents computed vertical guidance to the pilot 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).

CDFA – CDFA is a flight operational 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).

CRC – Cyclic Redundancy Check

DA/H (Decision Altitude/Height) - A specified altitude or height in a 3D instrument approach operation at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.

EGNOS – The European Geostationary Navigation Overlay Service. This is the European Satellite Based Augmentation System (SBAS).

EGNOS SoL – The EGNOS Safety of Life Service is the Service offered to aviation users as described in the EGNOS SoL Service Definition Document issued by the European Commission [16].

ESSP – The European Satellite Services Provider (ESSP) is the EGNOS operator. It holds an Air Navigation Service Provider certificate and is under EASA oversight.

Final approach segment (FAS) data block. The coding of procedures to LPV minima in the on-board navigation database includes a FAS Data Block. The FAS Data Block information is protected with high integrity using a cyclic redundancy check (CRC). GLS approaches based on GBAS also use a FAS data block which is slightly different.

GNSS – Global Navigation Satellite System. GNSS is a generic term for all satellite navigation systems including core constellations such as GPS, Galileo, Glonass and BeiDou augmented as necessary by ABAS, SBAS and GBAS to support the required navigation performance for the intended operation.

Instrument approach procedure (IAP). According ICAO Annex 6 [3]: A series of predetermined manoeuvres by reference to flight instruments with specified protection from obstacles from the initial approach fix, or where applicable, from the beginning of a defined arrival route to a point from which a landing can be completed and thereafter, if a landing is not completed, to a position at which holding or en-route obstacle clearance criteria apply. Instrument approach procedures are classified as follows:

- Non-precision approach (NPA) procedure. An instrument approach procedure designed for 2D instrument approach operations Type A.

  Note.— Non-precision approach procedures may be flown using a continuous descent final approach (CDFA) technique. CDFAs with advisory VNAV guidance calculated by on-board equipment are considered 3D instrument approach operations. CDFAs with manual calculation of the required rate of descent are considered 2D instrument approach operations. For more information on CDFAs, refer to PANS-OPS (Doc 8168), Volume I, Part II, Section 5.

- Approach procedure with vertical guidance (APV). A performance-based navigation (PBN) instrument approach procedure designed for 3D instrument approach operations Type A.

- Precision approach (PA) procedure. An instrument approach procedure based on navigation systems (ILS, MLS, GLS and SBAS CAT I) designed for 3D instrument approach operations Type A or B.

LNAV, LNAV/VNAV, LPV and LP distinguish the various minima lines on an RNP Approach chart. The minima line to be used depends on the aircraft capability.

LNAV – Lateral Navigation. The minima line on a chart for RNP approach without vertical guidance which does not require the use of SBAS.

LNAV/VNAV – the minima line on a chart for RNP Approach based on Baro-VNAV system performances that can be used by aircraft approved according to CS-ACNS [6] or equivalent. LNAV/VNAV minima can also be used by aircraft capable of RNP APCH to LPV minima if this is approved by the local regulatory authority.

LPV – Localiser Performance with Vertical Guidance: the minima-line on a chart for RNP Approach with vertical guidance based on SBAS performances that can be used by aircraft approved according to CS-ACNS (replacing AMC 20-28) or equivalent.

LPV 200 – the EGNOS SoL Service level declared by the EGNOS Service Provider in September 2015 which enables SBAS-based Category I precision approach (RNP Approach down to LPV minima as low as 200 ft) with a Vertical Alert Limit (VAL) equal to 35m. The LPV 200 service level is described in the SoL Service Definition Document.

LP – Localiser Performance: The minima line on a chart for RNP approach without vertical guidance which requires the use of SBAS. At some airports, it may not be possible to meet the requirements to publish an approach procedure to LPV minima. This may be due to: obstacles and terrain along the desired final approach path, airport infrastructure deficiencies, or the inability of SBAS to provide the desired availability of vertical guidance (i.e., an airport located on the fringe of the SBAS service area). When this occurs, a State may provide an RNP Approach to LP minima; an approach procedure with angular lateral guidance equivalent to a localizer approach, with lower minima than an RNP Approach to LNAV minima.

MDA/H (Minimum Descent Altitude/Height) - A specified altitude or height in a 2D instrument approach operation or circling approach operation below which descent must not be made without the required visual reference.

NPA – Non-Precision Approach. See definition of Instrument approach procedure (IAP).

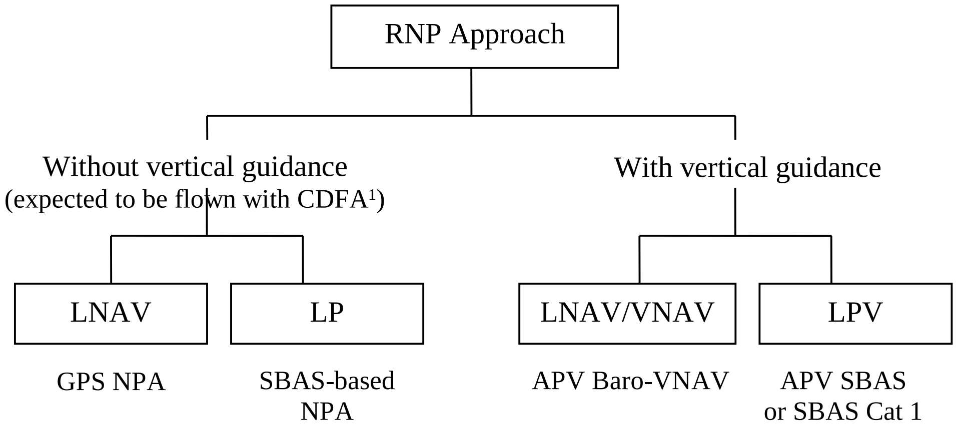
PA - Precision Approach. See definition of Instrument approach procedure (IAP)

PBN – Performance-Based Navigation. 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 (RNAV specification, RNP specification) in terms of accuracy, integrity, continuity and functionality needed for the proposed operation in the context of a particular airspace concept. Availability of GNSS SIS or some other NAVAID infrastructure is considered within the airspace concept in order to enable the navigation application. [4]".

RNP APCH – This is the name of the navigation specification in the ICAO PBN Manual [4] for the four approach types shown in Figure 1.

Figure 1: The four types of RNP Approach described in the ICAO PBN Manual [4]



RF – Stands for Radius to Fix. RF is an ARINC 424 path terminator which defines a precise curved path to be flown by RF-capable aircraft. The RF function is optional with the RNP APCH navigation specification. RF legs can be used outside of the final approach segment of an RNP Approach procedure and for the latter stages of a Missed Approach. This can be a useful procedure design tool in obstacle rich or constrained environments (e.g. better protection against obstacles, avoidance of noise sensitive areas).

RNP Approach –This is a generic name that refers to any kind of approach enabled by Global Navigation Satellite System (GNSS) and designed to be flown using the RNP system. RNP Approaches used to called "RNAV Approaches". ICAO prescribed the transition to new chart titles "RNP" to ensure alignment with the name of the RNP APCH navigation specification [5].

RNP AR APCH – An approach which always requires specific aircraft qualification and operational approval. Such procedures are useful in particular environments rich in obstacles and dense terminal areas.

RNP – Required Navigation Performance. A requirement for on-board navigation performance monitoring and alerting, by means of a navigation system that supports area navigation operations by integrating information from one or more positioning sensors and provides flight crew with the means to define a desired flight path [6].

SBAS – Satellite-Based Augmentation System. This is a generic name for a system based on geostationary satellites and accompanying ground stations used for the augmentation of core constellation GNSS signals. 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.

SBAS Cat I – RNP Approach down to LPV minima, designed according to SBAS Cat I procedure design criteria.

VNAV – Vertical Navigation. Refers to a method of navigation based on a computed vertical path [6].

3. APPLICABLE STANDARDS AND DOCUMENTATION

[1] COMMISSION IMPLEMENTING REGULATION (EU) 2018/1048 of 18 July 2018 laying down airspace usage requirements and operating procedures concerning performance-based navigation

[2] ICAO, Annex 10 to the Convention on International Civil Aviation, Aeronautical Telecommunications, Volume 1, Radio Navigation aids, Seventh Edition July 2018.

[3] ICAO Annex 6 to the Convention on International Civil Aviation, Operation of Aircraft, Part I – International Commercial Air Transport – Aeroplanes, Tenth Edition, July 2016

[4] ICAO Doc 9613, Performance Based Navigation (PBN) Manual, 4th Edition, 2013

[5] ICAO Circular 353: Transition Planning for Change to Instrument Flight Procedure Approach Chart Identification from RNAV to RNP, 2018

[6] EASA Certification Specifications and Acceptable Means of Compliance for Airborne Communications, Navigation and Surveillance, CS ACNS, Issue 2, 26 April 2019.

[7] ICAO Doc 9750, The Global Air Navigation Plan (GANP), Sixth Edition, 2019

[8] ICAO Doc 9992 Manual on the use of PBN in Airspace Design. First Edition, 2013

[9] Regulation (EU) 2018/1139, EASA Basic Regulation, 4th July 2018

[10] EUROCONTROL Airspace Concept Handbook for PBN implementation, Edition 3.0, 2013

[11] ICAO Annex 14 to the Convention on International Civil Aviation, Aerodromes, Volume 1, Aerodrome Design and Operations, Seventh Edition, July 2016

[12] ICAO Doc 8168, Procedures for Air Navigation Services, Aircraft Operations, (PANS OPS), Volume II, Construction of Visual and Instrument Flight Procedures, Sixth Edition, 2014.

[13] ICAO Doc 9365, Manual of All Weather Operations, Fourth Edition, 2017

[14] COMMISSION REGULATION (EU) No 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council EASA, AIR OPS

[15] SES Regulation - Regulation (EC) No 550/2004, The Service Provision Regulation, as amended by Regulation (EC) 1070/2009 - Article 10.

[16] EGNOS Safety of Life (SoL) Service Definition Document (SDD), Issue 3.3, March 2019 – available on the EGNOS User Support website: https://egnos-user-support.essp-sas.eu)

[17] ICAO Doc 9849, GNSS Manual, Third Edition, 2017

[18] ICAO Doc 8071, Manual on Testing of Radio Navigation Aids, Volume II, Testing of Satellite-based Radio Navigation systems, Fifth Edition, 2007

[19] ICAO Doc 4444, Procedures for Air Navigation Services, Air Traffic Management, PANS ATM, Sixteenth Edition, 2016.

[20] Integrated Initial Flight Plan Processing System (IFPS) User Manual, Edition 23.0, Eurocontrol. 07/05/2019

[21] ICAO Doc 9906, Quality Assurance Manual for Flight Procedure Design, Volume 2 — Flight Procedure Designer Training (Development of a Flight Procedure Designer Training Programme), First Edition, 2009.

[22] COMMISSION IMPLEMENTING REGULATION (EU) 2020/469 of 14 February 2020 amending Regulation (EU) No 923/2012, Regulation (EU) No 139/2014 and

Regulation (EU) 2017/373 as regards requirements for air traffic management/air navigation services, design of airspace structures and data quality, runway safety and repealing Regulation (EC) No 73/2010

[23] ICAO Annex 19 to the Convention on International Civil Aviation, Safety Management, Second Edition, July 2016.

[24] ICAO Doc 9859, Safety Management Manual, Fourth Edition, 2018

[25] COMMISSION IMPLEMENTING REGULATION (EU) 2017/373 of 1 March 2017 laying down common requirements for providers of air traffic management/air navigation services and other air traffic management network functions and their oversight.

[26] ICAO Doc 9906, Quality Assurance Manual for Flight Procedure Design, Volume 5– Validation of Instrument Flight Procedures, First Edition, 2012

[27] ICAO Doc 9906, Quality Assurance Manual for Flight Procedure Design, Volume 1 – Flight Procedure Design Quality Assurance System, First Edition, 2009.

[28] ICAO Annex 4 to the Convention on International Civil Aviation, Aeronautical Charts, Eleventh Edition 2009.

[29] ICAO Annex 15 to the Convention on International Civil Aviation, Aeronautical Information Services, Sixteenth Edition, July 2018

[30] ICAO Doc 10066, Procedures for Air Navigation Services, Aeronautical Information Management, PANS AIM, First Edition, 2018

[31] ICAO Doc 8126 Aeronautical Information Services Manual, Sixth Edition, 2003

[32] RTCA DO 200B/EUROCAE ED-76A, Standards for Processing Aeronautical Data, 2015.

[33] COMMISSION REGULATION (EU) 1178/2011 of 3 November 2011 laying down technical requirements and administrative procedures related to civil aviation aircrew pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council.

4. PART A – INTRODUCTION TO RNP APPROACH OPERATIONS

4.1. Background Information

4.1.1. The widespread availability of high-performance area navigation systems on all types of aircraft and in particular the introduction of GNSS has made it possible to use area navigation in the approach phase of flight. Safety is improved by providing pilots with better situational awareness than on conventional Non-Precision Approaches (NPA), thereby reducing the risk of controlled flight into terrain (CFIT). Better access can also be provided to runways that are not equipped with precision approach and landing aids.

4.1.2. This guidance material is mainly intended for States in the ICAO European Region who wish to implement RNP Approach operations. It describes the steps that an ANSP and/or Airport should undertake to implement such operations and indicates the applicable standards and relevant documentation that is available. Finally, it provides guidance to air operators as to how to obtain approval for such operations.

4.1.3. Instrument Approach Procedures

Traditionally, there have been two types of Instrument Approach Procedure:

- Precision Approach (PA) using an instrument landing system (e.g. ILS, GLS, MLS, SBAS CAT I) which provides both lateral and vertical guidance on a geometrically defined continuous descent path along the final approach segment.

- Non-Precision Approach (NPA) using conventional navigation aids (e.g. NDB, VOR, DME) or GNSS providing only lateral guidance along the final approach segment.

4.1.4. Studies have shown that the risk of controlled flight into terrain (CFIT) on non-precision approaches could be significantly reduced. An improvement that gives pilots better situational awareness on NPA is to fly them using the RNAV or RNP capability of the aircraft. The area navigation system can be used for the approach phase of flight, provided RNP Approach procedures are designed and published. RNP Approaches are described by a series of waypoints, legs, altitude, glide path angles (GPA) and speed constraints published and stored in the navigation database.

4.1.5. GNSS-based RNP capabilities may be used to fly NPA procedures. These procedures are flown down to a Minimum Descent Altitude/Height (MDA/H), as with any conventional NPA procedure. The MDA/H is derived from the OCA/H indicated in the LNAV or LP minima line on the RNP instrument approach chart.

4.1.6. No modifications to the cockpit instruments (e.g. conventional Course Deviation Indicator – CDI, or electronic displays) are in principle necessary to use RNP Approach.

4.1.7. The level-off or "dive and drive" descent technique used along the conventional final approach segment in NPA procedures should be replaced by a stabilised vertical path. Operators are indeed encouraged[1] by Authorities to fly these procedures using the Continuous Descent Final Approach (CDFA) flying technique. This can be based on a manual calculation of the required rate of descent or it can make use of the VNAV guidance function available on many aircraft. The design of a NPA procedure is made according to a single set of design criteria in

[1] This is even mandatory for Commercial Air Transport (CAT) according EASA AIR OPS [14]

ICAO PANS-OPS and is not dependent on the flying technique. Charts include the nominal descent gradient. The minima are calculated in accordance with National Operating Regulations (based on EASA AIR OPS [14] in EASA States where values to be added to RVR minima are provided in case CDFA is not used). Whatever the flying technique (with or without CDFA) the aircraft must comply with MDA/H of the NPA.

4.1.8. RNP approaches with only lateral guidance are classed by ICAO as 2D approach operations Type A and therefore the lowest decision height to be used is 250ft.

4.2. Approaches with vertical guidance

4.2.1. In addition to lateral navigation capabilities, modern multi-sensor area navigation systems provide a VNAV function which allows a vertical path to be flown with a constant rate of descent based on the barometric altimeter, or on SBAS-augmented GPS position.

4.2.2. RNP Approaches using both lateral and vertical guidance are defined by ICAO in PANS OPS (Doc 8168) as Approach with Vertical Guidance (APV) or Precision Approach (PA). The vertical guidance is defined along the final segment only.

4.2.3. The RNP Approach procedures using barometric VNAV for vertical guidance are called APV Baro VNAV and are flown to a DA/H indicated in the LNAV/VNAV minima line on the chart. The lowest DH for APV Baro VNAV is 250ft. Aircraft equipped with SBAS and LPV-capable area navigation systems can also fly procedures designed for APV Baro VNAV if the State publishing the procedure permits it.

4.2.4. The RNP Approach procedures using SBAS for vertical guidance can be either SBAS APV or SBAS Cat I procedures depending on the criteria used for procedure design (APV I or Cat I criteria respectively). ICAO classifies these as 3D approach operations. They are flown to a DA/H derived from the OCA/H indicated in the LPV minima line on the chart. The lowest DH for SBAS APV is 250ft and for SBAS Cat I, 200ft.

4.3. Approaches and the PBN concept

4.3.1. ICAO's PBN concept was originally published in the ICAO PBN Manual [4] in 2007 replacing the previous RNP Concept and RNP Manual. The PBN Concept aims to streamline RNAV and RNP applications on a global basis by reducing the number of navigation specifications in use worldwide and thus enhancing safety, improving interoperability and reducing costs for operators. To these ends, the PBN Manual [4] includes a limited set of PBN specifications for worldwide use in different phases of flight.

4.3.2. The RNP APCH navigation specification available in the ICAO PBN Manual,[4] Volume II, Part C, Chapter 5 can support all segments of an RNP APCH operation, from the initial approach to the final phase of the missed approach. Alternatively, the Initial segment of an RNP APCH can be replaced by a Transition based on RNP 1, RNAV 1 or Advanced RNP. The missed approach can be based on other than PBN criteria or additional requirements requiring compliance to other Navigation specifications can be attached to the final segment of the RNP APCH missed approach the .

4.3.3. RNP Approach procedures used to be published on charts with the title RNAV (GNSS) RWY XX. That is one reason why they were referred to so far as RNAV or RNAV (GNSS) approaches. ICAO now prescribes these procedures are published on charts with the title

RNP [5] . This is to ensure alignment with the PBN Manual [4] which refers only to RNP APCH or RNP AR APCH applications for approach procedures. These approach charts can have several minima lines depending on the type of final segment defined within the RNP Approach. The table below provides cross reference between PANS-OPS and PBN terminology.

Table 1: RNP Approach terminology as per PBN Manual [4]

PANS-OPS Terminology	PBN Terminology	Chart Minima	Minimum Sensor
GPS NPA	RNP APCH	LNAV (MDA/H)	ABAS
APV Baro-VNAV	RNP APCH	LNAV/VNAV (DA/H)	ABAS + Baro-VNAV
SBAS NPA	RNP APCH	LP (MDA/H)	SBAS
SBAS APV	RNP APCH	LPV (DA/H)	SBAS
SBAS Cat I	RNP APCH	LPV (DA/H)	SBAS

4.3.4. An example of an RNP Approach chart containing the different minima lines is provided in Section 5.3.8 describing Activity 15 concerning procedure publication.

4.4. Provision of vertical guidance

4.4.1. The important distinction between the different types of RNP Approach operations is the provision of vertical guidance. RNP Approach to LNAV and LP minima include only lateral guidance and are flown to a MDA/H while RNP Approach procedures with vertical guidance are flown to a DA/H, which is usually lower than the NPA minima thus potentially increasing airport accessibility. In addition, the provision of vertical guidance improves pilot situational awareness, reduced Flight Technical Error (FTE) and lower flight crew workload if flown with either autopilot (AP) or flight director (FD), thus improving safety.

4.4.2. The procedure design criteria and the construction of a vertical profile are different for the different RNP Approach operations. RNP Approach to LNAV/VNAV minima accounts for vertical guidance in addition to lateral guidance (which is the same as for LNAV-only). The theoretical vertical descent profile is defined by a geometrical path with fixed flight path angle. The vertical path angle is computed between 50ft above the runway threshold and a final capture point which corresponds to the location of the FAF associated with the LNAV procedure. Vertical deviations are usually linear. Given that the vertical path is based on barometric inputs, it is very important that the correct local pressure setting (QNH) is entered into the area navigation system.

4.4.3. The final descent for APV Baro-VNAV is also influenced by temperature: With temperatures lower than ISA, the true altitude of an aircraft is lower than what the altimeter indicates; obstacle protection is therefore reduced. Temperatures greater than ISA have the opposite effect. They make the true altitude higher than the indicated altitude, leading to a steeper descent to the runway with a higher risk of an unstabilised approach. Some area navigation system provide temperature compensation to protect the aircraft from the temperature effect. Aircraft without temperature compensation will operate safely on this type of approach as long as the temperature stays within limits published on the chart. Extreme high temperature conditions rarely happen in Europe and high temperature limits are rarely published in our region. A low temperature will always be promulgated on an instrument chart. Assumptions made for the design of the procedure will set this low temperature limit. Note that the temperature correction of all altitudes published on a chart, including DA/MDA, is a requirement (except when under vectoring), regardless of the availability and use of a temperature compensation function on-board the aircraft.

4.4.4. RNP Approach to LPV minima is based on GNSS core constellation and SBAS. It assumes angular vertical guidance on the final approach segment defined in the Final Approach Segment Data Block (FAS DB). The vertical path angle is defined (not computed) and published in degrees (3° VPA is standard). Integrity of the FAS DB data is maintained through the use of a CRC.

5. PART B – GUIDANCE ON THE IMPLEMENTATION OF RNP APPROACH

5.1. General

5.1.1. Implementation of RNP Approach operations is a complex process covering a wide range of actors. In the following description the necessary activities are divided into two parts addressing the planning and implementation. These activities have been derived from the ICAO Manual on the use of Performance Based Navigation (PBN) in Airspace Design (ICAO doc 9992) methodology [8], adapted to RNP Approach implementation. Activities are presented here, as far as possible, in a chronological order. Annex 1 provides an illustration of the processes and their activities.

5.1.2. In the first part the objective is to gather information so that a decision can be taken on what type of RNP Approach should be implemented and where. The second part consists of the tasks needed to perform the actual implementation. General implementation considerations are provided here and States should feel free to adapt them to their specific situation.

5.2. Agreeing the operational requirement and building the implementation plan

5.2.1. General

5.2.1.1. The need to implement RNP Approach operations should be discussed and clarified. At this stage, the reasons for the deployment of RNP Approach are being considered.

5.2.1.2. The first part describes the activities required to take a decision on what type of RNP Approach should be implemented and at which locations. The output of this set of activities is a decision to implement RNP Approaches and a deployment strategy.

5.2.1.3. In case the implementation plan is developed at State level, the following activities will consist of selecting a pool of potential airports and selecting the preferred implementation locations. This activity must be performed in close co-operation with all the stakeholders such as Aircraft Operators, ANSPs, Regulators and Airport Operators in order to identify the most suitable airports/runway ends for RNP Approach implementation and the deployment sequence.

5.2.1.4. Alternatively, the implementation plan can be developed by an ANSP or at the level of an individual Airport. This would be mainly due to Aircraft Operator request. In this case, other stakeholders such as the Regulator need to be involved as soon as possible in the RNP Approach implementation process.

5.2.2. Activity 1: Assess the need for RNP Approach

5.2.2.1. Implementation of RNP Approach procedures may be triggered by a number of different factors, which can depend on the organisational and institutional arrangements. These inputs may include, though are not limited to, the following:

5.2.2.2. ICAO Assembly Resolutions and the Global Air Navigation Plan (GANP) [7]

5.2.2.2.1. The implementation of RNP Approach procedures with vertical guidance (APV) was primarily encouraged by ICAO Assembly Resolution 36-23 which urged the States to implement APV procedures to all instrument runway ends by 2016, either as primary or as backup approach procedures. RNP Approach to LNAV/VNAV and RNP Approach to LPV minima were the two options to fulfil the resolution. But the resolution A36-23 was updated at the 37th Assembly of ICAO, and resolution A37-11 (supersedes A36-23) now presents RNP Approach to LNAV minima as an acceptable alternative in places where APV implementation is not possible or does not make sense as no aircraft are suitably equipped. RNP Approach implementation is part of the resolution for ICAO PBN deployment, the main objective of which is to improve safety.

5.2.2.2.2. The executive part of the resolution A37-11 states:

[…]The Assembly:

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

2. Resolves that:

a) States complete a PBN implementation plan as a matter of urgency to achieve:

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

2) implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS), including LNAV only minima for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 per cent by 2010, 70 per cent by 2014; and

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

b) ICAO develop a coordinated action plan to assist States in the implementation of PBN and to ensure development and/or maintenance of globally harmonized SARPs, Procedures for Air Navigation Services (PANS) and guidance material including a global harmonized safety assessment methodology to keep pace with operational demands;

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

4. Instructs the Council to provide a progress report on PBN implementation to the next ordinary session of the Assembly, as necessary;

5. Requests the Planning and Implementation Regional Groups (PIRGs) to include in their work programme the review of status of implementation of PBN by States according to the defined implementation plans and report annually to ICAO any deficiencies that may occur; and

6. Declares that this resolution supersedes Resolution A36-23. […]

5.2.2.2.3. Moreover, the Global Air Navigation Plan [7] has the objective of a future harmonised global navigation capability based on Performance Based Navigation (PBN) supported by the global navigation satellite system (GNSS). The GANP identifies PBN as the highest priority and outlines implementation issues involving PBN planning and implementation as part of the Aviation System Block Updates (ASBUs)

5.2.2.3. Strategic objectives (e.g. safety, accessibility)

5.2.2.3.1. RNP Approaches have the potential to provide better minima than conventional NPA. Consequently, better airport accessibility can be achieved at those airports without PA capability, as well as providing a back-up at airports where the precision approach aid is out of service.

5.2.2.3.2. Additionally, RNP Approach brings improved situational awareness for the pilots in both the horizontal and vertical domain (in the case of 3D operations), as well as the means to perform a better stabilised approach, both of which contribute to improve safety.

5.2.2.3.3. Those two issues are often identified as strategic objectives for airports in locations with challenging terrain and/or meteorology.

5.2.2.4. Aircraft operator requests

5.2.2.4.1. With the widespread availability of GNSS-based RNP and VNAV capability on many types of aircraft, operators may want to encourage RNP approaches to be published so that they can benefit from these on-board capabilities. The operators could be motivated by better airport accessibility and/or improved safety.

5.2.2.5. PBN implementation plans and airspace concept

5.2.2.5.1. States may have already identified the need for RNP approach implementation through the publication of a PBN implementation plan or through the development of a PBN compliant Airspace Concept. The PBN Manual [4] introduces the Airspace Concept as a formal way of setting strategic objectives to be satisfied by selected operations within an airspace. Airspace changes are triggered by operational requirements such as for example the addition of new runways, need to reduce aircraft noise over a residential area or improve airport accessibility. The Manual on the Use of PBN in Airspace Design [8] is the ICAO reference document on this matter.

5.2.2.6. ATM operational requirements

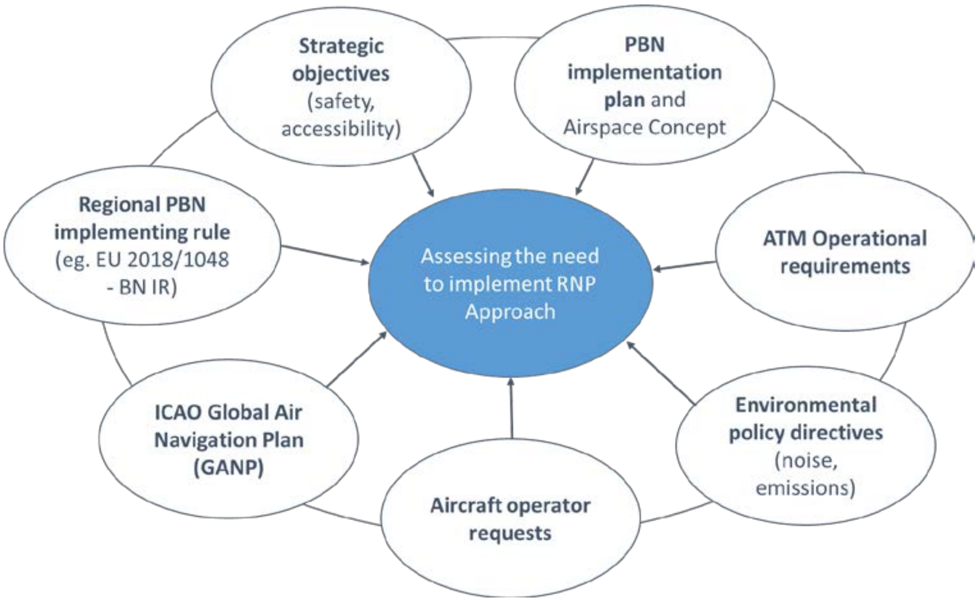
5.2.2.6.1. In Europe, the future ATM concept is described in the European ATM Master Plan and SESAR ATM Concept for 2020+. RNP Approach implementation is part of the near term Operational Improvement Steps, Enhancing Terminal Area, as identified by the European ATM Master Plan and Work Program. https://www.atmmasterplan.eu/ The key performance areas of RNP operations identified in the Master Plan are capacity, environmental sustainability, cost effectiveness, capacity and safety.

5.2.2.7. Environmental policy directives

5.2.2.7.1. Potential policy directives for noise and environment demanding changes to arrival and departure routes and the introduction of PBN terminal procedures may stimulate the need to implement RNP Approach operations.

5.2.2.7.2. Once the potential benefits are identified and agreed among all the stakeholders, there should be a high level consensus around the decision to implement RNP approach operations. At the same time, the actors need to comply with the applicable regulations in all areas of their activities. An additional reason to implement could be if it were required by a regional PBN regulation. This is the case in the European Union.

Figure 2: Assessing the need for RNP Approach implementation



5.2.2.8. The European Regulatory Framework

5.2.2.8.1. In July 2018, the European Commission adopted the PBN IR [1]. This regulation mandates the publication of RNP Approaches to LNAV, LNAV/VNAV and LPV minima at all instrument runway ends without precision approach capabilities by 3 December 2020 and at all instrument runway ends by 25 January 2024.

5.2.2.8.2. All aspects of RNP Approach implementation are covered by regulatory oversight. In the European Union area for instance, the EASA Basic Regulation [9] sets the regulatory framework.

5.2.2.8.3. In order to implement RNP Approach procedures all constituents in the area regulated by EASA, products, operations and services are under the responsibility of clearly identified organisations. This includes:

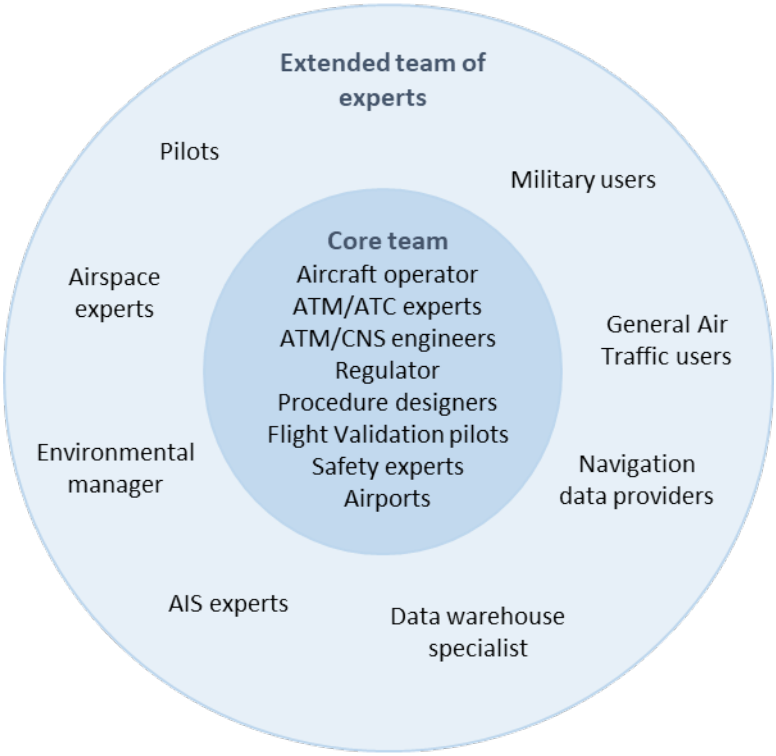
- Navigation Service Providers who provide radio-navigation signals.
- Aircraft and avionics design approval holders
- Aircraft operators
- Aerodrome operators
- Providers of Air Traffic Services
- Airspace/flight procedures designers
- AIS Service Providers
- Data suppliers

5.2.3. **Activity 2: Create the implementation project team**

5.2.3.1. A multi-disciplinary team is needed to ensure all necessary aspects of the implementation of RNP Approach procedures are recognised and adequately addressed, whether they are intended for a State, a set of airports or a single airport. The team composition may vary in different States, but principally, there should be a core team which can be extended on an “as needed” basis to include experts in particular domains as the implementation progresses. For example, it is recommended that the navigation data providers are consulted regarding the design of procedures when they rely on the use of new and not yet tested concepts within a state’s airspace. This should be done well in advance of publication and prior to any validation flight to ensure it can be coded correctly.

5.2.3.2. Depending on arrangements in different States, implementation of RNP Approach operations may be initiated by different stakeholders, namely Aviation Authorities, ANSPs, or Airport operators. Regardless of which stakeholder is the initiator, they will all need to co-operate to ensure a smooth implementation and subsequent operation. ANSPs, whether they provide a service for a country or a specific airport, are recognised to be the key actor who will drive the implementation of the change.

Figure 3: Establish a national RNP Approach implementation team



5.2.4. Activity 3: Agree project objectives, scope and timescale

5.2.4.1. Once the implementation team has been established, it needs to define the objectives, scope and resources required to build the implementation plan.

5.2.4.2. The timing for preparation of this plan may not be compatible with the objectives set in the PBN IR [1] of the European Commission, but the priority should be put on enabling the first implementation as soon as possible in order to gain the necessary experience.

5.2.4.3. If the RNP Approach implementation is made in the frame of an airspace concept development, a sample estimation of project timescale is available in Attachment 1 to the EUROCONTROL Airspace Concept Handbook for the implementation of PBN [10].

5.2.5. Activity 4: Survey of candidate airports

5.2.5.1. When implementation of RNP Approach is planned on a national basis, or for a group of airports, a survey of airports should be performed.

5.2.5.2. As a first step, one or two candidate airports can be identified to be the first implementation locations. This will allow the national team to exercise all the necessary activities and gather the lessons learned before implementation on a wider scale.

5.2.5.3. The new runway classification of ICAO makes it possible to implement RNP Approaches to non-instrument runway ends or aerodromes without ATS services. However, such implementation will require a case by case analysis. The first implementations should therefore take place at runways that already have an instrument approach procedure.

5.2.6. Activity 5: Assessment of Airport Capabilities

5.2.6.1. General

5.2.6.1.1. The capabilities of each of the airports chosen in the previous activity need to be assessed to determine whether RNP Approach operations can be implemented there, and if not, what modifications need to be made to enable the implementation.

5.2.6.1.2. The assessment should address the following domains:

5.2.6.2. Aerodrome infrastructure

5.2.6.2.1. An assessment of the aerodrome infrastructure should be performed in order to determine the type of runways on the airports of interest. The type of runway (instrument/ non-instrument, precision/non-precision as defined in [11]) will impact the minima that can be achieved.

5.2.6.2.2. According to ICAO PANS-OPS [12] the following principle applies:

- Non-precision instrument runways allow DH not lower than 250 ft.
- Precision instrument runways support approaches with DH lower than 250 ft.

5.2.6.2.3. Applicable aerodrome operating minima may be found in the ICAO All Weather Operations Manual [13] and in AMC&GM to Annex IV of EASA AIR OPS [14] for EASA countries.

5.2.6.3. Meteorological data

5.2.6.3.1. The project team may want to collect data on the meteorological conditions such as wind statistics, cloud ceiling and RVR per runway end. This data can be used as an input to estimating the benefits in terms of improved runway accessibility. Indeed, the potential for lower minima with RNP Approach allows a better runway use in case of bad weather. For more details about benefit assessment please refer to Activity 8.

5.2.6.4. GNSS infrastructure

5.2.6.4.1. All RNP Approach operations rely on the use of GNSS and the appropriate authority needs to agree to the use of GNSS in their airspace. Today, the US GPS and the Russian Federation's GLONASS are the GNSS core constellations standardized in ICAO Annex 10 [2]. ICAO recommends the authority approves the use of all GNSS elements available in their area.

5.2.6.4.2. RNP Approaches flown to LPV minima rely on the use of GPS augmented by SBAS such as the European Geostationary Navigation Overlay Service (EGNOS) in Europe, the US WAAS in the northern and western part of the European region or the Russian Federation's SDCM under development. EGNOS and WAAS augment GPS, but SDCM is planned to augment GPS and GLONASS.

5.2.6.4.3. Any Pan-European Service used by aircraft and ANSPs provided by an organisation established in the territory of the EU Member States, is subject to the SES Regulations. This applies to the EGNOS Service Provider. Article 41 of the EASA Basic regulation [9] requires that the ATM/ANS Provider holds a certificate. The provider has to demonstrate compliance with the implementing acts referred to in Article 43 adopted to ensure compliance with the essential requirements referred to in Article 40.

5.2.6.4.4. The EGNOS Safety of Life (SoL) APV I service level was declared on 2 March 2011 and the LPV 200 service level in 2015. The EGNOS SoL services are provided free of direct user charges.

5.2.6.4.5. RNP Approach procedures flown to LPV minima relying on EGNOS and make use of the EGNOS SoL service. According the Single European Sky [15] and EASA Basic Regulations [9] an ANSP implementing LPV is required to have an agreement with the EGNOS service provider. The EGNOS Working Agreement (EWA) is the interface between the ESSP and ANSPs implementing RNP Approaches to LPV minima. However, an EWA can be established with organizations other than ANSPs, such as Aerodrome or Aircraft Operator if required.

5.2.6.4.6. RNP Approach to LPV minima relying on EGNOS can be planned at any airport within the EGNOS APV I or LPV200 service area published in the EGNOS Service Definition Document (SDD) [16]. However, a specific assessment can be made with support from the ESSP to confirm that the EGNOS service available at the aerodrome concerned is suitable for intended operations.

5.2.6.4.7. According to ICAO recommendations, a legal recording mechanism should be put in place for any navigation system to be used in operations. This recommendation applies to GNSS. The archived data will be useful in the context of post-accident/incident investigations. ANSPs or States do not necessarily have to set up their own recording system; they can have agreements with other parties to provide them with the necessary data (e.g. IGS for GPS or ESSP for EGNOS).

5.2.6.4.8. Concerning the availability of real-time monitoring for GNSS systems, there are a number of specific features of RNP Approach which make operational status monitoring neither practical nor required for such operations. l[2]. ICAO plans to provide further guidance on this topic in the future.

5.2.6.4.9. Impracticability includes considerations on the variety of avionics designs, the difference between performance observed on the ground and performance experienced on-board approaching aircraft and the fact that with PBN there is no longer a direct link between the navigation infrastructure and the aircraft's ability to perform an operation. The PBN Manual [4] also highlights the fact that ATC will not be aware of the type of minima an aircraft will fly to except when only one minima is available on the approach chart (approach clearance is according to the chart identification - RNP

[2] However ICAO requires the provision of information on the operational status of essential radio navigation services on a timely basis consistent with the use of the service involved.

– and not to the specific minima). SBAS monitors might therefore not always help ATC in managing PBN approach operations..

5.2.6.4.10. According to the PBN Manual [4], the absence of service monitoring for PBN operations can be mitigated even if they are essential operations. Mitigations include the availability of pre-flight GNSS prediction services, the provision of GNSS NOTAM and real-time information to ATC provided by pilots.

5.2.6.4.11. A signal availability and spectrum check should be performed as part of the validation of the procedure at the intended location, but real time GNSS signal monitoring is not required. Real-time information, in particular integrity is provided on-board the aircraft.

5.2.6.4.12. More details on these subjects are available in ICAO annex 10 [2], the GNSS Manual [17], the PBN Manual [4] and the Manual on Testing of Radio Navigation Aids [18].

5.2.6.5. Other infrastructure

5.2.6.5.1. RNP Approach operations are based upon GNSS including the missed approach segment. Nevertheless, an RNP APCH may have a conventional missed approach if desired. Some conventional navigation aids (VOR, DME) may therefore be maintained. The use of NDB is discouraged and should be limited only to cases where the use of VOR and/or DME is not possible.

5.2.6.5.2. No specific communication and surveillance requirements are identified for RNP Approach implementation.

5.2.6.5.3. RNP Approaches can be implemented in environments both with and without ATS surveillance. The availability of a local ATS service is not necessarily required. This should be verified through the local safety assessment to be performed in the scope of Activity 12.

5.2.6.5.4. The availability of a local QNH is a requirement for the publication of RNP approach to LNAV/VNAV minima. Remote QNH is acceptable in the case of RNP Approach to LNAV minima and as long as this is accounted for in the procedure design. Remote QNH for RNP Approaches down to LPV minima is permitted.

5.2.6.5.5. PANS-OPS states that the temperature used as an input for temperature corrections shall be that of the altimeter setting source. A local QNH source is required for RNP Approach to LNAV/VNAV minima, therefore the availability of a local temperature measurement is also a requirement for the publication of such procedure.

5.2.6.6. Achievable minima estimation

5.2.6.6.1. This will be useful in future steps to determine the minima reduction enabled by RNP Approach, and consequently to estimate the airport accessibility gain provided by the implementation of the procedure (see Activity 8).

5.2.6.7. Integration of the new procedure into the terminal area

5.2.6.7.1. An initial airspace analysis should be made in order to assess the impact that implementation of RNP Approach would have on departure and arrival routes.

5.2.7. Activity 6: Survey of Traffic Characteristics and Aircraft Operators

5.2.7.1. Survey of traffic characteristics

5.2.7.1.1. Fleet capability is evolving with time: GNSS-based navigation capabilities are spreading and the publication of the PBN IR [1] is expected to speed up the rate of SBAS equipage. However, it cannot be assumed that airspace users are capable to perform all types of RNP Approach. Traditionally, Baro-VNAV procedures were the preferred option for commercial air transport operators whose aircraft tend to be equipped with APV barometric VNAV functions rather than with SBAS APV capability. On the contrary, regional operators, business aviation and general aviation where VNAV capability based on barometric altimetry is not widely available were the first user segments to equip for RNP Approach operations based on SBAS. The type of aircraft flying to and from an airport is therefore likely to remain an influencing factor in the implementation of one or another type of RNP Approach. Nevertheless it is recommended to implement an RNP Approach procedure with all three minima lines (LNAV, LNAV/VNAV and LPV) to best serve all types of users at an airport: the cost of designing and publishing all types of minima at the same time will be lower than the sum of costs for the design and publication of the different minima one after the other. The PBN IR [1] even makes it a requirement to publish all three minima lines.

5.2.7.1.2. In certain cases, the team must work with an estimation of a future traffic sample, for example, if the approaches are planned to be implemented at a new airport or where significant changes in the airspace concept are planned.

5.2.7.2. Survey of Aircraft Operators

5.2.7.2.1. The RNP Approach implementation process should be conducted in close co-operation with Aircraft Operators. It is very important to collect information regarding current and projected PBN capabilities of aircraft operating at the airport of interest, through a survey of Aircraft Operators. The survey should also include questions regarding the Aircraft Operators preferred approach operations.

5.2.7.2.2. Information should be collected regarding the following:

- aircraft equipment and navigation capabilities
- current experience with RNP Approach procedures
- operator requirements and preferences for RNP Approach procedures
- plans in terms of future equipage and operational approval

5.2.7.2.3. As several terminologies have proliferated around the use of RNAV, RNP and GNSS equipment and operations, it is suggested to use simple and straightforward questions to operators. If possible, provide an introduction section before the questions introducing RNP Approaches in order to avoid ambiguity.

5.2.7.2.4. Some sample questions may be:

- Please list the types of aircraft that are being operated.
- Do you have certified GPS receivers onboard the aircraft? If yes, please list for each type of aircraft the kind of the GPS receiver (e.g. TSO-C129a, TSO-C145(), TSO-146() or corresponding E-TSO) installed onboard.
- Which PBN operations have been approved?
- Does the aircraft have Baro-VNAV capability?
- Does the aircraft have SBAS capability?
- Does the aircraft have an airworthiness approval for the use of GPS and/or EGNOS in the approach phase of flight? If yes, for which type of operation (among different types of RNP Approach)?
- Does the operator have plans to equip with RNP Approach capability in the future?
- What would motivate the operator to equip with RNP Approach capability in the future?
- What type of RNP Approach operation is preferred by the operator?
- Would the potential removal of a conventional procedure cause any particular problem? If yes, which one?
- At which airports would the operator like to have RNP Approach published and to which minima (LNAV, LNAV/VNAV and/or LPV)? At which runway end(s) and why?

5.2.7.2.5. Information regarding the airworthiness approvals of the aircraft operators registered in the State should be available from the Civil Aviation Authorities. Additional sources of information to the survey can be used to evaluate the fleet capabilities, including the EUROCONTROL CNS dashboard which analyses the capabilities declared in the ICAO flight plans submitted by operators (https://www.eurocontrol.int/dashboard/communication-navigation-and-surveillance-dashboard). In some cases given a particular type of aircraft, an estimate can be made regarding its navigation capability.

5.2.7.2.6. The data collected through the survey and other sources of information should be compiled to provide meaningful information to the project team for choosing among candidate RNP Approach procedures to be implemented. Indeed fleet capability will have a direct impact on how the procedures will be used when they are published (see Activity 14).

5.2.8. Activity 7: Assess the impact on ATS and NOTAM services

5.2.8.1. An assessment should be made of the impact that RNP Approach implementation may have on the ATS and AIS services.

5.2.8.2. PANS ATM, ICAO Doc 4444 [19] covers the case of RNP Approach and provides, in its version applicable from November 2022, improved applicable phraseology for ATS to manage/deal with RNP Approach clearances. With existing standards, ATS will not be aware of the specific minima line the crew will use.

5.2.8.3. In most cases, an RNP Approach will be performed on pilot demand and the chart identification 'RNP' is to be used in the approach clearance (e.g. "Cleared RNP Approach runway 26"). The chart identification will include any suffix used in chart names (e.g. 'Cleared RNP Zulu approach runway 26' for a procedure charted as 'RNP Z RWY 26').

5.2.8.4. PANS ATM provisions applicable from November 2022 better cover all cases, including those RNP Approaches with only an LPV line of minima and without an LNAV minima line entitled 'RNP RWY 26 (LPV only)'. Indeed, chart identification details provided within brackets in such cases will not be pronounced.

5.2.8.5. Amendment 1 to the 5th Edition of Doc 4444 [19] in 2012 introduced the new ICAO flight plan provisions including indicators for operators to declare the aircraft's PBN equipage in items 10 and 18 of the flight plan. ATM automated systems need to be upgraded to be able to extract this information from the FPL and it would need to be discussed if any such information needed to be displayed on ATS working positions. However, ATS do not require detailed information about the PBN equipment on-board an aircraft requesting or announcing its intention to carry out an RNP Approach because in that case, it is assumed to be capable. RNP Approach implementation can consequently be planned independently of the new flight plan provisions. EUROCONTROL makes available the IFPS User Manual [20] where PBN content of the flight plan is described in detail.

5.2.8.6. In order to support pre-flight planning, models of GPS and EGNOS allow the prediction of the impact of known and scheduled GNSS systems/subsystems outages. EUROCONTROL makes available a web-based service called AUGUR (http://augur.eurocontrol.int/) which provides GPS RAIM outage predictions to users.

5.2.8.7. GPS RAIM predicted unavailabilities may also be provided in the form of NOTAMs. EUROCONTROL proposes such a service as part of the catalogue of EAD services. The DFS is another provider of GPS RAIM NOTAM proposals.

5.2.8.8. EGNOS NOTAM proposals are provided by the EGNOS Service Provider to the AIS provider for validation and publication. The details of such a service are described and agreed in the scope of an EGNOS Working Agreement (EWA, as mentioned in section 5.2.6.4.6). Note that EGNOS availability to support operations to LNAV/VNAV and LPV minima is also available on the EGNOS User Support website (https://egnos-user-support.essp-sas.eu)

5.2.9. Activity 8: Identify expected benefits and costs for RNP Approach implementation

5.2.9.1. The outcome of a Cost and Benefits assessment can be one decision factor to implement RNP Approach. The following paragraphs discuss the different benefits and costs for such operations. Such aspects could be verified after implementation (e.g. under Activity 20 - post implementation review).

5.2.9.2. Benefits

5.2.9.2.1. The main benefit of implementing RNP Approach is to improve safety. RNP Approach operations reduce the risk of CFIT by providing better situational awareness to pilots leading to a stabilised approach. RNP Approach implementation can support the withdrawal of some conventional navigation aids thus saving costs for maintenance and flight calibration. This can lead to fewer building constraints on and around aerodromes and the possibility to develop and improve services.

5.2.9.2.2. The safety objective alone can be a sufficient argument to implement RNP Approach procedures, particularly in cases where most aircraft operators in a particular airspace already have PBN capabilities. Some States have already implemented RNP Approach procedures for this purpose and other States can benefit from this experience.

5.2.9.2.3. Nevertheless, if an ANSP or airport intends to perform a benefit assessment for implementing RNP Approach, the operational improvements that can be quantified are those associated with avoidance of delay and diversion that may result from the reduced operational minima. The RNP APCH may also support reversion operations when an ILS is out due to maintenance.

5.2.9.3. Costs

5.2.9.3.1. The costs to implement RNP Approaches should be estimated for all stakeholders such as ANSPs, Airports Operators and Aircraft Operators.

5.2.9.3.2. Costs for ANSPs and/or Airports Operators may emerge from the following:

- Procedure design and implementation costs which might include procedure designers' training, flight validation, chart preparation and AIP changes
- Safety assessment
- Runway upgrades as identified in Activity 5 – e.g. upgrade of runway lighting
- Operations' costs may include, but are not limited to, implementation of changes to airspace, design and publication of terminal procedures, update to operating procedures, etc.
- ATC training in PBN – the same cost as for training in conventional navigation

5.2.9.3.3. The implementation of RNP Approach procedures that are based on the use of GNSS do not require the installation of ground navigation aid infrastructure. Consequently, there is a potential for cost saving for ANSPs if a rationalisation of conventional navigation aids is made together with the deployment of the RNP Approaches.

5.2.9.3.4. The costs for aircraft operators will depend on the type of aircraft used (see information collected in Activity 6). This cost may include:

- Equipment acquisition and installation
- Airworthiness certification
- Operating procedures and documentation
- Flight Crew training
- Operational authorization

5.2.9.3.5. It is acknowledged that the widespread use of RNP Approach operations will happen in the future. On the one hand, experience has shown that operators must see clear benefits before deciding to acquire and install avionics. On the other hand, Airport Operators tend to delay the provision of new navigation services to when the fleet is ready for it. It is therefore most important that all actors coordinate and synchronise their investments to maximise return on investment.

5.2.10. **Activity 9: Choose which type of RNP Approach to implement**

5.2.10.1. At this stage of the process, outputs from earlier activities are available to the team in order to arbitrate between different scenarios for implementing RNP Approach operations.

5.2.10.2. The rationale behind all the decisions taken should be documented in an implementation plan.

5.2.10.3. The implementation plan should include at least the following elements:

- The rationale behind the particular RNP Approach implementation, the target strategic objectives and the expected benefits.
- The target airspace users (air transport, business, general aviation etc.).
- A deployment strategy which clearly indicates which RNP Approach (with minima LNAV, LP, LNAV/VNAV and/or LPV) will be implemented and for which runway end.
- Note that LNAV, LNAV/VNAV and LPV minima lines of RNP Approach can be published on a single chart. In some cases it might be necessary to publish different minima lines on separate charts. For example, when the missed approaches are different or step-down fixes are used. The application of the ICAO duplicate procedure identification concept i.e. usage of a single letter suffix may also be considered.
- It is recommended that, whenever possible, all three types of RNP Approach procedure be implemented at the same time for a particular runway.
- It is recommended that an RNAV Missed Approach Procedure is implemented in the design, or if a conventional Missed Approach is retained, a coding table is provided such that it may be flown with an RNP system.

5.3. RNP Approach implementation

5.3.1. General

5.3.1.1. This part consists of all activities required to deploy the RNP Approach implementation plan resulting from the previous activities.

5.3.2. Activity 10: Procedure design

5.3.2.1. Early identification of any issue related to procedure design expertise would allow time for training and procurement of such know-how that is indispensable during the implementation phase. Special consideration should be given when designing an LNAV procedure using step-down fixes (SDF). The use of the SDF is a valid design criteria permitting additional descent within a segment by identifying a point at which a controlling obstacle has been safely over-flown. However, due to the fact that RNP Approach procedures rely on navigation databases and Flight Management Systems (FMS), it has been recognized that there are some avionics limitations in handling coded SDFs within the final approach segment. For instance, if SDFs are coded, the distance to the next waypoint given to pilots during final approach is not the runway threshold or the missed approach point and the comparison between the distance/altitude table on the approach chart and the actual flight profile can't be made. It is therefore clear that some State regulators will not accept SDFs in the final segment are coded in the navigation database under any circumstances. In that case, the State regulator that does not accept SDF coding, should advise the navigation data provider through an official letter. It is highly recommended not to name SDFs, because un-named points are normally not coded, and to publish for each SDF both the procedure altitude to be maintained to the SDF (along the profile) and the minimum obstacle clearance altitude (MOCA) available up to the SDF (as a shaded block). These two values are very often different and publishing both is of helpful for pilots.

5.3.2.2. ICAO Doc 8168 [12] Volume II, Part III, and ICAO Annex 10 [2] include requirements for PBN training for procedure designers. However, it is recognised that the current ICAO material does not provide for the complete training needs of procedures designers. ICAO Doc 9906 Volume 2 [21] —provides additional guidance for the establishment of flight procedure designer training. Training is the starting point for any quality assurance programme. This volume provides guidance for the establishment of a training programme. In the European Union, the Commission Implementing Regulation (EU) 2020/469 [22] sets the requirements for Providers of Flight Procedure Design services (Annex XI - Part- FPD).

5.3.2.3. Procedure design will be performed accounting for the categories of aircraft operating on the airport (see outcomes of Activity 6).

5.3.2.4. The procedures design criteria regarding different RNP Approach operations can be found in ICAO Doc 8168 [12].

5.3.2.5. The criteria for RNP Approach procedures to LNAV minima (NPA) are provided in ICAO PANS OPS Volume II, Part III, Section 3, Chapter 3.

5.3.2.6. The criteria for RNP Approach with vertical guidance based on Baro VNAV (APV Baro-VNAV) design are described in ICAO PANS OPS Volume II, Part III, Section 3, Chapter 4.

5.3.2.7. The criteria for RNP Approach based on SBAS (SBAS NPA (LP), SBAS APV and SBAS Cat 1) criteria are provided in ICAO PANS OPS Volume II, Part III, Section 3, Chapter 5.

5.3.3. **Activity 11: Verification of expected benefits**

5.3.3.1. At this stage of the process, the actual minima enabled by RNP Approach procedure are known (Activity 10). It is consequently recommended to confirm that the benefits that were identified in Activity 8 are still valid.

5.3.4. **Activity 12: Local Safety Assessment**

5.3.4.1. The Local safety assessment should start as soon as possible because the analysis can have an impact on the design or on the charting of the procedure.

5.3.4.2. The ICAO references for risk assessment and mitigation include Annex 19 [23] and Doc 9859 [24]. According to ICAO, service providers shall have processes in place to identify and manage the safety risks that may arise from changes; and no operation should take place in a changed system or operational context until all safety risks are evaluated. In the European Union, Regulation (EU) No 2017/373 [25] applies and requires that risk assessment and mitigation activities are carried out before implementing any change in the ATM/ANS. Implementing RNP Approach is a change which requires such activities under oversight of the competent authority.

5.3.4.3. Finally, and in anticipation of implementation, a performance and safety monitoring system and procedures should be defined. This will include an occurrence reporting mechanism.

5.3.5. **Gate: Final decision to implement**

5.3.5.1. Once Activities 10, 11 and 12 are completed, the implementation plan developed earlier can be updated according to the latest conclusions.

5.3.5.2. Additionally, the following tasks can be performed:

- A notice on any potential airspace design change that can result from RNP Approach implementation.
- Notification of intent to operators by ANSP to implement RNP Approach.
- Notification of intent to operators of the removal of conventional procedures, if any conventional procedures are to be removed.
- A planned date for implementation should be announced.

5.3.5.3. A notification of each of the above tasks to the navigation data providers is highly recommended.

5.3.6. **Activity 13: Procedure validation**

5.3.6.1. Once designed, the procedure should undergo a validation process. The objective of procedure validation is to verify obstacles and navigation data and assess the fly ability of the procedure.

5.3.6.2. Validation will consist of ground validation and maybe also flight validation. Ground validation must always be undertaken. This consists of an independent instrument flight procedure design review and pre-flight validation. The review requires appropriate knowledge of flight validation issues and the involvement of a flight validation pilot is best practice. When ground validation can validate the accuracy and completeness of all obstacles and data considered in the procedure design and any other factors normally considered in the flight validation, then the flight validation requirement may be dispensed with. More details on this subject are available in ICAO Doc 9906 Volume 5 – Validation of Instrument Flight Procedures [26].

5.3.6.3. The process of quality assurance regarding the elements of procedure design, such as procedure design documentation, verification and validation methods, and guidelines on acquisition and processing of source data are described in ICAO Doc 9906 Volume 1 – Quality Assurance Manual for Flight Procedure Design, [27].

5.3.7. **Activity 14: Preparing the entry into operations (ATC considerations)**

5.3.7.1. Depending on the fleet mix, it is very likely that a certain number of aircraft operating at the airports where RNP Approach operations are to be introduced would not be capable of performing them or capable but not approved. Therefore, ATC must be capable of retaining a sufficiently high level of safety and performance of its service provision even in a mixed-mode environment where there is a mix of aircraft using conventional and area navigation.

5.3.7.2. RNP Approach procedures providing vertical guidance may be published either as backup for precision approaches or as sole approaches when there is no ILS/MLS/GLS. When they are published as a back-up to a precision approach procedure it is helpful to design the RNP Approach procedures as an overlay of the existing precision approach in order to assist ATC in managing the transition in case the navigation aid support the precision approach becomes unavailable. Once the RNP Approach becomes the main approach procedure used in operations, the procedure might be redesigned to optimise it and maximise the benefits.

5.3.7.3. When an RNP Approach procedure is published, it is possible that not all the three minima lines will be available on the chart. Aircraft equipped with Baro-VNAV capability only are not capable of flying LPV procedures however aircraft capable of RNP APCH to LPV minima have the potential to be approved for LNAV/VNAV procedures. Where possible, all runway ends should have an RNP Approach to LNAV minima and aircraft approved for either LNAV/VNAV or LPV may use it. It is common practice to publish all three minima lines on a single RNP approach chart.

5.3.7.4. If required, certain provisions should be implemented to enable the ATC to cope with mixed mode operations (conventional navigation versus area navigation where some aircraft are equipped to fly the RNP Approach and others are not). It may be necessary to provide navigation services to aircraft that are not capable and/or approved for RNP operations. Conventional procedures would therefore need to be retained. Conventional navigation aids may also be needed to support operators' contingency procedures in case of a GNSS outage.

5.3.7.5. In Europe and as defined in the PBN IR [1], the proportion of PBN non-capable aircraft is expected to reduce gradually so that providers of ATM/ANS can withdraw services using conventional procedures by 2030 (except for Cat II/III precision landing). A minimum network of conventional navigation aids will be retained for contingency situations.

5.3.8. **Activity 15: AIS Requirements**

5.3.8.1. Approach publication

5.3.8.1.1. For charting, general criteria apply as specified in ICAO PANS OPS Volume II. The title of the instrument approach chart shall be RNP RWY XX. The minima box could include OCA/H values for LNAV, LNAV/VNAV and LPV minima. An example of a chart that includes all three minima lines is provided in Figure 4.

5.3.8.1.2. If multiple RNP Approaches exist to the same runway, a suffix is added to each of the applicable approach identifiers, for example RNP Y RWY 27 and RNP Z RWY 27. Using a suffix is a common rule not specific to RNP Approach procedures. There is no harmonised use of suffices in Europe. The Z suffix often represents the preferential approach from an ATC perspective. But other suffices like 'N', 'S', 'W' or 'E' for approaches respectively from the North, South, West or East have also been observed. Suffix 'E' has also been used on approach charts with only an LPV minima ('E' refers to 'EGNOS' in that case), whereas suffix 'H' is sometimes used for Helicopter procedures.

5.3.8.1.3. To ensure that the procedures can be coded in ARINC 424 format, procedure designers have to be familiar with the path terminators used to code PBN procedures and their use. Understanding the functional capabilities of different area navigation systems for each path terminator is not a requirement. A close co-operation should exist between procedure designers, those involved in procedure validation and the navigation data providers that compile the coded data for the navigation database. Both procedure designers and data providers belong to the ANSP family as manifested in the EASA Regulatory framework (see [25] Part FPD[3] and Part DAT). All procedures must be based upon WGS-84 coordinates.

5.3.8.1.4. The State AIP should clearly indicate that the navigation application is RNP APCH. This should be indicated in the PBN Box of the approach chart, together with

[3] Previously known as Part ASD

optional on-board PBN functions which might be required (e.g. RF). The navigation data published in the State AIP for the procedures and supporting navigation aids must meet the charting requirements of Annex 4 [28], Chapter 11, paragraph 11.10.9; Annex 15 [29] and Doc 10066 [30] (as appropriate).

5.3.8.1.5. A coding table or a formal textual description should be published on the back of the chart providing the coordinates of all the waypoints (and fixes) used in the procedure. If it is not possible to put this information on the back of the chart a separate, properly referenced sheet can be used.

5.3.8.1.6. In the case of LPV, the data required to code the procedure includes an SBAS FAS Data Block, which contains an eight character hexadecimal representation of the calculated remainder bits called the CRC remainder. The CRC remainder is used to determine the integrity of the FAS data during transmission and storage and it is computed electronically using a FAS data block software tool. The content of the SBAS FAS Data Block should be published on the verso of the chart in order to ensure that the LPV portion of the procedure is correctly coded in the navigation database.

5.3.8.1.7. An SBAS FAS DB tool is made available on the EUROCONTROL web site (https://fasdb.eurocontrol.int/fasdb/). This tool allows the calculation of the CRC value for an SBAS FAS DB, generates an electronic version of the Data Block and converts electronic Data-Block into a textual form. Generally, FAS DB tools also generate a Data Block representation as a hexadecimal string. The textual description only, together with the CRC remainder value can be made available on the verso of the chart.

5.3.8.1.8. Project management should allow a reasonable amount of time for unexpected events, especially those related to procedure validation and coding.

5.3.8.1.9. Another detail concerning the publication of LPV procedures is that a unique SBAS channel number is needed for every published approach. Until 2019 and as agreed with ICAO and FAA, EUROCONTROL was the focal point in Europe for SBAS channel allocation. ICAO has now set up a global system of SBAS Channel assignments (https://www4.icao.int/SBAS/). Procedure designers are expected to request the channel number through National points of contacts. The SBAS channel number is a five digit number that must be globally unique and shall be in the range of 40,000 to 99,999. Channel number assignments are required for RNP Approach to LPV and LP minima and will be promulgated on the approach charts respectively. It should be noted that either an LP or an LPV minima is expected to be published to a single runway end, not both.

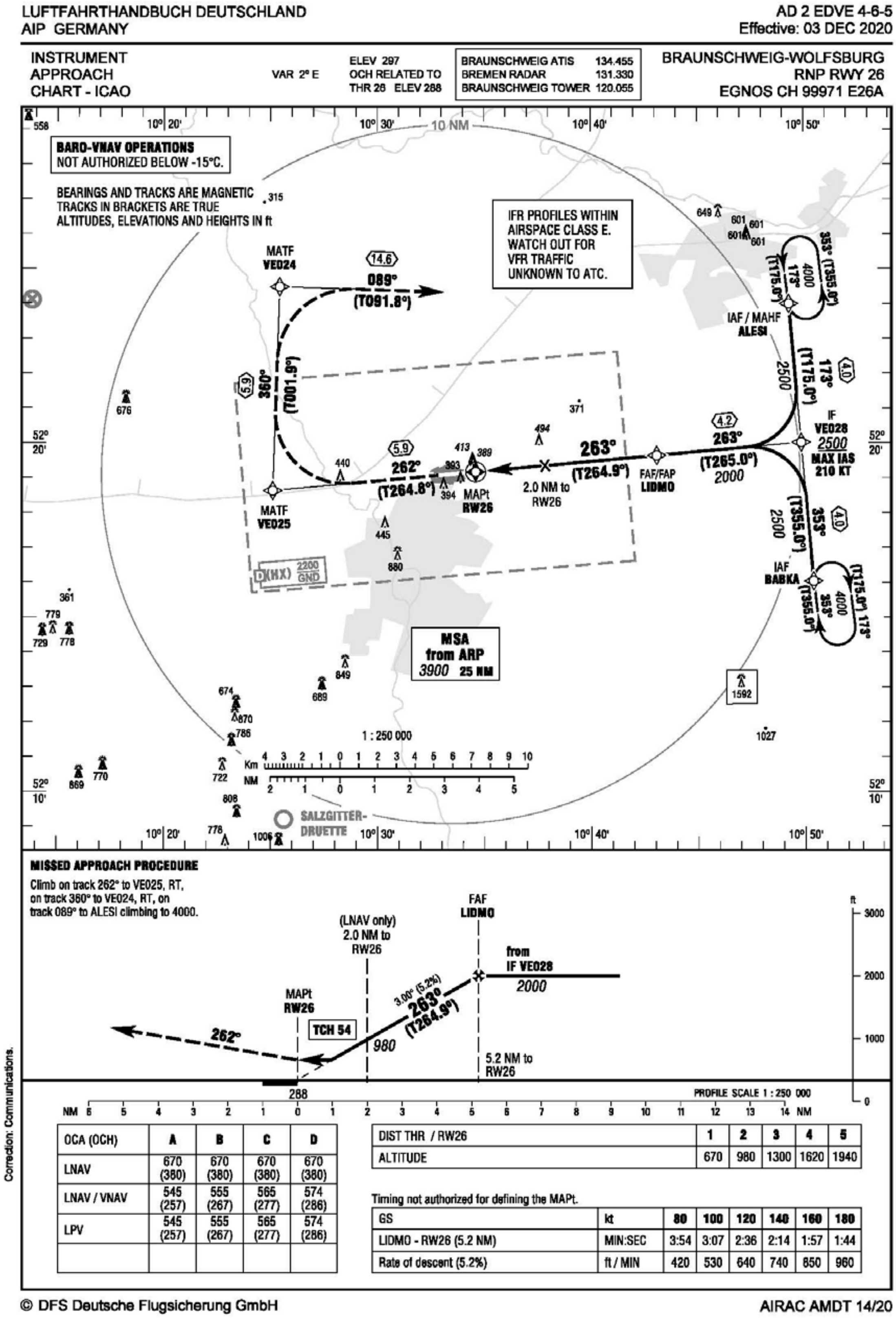
5.3.8.1.10. The information regarding the establishment of new RNP Approach procedures will need to be provided in accordance with the AIRAC publication system. It is recommended that new RNP Approach procedures are considered by States AIS as 'major changes' in respect of circumstances listed in Appendix 4, Part 3 of ICAO Annex 15 [29] (guidance on what constitutes a 'major change' is included in Doc. 8126

'AIS Manual' [31]). Therefore, it is recommended that new RNP Approach information is distributed by the AIS unit at least 56 days in advance of the planned effective date.

5.3.8.2. AIC and AIP publication

5.3.8.2.1. States are recommended to use AIC and AIP to provide information to users regarding GNSS, including SBAS. PANS AIM is in the process of being updated and it is expected that GNSS-related elements providing the navigation service are published in the State AIP General (GEN 3.4) and En-Route (ENR 4.3) sections. Even if the same aid (GNSS core constellations and/or SBAS) is used for both en-route and aerodrome purposes, a description will not be needed in AIP AD 2 and/or (if appropriate) AD 3 sections, as these sections will be dedicated to local systems.

Figure 4 Example RNP Approach Chart including all three minima lines



5.3.9. Activity 16: Navigation Database

5.3.9.1. The navigation database should be obtained from a supplier that complies with RTCA 200B/EUROCAE ED-76A 'Standards for Processing Aeronautical Data [32] (EUROCAE ED-76/RTCA DO-200A may also be acceptable). Such compliance shall be overseen by the appropriate regulatory authority. In States applying EASA rules, the Commission Implementing Regulation (EU) 2017/373 [25] applies since 1st January 2019. It sets the requirements for the certification of organisations processing aeronautical data for use on aircraft (DAT providers).

5.3.9.2. Virtually all aeronautical databases are loaded according to the specifications in the Aeronautical Radio, Incorporated (ARINC) 424 standard 'Navigation System Data Base'. While the ARINC 424 specification covers a large percentage of the aeronautical requirements, it is impossible to write a specification that wraps up every combination of factors used to design and fly instrument procedures.

5.3.9.3. Many of the differences between charts and databases are because there can be no standard implemented to have the information in both places depicted in exactly the same way. It is recognized that the basic design for most aeronautical information contained in instrument procedures i.e. conventional ones has been created for the analogue world. The art of entering data into an aeronautical database i.e. translation of the textual & graphical description of a procedure with the help of Path and Terminator (P/T) codes is one that balances the intent of the original procedure designer and the requirements of Flight Management Systems(FMS). With the implementation of PBN applications, a high degree of standardization and harmonization of chart and database information has been reached due to the following reasons:

- RNP Approach procedure standard shape 'Y' or 'T';
- Mostly straight segments (TF leg);
- Curved segments (RF legs) – optional outside of the final approach and initial missed approach segments;
- Small sub-set of Path Terminators compatible for PBN procedure coding;
- ICAO requirement for formal or tabular procedure description on chart verso which significantly reduced the misinterpretation of procedures by coders;

5.3.9.4. However, there are many different types of avionics equipment utilizing the same baseline navigation database. The same database information may be presented differently on certain types of airborne equipment even being manufactured by the same FMS vendor. In addition, some equipment may be limited to specific types of navigation database information, omitting other database information.

5.3.9.5. Since 1995, navigation data provider experts have been working with all avionics vendors to achieve as much standardization of PBN procedures as possible. In certain cases, alternative coding (such as path terminators, speed and altitude restrictions) may be used to enable specific area navigation systems to better follow the intended track.

5.3.9.6. Within an ARINC 424 output file for an RNP Approach to LPV minima, the SBAS FAS DB data is carried in a dedicated type of record called the Path Point (PP) file. The PP Primary record description contains all FAS data fields (twenty-one fields including the CRC remainder field) as required for the data wrap for CRC calculations. The specific order and coding of the twenty-one fields should be followed rigorously when computing the CRC to ensure avionics compatibility. When 'un-wrapping 'the FAS Data Block, the navigation data provider and avionics must compare the resulting CRC remainder i.e. representing the integrity field with the value provided by the procedure designer. If the values do not match, the FAS Data Block cannot be validated and extracted from database.

5.3.9.7. Additionally, the Path Point record has been further extended following industry requirements with a continuation record. The PP Continuation record containing fields such as LTP and FPAP orthometric heights, FPAP ellipsoid height and SBAS channel number. Therefore, States are also required to provide these parameters to the data provider in addition to the FAS DB.

5.3.9.8. In conclusion, RNP Approach procedures authorized for SBAS navigation demand a complex work-process for generation and extraction of the complete set of records by the navigation database supplier.

5.3.9.9. From a data quality and integrity level stand point, some elements of the SBAS FAS DB are classified as critical data requiring the highest possible resolution for latitude/longitude & elevation (hundredth of sec and 1 foot respectively). Therefore, attention should be paid throughout the entire chain of involved actors i.e. procedure designer – AIS expert – navigation data specialist – avionics representative in order that the highly demanding navigation database requirements for RNP Approach should be closely coordinated in a collaborative process.

5.3.10. **Activity 17: Training Requirements**

5.3.10.1. Training for ATC

5.3.10.1.1. Air traffic controllers, who provide control services at airports where RNP Approaches have been implemented, should have completed training that covers the items listed below.

5.3.10.1.2. Core training

How area navigation systems work:

- include functional capabilities and limitations;
- accuracy, integrity, availability and continuity including on-board performance monitoring and alerting;
- GPS receiver, RAIM, FDE, and integrity alerts;
- waypoint fly-by versus flyover concept (and different turn performances);

Flight plan requirements;

ATC procedures;

- ATC contingency procedures;
- separation minima;
- mixed equipage environment;
- transition between different operating environments; and
- phraseology.

5.3.10.1.3. Training specific to RNP Approach

a) Related control procedures:
- o radar vectoring techniques (where appropriate);

b) RNP Approach and related procedures:
- o including T and Y approaches; and
- o approach minima;
- o RF legs

c) impact of requesting a change to routing during a procedure.

Some items of the training are general. Local considerations may be added as a result of the local safety assessment.

5.3.10.2. Training for Flight Crew

Commission Regulation (EU) 2016/539 amended Regulation (EU) No 1178/2011 [33] as regards pilot training, testing and periodic checking for performance-based navigation (Part-FCL). This eliminated the specific operational approval for most PBN operations, including for RNP Approach, for CAT, SPA, NCC and NCO operators. AMC and GM to Part FCL contain theoretical knowledge and flight instruction elements on PBN and RNP Approach

5.3.11. **Activity 18: Final Review before implementation**

5.3.11.1. Once the above steps are performed, a final verification should be made so that the deployment can proceed.

5.3.11.2. The following list is proposed as a check list for this final review:

- Demonstrate how the targets set for the implementation of the RNP Approach procedures are to be met.
- The risk assessment and mitigation for the change must be accepted by the competent authority.
- The validation of the procedures must have demonstrated that the procedures can be successfully implemented.
- The impact on training and the level of fleet equipage on implementation date must be considered and if needed, a new target date for implementation should be agreed.
- In case a GO decision has been made, a commitment to implement and the agreed target date for the publication of the procedures should be announced.

5.3.12. **Activity 19: Introduction into service**

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

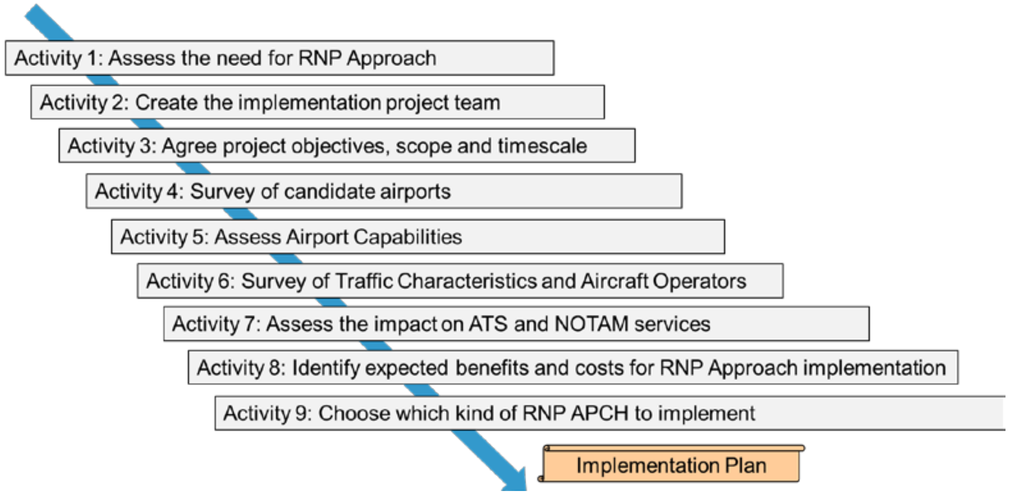
5.3.13. **Activity 20: Post-implementation activities**

5.3.13.1. Once the RNP Approach operations are introduced, their performance should be monitored. For this purpose, data on success and failure rates of RNP Approaches should be collected. This will allow for instance the verification of any expected safety improvements. A Post Implementation Review (PIR) should be undertaken after a suitable period of operational experience, typically one year.

5.3.13.2. If unacceptable events occur during initial operations, the procedures should be removed and the operational concept should be reviewed in order to put in place the appropriate mitigations.

ANNEX 1: RNP APPROACH IMPLEMENTATION ACTIVITIES

Agreeing the operational requirements and building the implementation plan



RNP Approach implementation