



GUIDANCE MATERIAL FOR Performanced-Based Navigation (PBN)

Approved by



.....
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Acting Director General
The Civil Aviation Authority of Thailand

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Revision No: 1

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ISSUE APPROVAL

This Guidance Material (GM) contains the standards, policies, procedures and guidelines concerning the Thai Air Operator Requirement (AOCR) and is published for use by The Civil Aviation Authority of Thailand (CAAT) personnel delegated with the responsibility of certifying Air Operators shall comply with all provisions in this GM during the certification process

In addition, this GM contains instruction in respect of certification to be eligible to conduct by Air Operators for guidance to reach the CAAT requirement.

Amendments to this GM will be notified through www.caat.or.th.



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REVISION HIGHLIGHTS

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Chapter/Section	Description of Change
All	New issue
All	Change name from DCA to CAAT

GLOSSARY (ABBREVIATIONS/ACRONYMS)

AAIM	Aircraft autonomous integrity monitoring AC Advisory circular
ACCUR	Accuracy
AFARP	As far as reasonably practical
AFM	Aircraft flight manual
AGL	Above ground level
AHRS	Attitude and heading reference system
AIP	Aeronautical information publication
AIRAC	Aeronautical information regulation and control
ALARP	As low as reasonably practical
AMC	Acceptable means of compliance
AMM	Aircraft maintenance manual
ANPE	Actual navigation performance error
ANSP	Air navigation service provider
AO	Air operator
AOC	Air operator certificate
AP	Auto pilot
AR	Authorization required
A-RNP	Advanced RNP
ARP	Aerodrome reference point
ASE	Altimetry system error
ATC	Air traffic control
ATCO	Air traffic controller
ATIS	Automatic terminal information service
Baro-VNAV	Barometric VNAV
B-RNAV	Basic RNAV
BG	Body geometry
CA	Certificating authority
CCA	Civil aviation authority
CAAP	Civil aviation advisory publication
CASA	Civil Aviation Safety Authority (Australia)
CCF	Common cause failure
CDI	Course deviation indicator
CDU	Control display unit
CS	Certification specification
DA	Decision altitude



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DA/H	Decision altitude/height
DF	Direct to a fix
DGCA	Directorate General of Civil Aviation
DME	Distance measuring equipment
DOP	Dilution of precision
DR	Dead reckoning
EASA	European Aviation Safety Agency
EGPWS	Enhanced ground proximity warning system
ENR	En-route
EPE	Estimated position error
ETSO	European Technical Standards Order
EUROCAE	European Organization for Civil Aviation Equipment
FA	Fix to an altitude
FAA	Federal Aviation Administration
FAF	Final approach fix
FAP	Final approach point
FCOM	Flight crew operations manual
FD	Flight director
FDE	Fault detection and exclusion
FGS	Flight guidance system
FM	Fix to a manual termination
FMS	Flight management system
FOSA	Flight operational safety assessment
FPA	Flight path angle
FPL	Flight plan
FRT	Fixed radius transition
FSD	Full-scale deflection
FSTD	Flight simulation training device
FTE	Flight technical error
GA	General aviation
GNSS	Global navigation satellite system
GPS	Global positioning system
HA	Holding/racetrack to an altitude
HAL	Horizontal alert limit
HF	Holding/racetrack to a fix
HFOM	Horizontal figure of merit
HIL	Horizontal integrity limit
HM	Holding/racetrack to a manual termination



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HPL	Horizontal protection limit
HIS	Horizontal situation indicator
IAF	Initial approach fix
IF	Initial fix
IFR	Instrument flight rules
INS	Inertial navigation system
IRS	Inertial reference system
IRU	Inertial reference unit
ISAD	ISA deviation
L/DEV	Lateral deviation
LCD	Liquid crystal display
LNAV	Lateral navigation
LOA	Letter of authorization
LP	Localizer performance
LPV	Localizer performance with vertical guidance
LRNS	Long range navigation system
MAPt	Missed approach point
MASPS	Minimum aviation system performance standard
MCDU	Multifunction control display unit
MDA	Minimum descent altitude
MDA/H	Minimum descent altitude/height
MEL	Minimum equipment list
MMEL	Master minimum equipment list
MOC	Minimum obstacle clearance
MOPS	Minimum operational performance standards
MSA	Minimum sector altitude
NAS	National airspace system (USA)
NAV	Navigation
NAVAID	Navigation aid
NDB	Non-directional radio beacon
NM	Nautical mile
NOTAM	Notice to airmen
NPS	Navigation performance scales
NSE	Navigation system error
OCA/H	Obstacle clearance altitude/height
OEI	One-engine inoperative
OEM	Original equipment manufacturer
OM	Operations manual



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OPS-SPEC	Operations specification
PA	Precision approach
PBN	Performance-based navigation
PDE	Position definition error
PFD	Primary flight display
PM	Pilot monitoring
P-RNAV	Precision RNAV
QRH	Quick reference handbook
RAIM	Receiver autonomous integrity monitoring
RF	Radius to fix
RNAV	Area navigation
RNP	Required navigation performance
RNP APCH	RNP approach
RNP AR	RNP authorization required
RSS	Root sum squared
RVSM	Reduced vertical separation minimum
SAAAR	Special aircraft and aircrew authorization required South American
SB	Service bulletin
SBAS	Space-based augmentation system
SID	Standard instrument departure
SL	Service letter
SOP	Standard operating procedure
STAR	Standard arrival route
STC	Supplemental type certificate
TAS	True airspeed
TAWS	Terrain awareness warning system
TC	Type certificate
TCDS	Type certificate data sheets
TF	Track to a fix
TGL	Temporary guidance leaflet
TLS	Target level of safety
TOGA	Take-off/go-around
TSE	Total system error
TSO	Technical standard order
US-RNAV	United States RNAV
VA	Heading to an altitude
VAE	Vertical angle error
V/DEV	Vertical deviation



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VEB	Vertical error budget
VHF	Very high frequency
VI	Heading to an intercept
VM	Heading to a manual termination
VMC	Visual meteorological conditions
VNAV	Vertical navigation
VOR	VHF unidirectional radio range
WAAS	Wide area augmentation system
WDM	Wiring diagram manual
WPR	Waypoint resolution error
WPT	Waypoint



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PART 1: PBN APPROVAL GUIDELINE



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CHAPTER 1 PERFORMANCE-BASED NAVIGATION

1.1. Introduction

1.1.1. Conventional navigation is dependent upon ground-based radio navigation aids. It has been the mainstay of aviation for the last seventy years, and pilots, operators, manufacturers and ANSPs are all familiar with the associated technology, avionics, instrumentation, operations, training and performance.

1.1.2. Performance-based navigation (PBN) detailed in Doc 9613, The Performance-based Navigation (PBN) Manual, is based upon area navigation principles. While various methods of area navigation have been in existence for many years, the widespread use of area navigation as a primary navigation function is a more recent phenomenon. The PBN concept is intended to better define the use of area navigation systems and is expected to replace many of the existing conventional navigation routes within the next twenty years.

1.1.3. The fundamentals of PBN operations are relatively straightforward, and operational approval need not be a complicated process for either applicant or regulator. However the transition to new technology, new navigation and new operational concepts and the dependence on data-driven operations require careful management. The PBN operational approval process is intended to ensure that the appropriate level of oversight is provided for all PBN operations in an environment where there are currently many variables in terms of State regulations as well as experience in the related equipment, engineering and operational issues. In this way, the benefits of PBN will be achieved consistently and safely.

1.1.4. The key to successful PBN implementation is knowledge and experience. In many States, operators and regulators lack both, and this manual is intended to assist in improving this level of knowledge.

1.2. PBN Overview

1.2.1. Area navigation systems evolved in a manner similar to conventional ground-based routes and procedures. The early systems used very high frequency unidirectional radio range (VOR) and distance measuring equipment (DME) for estimating their position in domestic operations, and inertial navigation systems (INS) were employed in oceanic operations. In most cases a specific area navigation system was identified, and its performance was evaluated through a combination of analysis and flight testing. In some cases, it was necessary to identify the individual models of equipment that could be operated within the airspace concerned. Such prescriptive requirements resulted in delays in the introduction of new area navigation system capabilities and higher costs for maintaining appropriate certification. The PBN concept was developed with globally applicable performance requirements, detailed in accompanying navigation specifications, in order to avoid these high costs and delays.

1.2.2. The PBN concept requires that the aircraft area navigation system performance be defined in terms of the accuracy, integrity, availability, continuity and functionality necessary to operate in the context of a particular airspace concept. Appropriate positioning sensors are also identified; these may include VOR/DME, DME/DME, GNSS and/or inertial systems. Performance is detailed in a navigation specification in sufficient detail to facilitate global harmonization. The navigation specification not only lays out the aircraft system performance requirements but also the aircrew requirements in terms of crew procedures and training, as well as any appropriate maintenance requirements, such as the provision of navigation databases.

1.2.3. Area navigation systems are described in more detail in Appendix A



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1.3. RNAV and RNP

1.3.1. RNAV specifications were developed to support existing capabilities in aircraft equipped with area navigation systems which, in the general case, were not designed to provide on-board performance monitoring and alerting. RNAV specifications are similar to RNP specifications but do not require an on-board performance monitoring and alerting capability.

1.3.2. RNP specifications developed from a need to support operations that require greater integrity assurance, where the pilot is able to detect when the navigation system is not achieving, or cannot guarantee with appropriate integrity, the navigation performance required for the operation. Such systems are known as RNP systems. RNP systems provide greater assurance of integrity and, hence, can offer safety, efficiency, capacity and other operational benefits.

1.4. Navigation Specifications

The navigation specifications in Table 1-1 have been published to date.

1.4.1.1.1. Table 1-1. Navigation specifications published to date

Navigation specification	Flight Phase							
	En-route oceanic/remote	En-route continental	Arrival	Approach				Departure
				Initial	Intermediate	Final	Missed	
RNAV 10	10							
RNAV 5 ^a		5	5					
RNAV 2		2	2					2
RNAV 1		1	1	1	1		1 ^b	1
RNP 4	4							
RNP 2	2	2						
Advanced RNP ^c	2 ^d	2 or 1	1	1	1	0.3	1 ^b	1
RNP 1			1 ^e	1			1 ^b	1 ^e
RNP 0.3 ^f		0.3	0.3	0.3	0.3	—	0.3 ^b	0.3
RNP APCH RNP				1	1	0.3 ^g	1 ^b or 0.3 ^h	
AR APCH				1-0.1	1-0.1	0.3-0.1	1-0.1 ⁱ	

Notes:

RNAV 5 is an en-route navigation specification which may be used for the initial part of a STAR outside 30 NM and above MSA.

Applies only once 50 m (40 m Cat H) obstacle clearance has been achieved after the start of climb.

A-RNP also permits a range of scalable RNP lateral navigation accuracies.

Optional; requires higher continuity.

Beyond 30 NM from the airport reference point (ARP), the accuracy value for alerting becomes 2 NM.



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The RNP 0.3 specification is primarily intended for helicopter operations.

RNP APCH is divided into two parts. This value applies during the initial straight ahead segment in RNP APCH Part B (SBAS LPV) approaches.

RNP APCH is divided into two parts. RNP 0.3 is applicable to RNP APCH Part A. Different angular performance requirements are applicable to RNP APCH Part B only.

If less than RNP 1 is required in the missed approach, the reliance on inertial to cater for loss of GNSS in final means that accuracy will slowly deteriorate, and any accuracy value equal to that used in final can be applied only for a limited distance.

1.5. PBN Applications

A navigation application uses a navigation specification and the associated navigation infrastructure to support a particular airspace concept. This is illustrated in Figure 1-1.

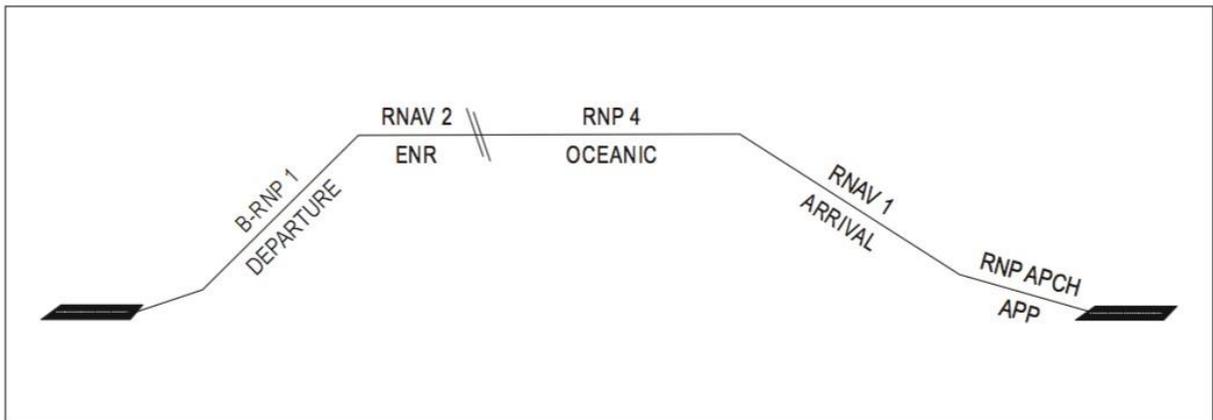


Figure 1-1. Navigation specifications to support a particular airspace concept



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CHAPTER 2 CERTIFICATION AND OPERATIONAL APPROVAL

2.1. Overview

The PBN concept requires that the aircraft meets certain airworthiness certification standards, including the necessary navigation system performance and functionality, to be eligible for a particular application and that the operator has operational approval from an appropriate regulatory body before the system can be used. A PBN navigation specification operational approval is an approval that authorizes an operator to carry out defined PBN operations with specific aircraft in designated airspace. The operational approval for an operator may be issued when the operator has demonstrated to CAAT that the specific aircraft are in compliance with the relevant airworthiness standard and that the continued airworthiness and flight operations requirements are satisfied.

The airworthiness element ensures that the aircraft meets the aircraft eligibility and safety requirements for the functions and performance defined in the navigation specifications (or other referenced certification standards) and the installation meets the relevant airworthiness standards, e.g. U.S. 14 CFR Part 25/EASA CS-25 and the applicable AC/AMC. The AC/AMC may also include other non-navigation equipment required to conduct the operation such as communications and surveillance equipment.

The continued airworthiness element of the operational approval is not directly addressed in the PBN Manual since it is inherent in the aircraft airworthiness approval through the airworthiness requirements, i.e. U.S. 14 CFR 25.1529/ EASA CS-25.1529, but the operator is expected to be able to demonstrate that the navigation system will be maintained compliant with the type design. For navigation system installations there are few specific continued airworthiness requirements other than database and configuration management, systems modifications and software revisions, but the element is included for completeness and consistency with other CNS/ATM operational approvals, e.g. RVSM.

The flight operations element considers the operator's infrastructure for conducting PBN operations and flight crew operating procedures, training and competency demonstrations. This element also considers the operator's MEL, operations manual, checklists, instrument flight procedure approval processes, navigation database validation procedures, dispatch procedures, etc.

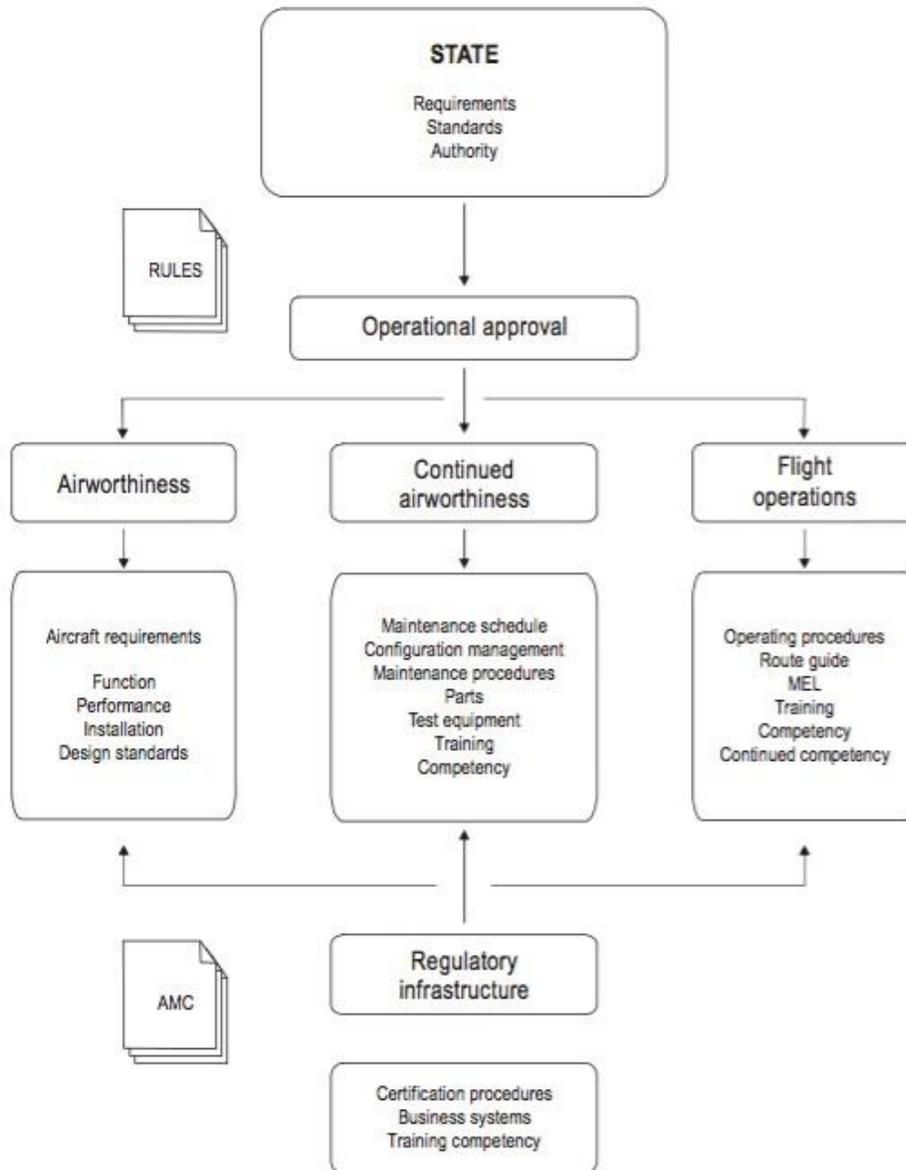


Figure 2-1. Overview of operational approval responsibilities

2.2. State Regulatory Responsibilities

2.2.1. Individual States must develop national regulatory material which addresses the PBN applications relevant to their airspace or relevant to operations conducted in another State by the operators and aircraft registered in their State. Responsibility for all or part of this activity may be delegated to regional safety oversight organizations. In line with current practice, small or less capable States may elect to adopt or even adapt, as an acceptable means of compliance, the national regulatory material of certification States that have a relevant developed regulatory framework.

2.2.2. There may be up to three different States and regulatory agencies involved in operational approval:

State of Design/Manufacture. The organization which has designed the aircraft applies for a type certificate (TC) from the State of Design. The State of Design also approves the master minimum equipment list (MMEL), the mandatory maintenance tasks and intervals, and the aircraft flight manual (AFM) and its amendments, which determine the PBN capabilities and limitations of the aircraft. A State of Design, which may be different from the State which issued the original TC, may issue a design change approval for an aircraft as a supplemental type certificate (STC).

State of Registry. The State of Registry is the State in which the aircraft is registered. The State of Registry is responsible for the airworthiness of the aircraft. It approves the aircraft maintenance programme, in accordance with its regulations, and issues the certificate of airworthiness. It also approves aircraft repairs and modifications (as stand-alone modifications or as STCs). For general aviation, the State of Registry approves the minimum equipment list (MEL) and the conduct of specified PBN operations.

State of the Operator. The State of the Operator (which may be different from the State of Registry for commercial air transport operations) accepts the aircraft maintenance programme and approves the MEL, the flight crew training programmes and the conduct of specified PBN operations, in accordance with its regulations.

2.2.3. technical data effectively transfers the regulatory responsibility for that data to the State re-approving the data with respect to aircraft registered under its jurisdiction. Where a State wishes to use technical data approved by another State, the State should review the data, determine that the data are acceptable for use in that State and formally accept the data; in this way, the regulatory responsibility remains with the State that originally approved the data. An example of regulatory text is provided in Appendix B.

2.3. Operational Approval

2.3.1. Operational approval is usually the responsibility of the regulatory authority of the CAAT for commercial air transport operations and the State of Registry for general aviation operations.

2.3.2. The following factors can influence a State's decision to require a formal operational approval process and specific documentation of approval:

The degree of linkage to the basis for aircraft/avionics certification, i.e. whether the aircraft, including its RNAV or RNP navigation system, has an airworthiness approval covering the type of envisaged PBN operations;

the complexity of the PBN operation and the level of associated challenges to operators and regulators;

the maturity of the related operational concept and systems and, specifically, whether the issues are well understood and relatively stable;

the risk associated with improper conduct of operations and operator-specific safety expectations, as well as those of third parties in the air and on the ground;

the availability of appropriate training, and checking standards and procedures for the respective type of PBN operations (mainly for pilots but also for maintenance and dispatcher personnel, as appropriate); and

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the promulgation of information from holders of TCs to air operators (e.g. MMEL and training requirements) throughout the life cycle of the aircraft.

2.3.3. CAAT decisions in this area should be based upon balancing the efficient use of available regulatory resources to ensure proper initial operator compliance and to promote ongoing operational safety, while also enabling the use of new technologies and operations in the interest of enhanced safety and efficiency.

2.3.4. In order to facilitate expedited approvals, provided all airworthiness and operational requirements are satisfied, CAAT may “bundle” certain operations, particularly by flight phase, thereby allowing for leveraging of an operator’s higher-level capabilities (see Figure 2-2). For example, an operator approved for RNP 1 operations might be readily approved for RNAV 1 operations provided CAAT guidance is in place. CAAT may also approach certain operations, such as those shown in the shaded area of Figure 2-2, as having less operational risk if adequate control mechanisms are implemented overall.

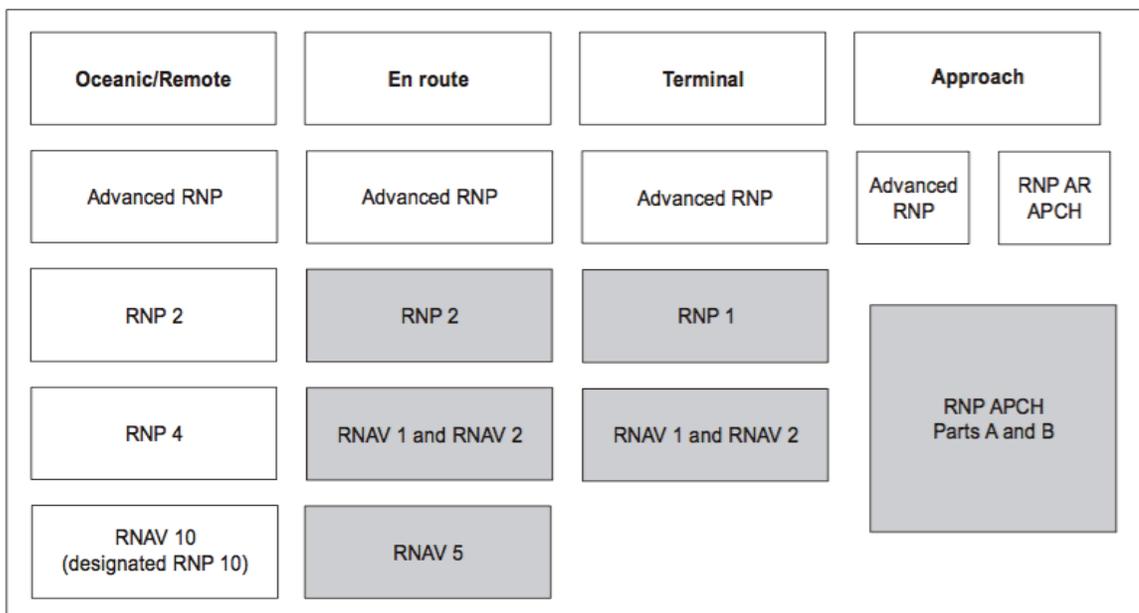


Figure 2-2. Bundling of navigation specifications

2.3.5. General aviation operators may not be required to follow the same authorization model as commercial operators although a State may determine that a letter of authorization (LOA) is also necessary for general aviation (GA). Alternatively, a State may determine that a GA aircraft may operate on a PBN route/procedure provided that the operator has ensured that the aircraft has suitably approved equipment (is eligible), the navigation database is valid, the pilot is suitably qualified and current with respect to the equipment, and adequate procedures (and checklists) are in place. Another consideration may be the ability of certain operators to document home State approval(s) for international operations. As such, issuance of a formal, specific approval may also be appropriate if only as an option to facilitate recognition by foreign States.

2.3.6. See <http://www.icao.int/safety/PBN/Pages/default.aspx> for example approaches to operational approvals for commercial air transport and GA operators.

Note 1. RNP 0.3 has not been included because it primarily deals with helicopter operations with specific applications.

Note 2. An RNP 4 navigation specification contains additional requirements beyond navigation.

2.3.7. The operational approval assessment must take account of the following:

*aircraft eligibility and airworthiness compliance (any limitations, assumptions or specific procedures considered in the framework of the airworthiness approval must be addressed);
operating procedures for the navigation systems used;
control of operating procedures (documented in the operations manual);
flight crew initial training and competency requirements and continuing competency requirements;
dispatch training requirements; and
control of navigation database procedures. Where a navigation database is required, operators need to have documented procedures for the management of such databases. These procedures will define the sourcing of navigation data from approved suppliers, data validation procedures for navigation databases and the installation of updates to databases into aircraft so that the databases remain current with the AIRAC cycle. (For RNP AR applications, the control of the terrain database used by TAWS must also be addressed.)*

2.3.8. Aircraft eligibility

2.3.8.1. An aircraft is eligible for a particular PBN application provided there is clear statement in:

the TC; or

the STC; or

the associated documentation — AFM or equivalent document; or

a compliance statement from the manufacturer, which has been approved by the State of Design and accepted by the State of Registry or the State of the Operator, if different.

The operator must have a configuration list detailing the pertinent hardware and software components and equipment used for the PBN operation.

2.3.8.2. The TC is the approved standard for the production of a specified type/series of aircraft. The aircraft specification for that type/series, as part of the TC, will generally include a navigation standard. The aircraft documentation for that type/series will define the system use, operational limitations, equipment fitted and the maintenance practices and procedures. No changes (modifications) are permitted to an aircraft unless the CAAT of the State of Registry either approves such changes through a modification approval process or STC, or accepts technical data defining a design change that has been approved by another State.

2.3.8.3. An alternate method of achieving the airworthiness approval of the aircraft for PBN operations is for the aircraft to be modified in accordance with approved data (e.g. STC, minor modification, FAA Form 8110-3).

2.3.8.4. One means of modifying an aircraft is the approved service bulletin (SB) issued by the aircraft manufacturer. The SB is a document approved by the State of Design to enable changes to the specified aircraft type, and the modification then becomes part of the type design of the aircraft. Its applicability will normally be restricted by airframe serial number. The SB describes the intention of the change and the work to be done to the aircraft. Any deviations from the SB require a design change approval; any deviations not approved will invalidate the SB approval. The State of Registry accepts the application of an SB and changes to the maintenance programme, while the State of the Operator accepts changes to the maintenance programme and approves changes to the MEL, training programmes and operations specifications. An OEM SB may be obtained for current-production or out-of-production aircraft.



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2.3.8.5. For recently manufactured aircraft, where the PBN capability is approved under the TC, there may be a statement in the AFM limitations section identifying the operations for which the aircraft is approved. There is also usually a statement that the stated approval does not itself constitute an approval for an operator to conduct those operations.

2.3.8.6. In many cases for legacy aircraft, while the aircraft is capable of meeting all the airworthiness requirements of a PBN navigation specification, there may be no clear statement in the applicable TC or STC or associated documents (AFM or equivalent document). In such cases, the aircraft manufacturer may elect to issue an SB with an appropriate AFM update or instead may publish a compliance statement in the form of a letter, for simple changes, or a detailed aircraft-type-specific document for more complex changes. The State of Registry may determine that an AFM change is not required if it accepts the OEM documentation. Table 2-1 lists the possible scenarios facing an operator who wishes to obtain approval for a PBN application, together with the appropriate courses of action.

Note. The European Aviation Safety Agency (EASA) publishes the criteria required for airworthiness certification and operational approval to conduct PBN operations, and member States apply these criteria. In the context of PBN, the EASA acceptable means of compliance (AMC) series is currently the repository for such criteria (in some cases, a temporary guidance leaflet (TGL) is used). The Federal Aviation Administration (FAA), similarly, publishes advisory circulars (ACs) and orders for operations in U.S. airspace. The ACs, orders and AMCs usually reference appropriate technical standard orders (TSOs) and European TSOs (ETSOs). TSOs/ETSOs are also the responsibility of the FAA and EASA and provide technical and performance requirements for specific parts or items of equipment. A design organization, typically the aircraft manufacturer, may require a vendor to produce a TSO/ETSO approval before including such equipment in a system design. The ACs and AMCs may also reference industry standard documents such as the minimum aviation system performance standards (MASPS) or the minimum operational performance standards (MOPS), which are usually developed under the aegis of the RTCA and EUROCAE, and specific interoperability and interface standards such as those published by ARINC. The airworthiness certification requirements in the USA and in the European Union are largely “harmonized” in order to reduce the costly and time-consuming work by OEMs and equipment vendors to gain approval from two different authorities with the same safety objectives. Some States have imposed additional constraints which are highlighted

in Chapter 4. Table 2-2 lists the certification standards published by EASA and the FAA for PBN applications in 2012 (each document may reference additional standards including ACs, TSOs and RTCA/EUROCAE documents) and is subject to change.

2.3.9. Operating procedures

2.3.9.1. Standard operating procedures (SOPs) must be developed to cover both normal and non-normal (contingency) procedures for the systems used in the PBN operation. The SOPs must address:

- a) pre-flight planning requirements including the MEL and, where appropriate, RNP/RAIM prediction;
- b) actions to be taken prior to commencing the PBN operation;
- c) actions to be taken during the PBN operation; and
- d) actions to be taken in the event of a contingency, including the reporting to the operator and to the CAAT of significant incidents such as:
 - 1. navigation errors not associated with transitions from an inertial navigation mode to a radio navigation mode;
 - 2. unexpected deviations in lateral or vertical flight path attributed to incorrect navigation data;
 - 3. significant misleading information without failure warning;
 - 4. total loss or multiple failures of the PBN navigation equipment; or problems with ground navigation facilities leading to significant navigation errors

Table 2-1. Approval scenarios

Scenario	Aircraft certification status	Actions by the operator/owner
1	Aircraft designed and type- certificated for PBN application. Documented in the AFM, TC or STC.	No action required; aircraft eligible for PBN application.
2	Aircraft equipped for PBN application but not certified. No statement in the AFM. SB available from the aircraft manufacturer.	Obtain the SB (and associated amendment pages to the AFM) from the aircraft manufacturer.
3	Aircraft equipped for PBN application. No statement in the AFM. SB not available. Statement of compliance available from the aircraft manufacturer.	Establish if the statement of compliance is acceptable to the regulatory authority of the State of Registry of the aircraft.
4	Aircraft equipped for PBN application. No statement in the AFM. SB not available. Statement of compliance from the aircraft manufacturer not available.	Develop a detailed submission to the State of Registry showing how the existing aircraft equipment meets the PBN application requirements. OEM support should be solicited where possible.
5	Aircraft not equipped for PBN application.	Modify aircraft in accordance with the aircraft manufacturer’s SB or develop a major modification in conjunction with an approved design organization in order to obtain an approval from the State of Registry (STC).

2.3.9.2. When operating procedures contribute directly to the airworthiness demonstration (e.g. in RNP AR) they should be documented in the AFM or an equivalent document (e.g. FCOM) approved by the State of Registry.

2.3.9.3. General aviation pilots must ensure that they have suitable procedures/checklists covering all these areas.

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Table 2-2. EASA and FAA certification standards

Navigation specification	EASA	FAA
RNAV 10	AMC 20-12	Oder 8400.12()
RNAV 5	AMC 20-4	AC 90-96 ()
RNAV 1 and RNAV 2	TGL 10 (expected to change to CS)	AC 90-100 ()
RNP 4	Expected in 2015	Order 8400.33
RNP 2	Expected in 2015	TBA
RNP 1	Expected in 2015	AC 90-105
Advanced RNP	Expected in 2015	TBA
RNP 0.3	Expected in 2015	TBA
RNP APCH (LNAV)	AMC-20-27	AC 90-105
RNP APCH (LNAV/VNAV)	AMC-20-27	AC 90-105
RNP APCH (LPV)	AMC-20-28	AC 90-107
RNP AR APCH	AMC-20-26	AC 90-101
RF Attachment	Expected in 2015	AC 90-105

2.3.10. Control of operating procedures

The SOPs must be adequately documented in the operations manual (OM) for commercial air operators and for general aviation operators of large or turbojet aircraft. For general aviation operators where an OM is not required, the PBN operating procedures must still be documented.

2.3.11. Flight crew and dispatch training and competency

A flight crew training programme and, if applicable, a dispatcher training programme must cover all the tasks associated with the PBN operation as well as provide sufficient background to ensure a comprehensive understanding of all aspects of the operation.

2.3.12. Control of navigation database procedures

Navigation databases are required for all PBN navigation specifications except RNAV 10 and RNAV 5. The procedures for maintaining currency, checking for errors and reporting errors to the navigation database supplier must be documented in the operations and maintenance manual. Moreover, the suppliers of the navigation data are usually required to comply with FAA AC 20-153 or to be issued with an LOA in accordance with EASA Opinion Nr. 01/2005.

2.3.13. Performance record

Navigation error reports should be recorded and analyzed to determine the need for any remedial action. Such action may involve the replacement of, or modifications to, the navigation equipment or changes to the operational procedures. All corrective action taken should be documented.

2.4. Documentation of Operational Approval

2.4.1. Operational approval may be documented through:

- a) an amendment to the operations manual (OM), if it is required; and
- b) an operations specification (Ops Spec), associated with the air operator certificate (AOC); or
- c) a letter of authorization (LOA) for general aviation aircraft.

Example Ops Spec entries are provided at Appendix C.

2.4.2. During the validity of the operational approval, the CAAT should consider any anomaly reports received from the operator or other interested party. Repeated navigation error occurrences attributed to a specific piece of navigation equipment may result in restrictions on use or cancellation of the approval for use of that equipment. Information that indicates the potential for repeated errors may require modification of an operator's procedures and training programme. Information that attributes multiple errors to a particular pilot or crew may necessitate remedial training and checking or a review of the operational approval.

2.5. State Regulatory Material

Individual States must publish national regulatory material which addresses the PBN applications relevant to their airspace or relevant to operations conducted in another State by the State's operators or by aircraft on their registry. The regulations may be categorized by operation, flight phase, area of operation and/ or navigation specification. Approvals for commercial operations should require specific authorization. Example regulatory text is provided at Appendix B.

Note. The EASA AMCs and the FAA ACs mentioned above also address operational approval. The ICAO South American Office (SAM) has published a set of PBN ACs covering operational approval for PBN applications for use within the region. Many other States publish similar ACs or refer to existing ACs or AMCs in their national regulations. Table 2-3 lists the operational approval material published by ICAO (SAM) and Australia for PBN applications (each document may reference additional standards including ACs, TSOs and RTCA/EUROCAE documents).

2.6. Approval Process

2.6.1. Since each operation may differ significantly in complexity and scope, the project manager and the operational approval team need considerable latitude in taking decisions and making recommendations during the approval process. The ultimate recommendation by the project manager and decision by the CAAT regarding operational approval should be based on the determination of whether or not the applicant:

- a) meets the requirements established by the State in its air navigation regulations;
- b) is adequately equipped; and
- c) is capable of conducting the proposed operation in a safe and efficient manner.

Table 2-3. Operational approval material

Navigation specification	ICAO (SAM)	Australia	New Zealand	Canada
RNAV 10	AC 91-001	AC 91U-2()		
RNAV 5	AC 91-002	DCAP B-RNAV-1		AC 700-015
RNAV 1 and RNAV2	AC 91-003	AC 91U-II-B-3		
RNP 4	AC 91-004	AC 91U-3	AC 91-10	
RNP 1	AC 91-006	AC 91U-II-C-3		
Advanced RNP	-	-		
RNP 0.3	-	-		
RNP APCH (LNAV)	AC 91-008	AC 91U-II-C-5		
RNP APCH (LNAV/VNAV)	AC 91-010	AC 91U-II-Attachment		
RNP APCH (LPV)	AC 91-011	-		
RNP AR APCH	AC 91-009	AC 91U-II-C-6		
RF Attachment		-		



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2.6.2. The complexity of the approval process is based on the inspector’s assessment of the applicant’s proposed operation. For simple approvals, some steps can be condensed or eliminated. Some applicants may lack a basic understanding of what is required for approval. Other applicants may propose a complex operation but be well prepared and knowledgeable. Because of the variety of proposed operations and differences in applicant knowledge, the process must be thorough enough and flexible enough to apply to all possibilities.

2.6.3. The approval process should consist of the following phases:

2.6.3.1.**Step 1 — Pre-application phase.** The operator initiates the approval process by reviewing the requirements; establishing that the aircraft, the operating procedures, the maintenance procedures and the training meet the requirements; and developing a written proposal to the regulator. A number of regulators have published “job aids” to assist the operator in gathering the necessary evidence to support the approval application. At this stage, a pre- application meeting with the regulator can also be very beneficial. If the proposed application is complex, the operator may need to obtain advice and assistance from OEMs or other design organizations, training establishments, data providers, etc.

2.6.3.2.**Step 2 — Formal application phase.** The operator submits to the CAAT a formal, written application for approval, which appoints a project manager (either for the specific approval or for PBN approvals generally).

Note. — An example application form is contained in Appendix D.

2.6.3.3.**Step 3 — Document evaluation phase.** CAAT project manager evaluates the formal, written application for approval to determine if all the requirements are being met. If the proposed application is complex, the project manager may need to obtain advice and assistance from other organizations such as regional agencies or experts in other States.

2.6.3.4.**Step 4 — Demonstration and inspection phase.** During a formal inspection by the project manager (assisted as necessary by a CAAT team), the operator demonstrates how the requirements are being met.

2.6.3.5. **Step 5 — Approval phase.** Following a successful formal inspection by the CAAT, approval is given via:

- a) an amendment to the OM; and
- b) an Ops Spec associated with the AOC; or
- c) an LOA.

Note 1.— The approval procedure described above consists of a simplified process of the certification guidance contained in Part III of the Manual of Procedures for Operations Inspection, Certification and Continued Surveillance (Doc 8335).

Note 2.— The demonstration and inspection phase may not be required depending upon the area navigation system used, the type of operation and the supporting State regulatory structure. An aircraft equipped with stand-alone ETSO/TSO-C129a (or higher) equipment and operated by an IFR qualified and current pilot may be “deemed” to hold a PBN operational approval for RNAV 5, for example.

2.7. INTERNATIONAL OPERATIONS

2.7.1. A State undertakes, in accordance with Article 12 of the Convention, to ensure that every aircraft flying over or maneuvering within its territory shall comply with the rules and regulations relating to the flight and maneuver of aircraft there in force. Article 33 of the Convention provides that certificates of airworthiness and certificates of competency and licences issued or rendered valid by the State in which an aircraft is registered shall be recognized by other States, provided that the requirements under which such certificates or licences were issued or rendered valid are equal to or above the minimum standards which may be established by ICAO. This requirement for recognition is now extended by Annex 6, Part I and Part III, Section II, such that Contracting States shall recognize as valid an AOC issued by another Contracting State, provided that the requirements under which the certificate was issued are at least equal to the applicable Standards specified in Annex 6, Part I and Part III.

2.7.2. States should establish procedures to facilitate the application by foreign commercial air operators for acceptance to operate into their territory. States should be careful, in their requirements for applications, to request only details relevant to the evaluation of the safety of



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the operations under consideration and their future surveillance. Guidance for evaluating an application by an operator from another State to operate within the territory of a State is contained in Part VI of Doc 8335. Such evaluation is necessary in order for the State, under the terms of Article 33 of the Convention, to have confidence in the validity of the certificates and licences associated with the operator, its personnel and aircraft, in the operational capabilities of the operator and in the level of certification and oversight applied to the activities of the operator by the State of the Operator.

2.7.3. The operator will need to make applications to each State into or over which it intends to operate. The operator will also need to keep its own CAAT, as the authority of the State of the Operator, informed of all applications to operate into other States. Applications should be made direct to the CAATs of the States into which it is intended to operate. In some cases it will be possible to download information and both the instructions for making an application and the necessary forms from a website maintained by the CAAT in question.

CHAPTER 3 OPERATIONAL APPROVAL GUIDELINES

3.1. AIRCRAFT ELIGIBILITY

3.1.1. The first step in assessing an application for PBN operational approval is to establish that the aircraft and its systems are suitable for the specific operation.

3.1.2. The PBN Manual and the associated State regulatory material have only recently been issued and this means that there are many aircraft whose TC, STC and associated documentation (AFM) do not include references to PBN.

3.1.3. However, a lack of specific airworthiness certification does not necessarily mean a lack of PBN capability. If the aircraft is suitably equipped, it will be necessary to demonstrate this and that the aircraft is capable of the specific PBN operation. It is not meant to imply that additional certification is required to obtain approval, although it is important that appropriate OEM input is obtained to support any claims of capability that are not part of the existing certification.

3.1.4. The aircraft eligibility assessment process needs to consider the capability, functionality and performance characteristics of the navigation and other relevant flight systems against the requirements of the particular PBN operation. In some cases operational mitigations and alternative means of meeting the PBN requirements may need to be considered. Considerable additional evaluation may be necessary before an aircraft is determined to be eligible for the issue of an operational approval, particularly for advanced navigation specifications such as RNP AR or A-RNP. While a large number of aircraft may never be considered to be eligible for RNP operational approval, for engineering, economical or practical reasons, many older aircraft have been certified to, or will be able to be approved for, RNAV operational approvals such as RNAV 10, RNAV 5, RNAV 2 and RNAV 1.

3.1.5. Operating mitigations are normally required to address deficiencies in the required aircraft qualification to undertake a particular operational procedure. These deficiencies could be items related to aircraft performance or information displays or availability.

3.1.6. Operators should discuss the proposed changes and mitigations with their regulatory authority as early as possible.

3.1.7. In order to develop possible operational mitigations operators should assess the:

- a) qualification standard and fully understand the associated shortfall in the qualification of the navigation specification;
- b) procedures that have been established by the State with respect to the area of operation. This review should identify the complexity of the proposed operation and the hazards associated with that operation.

3.1.8. Following the identification of the above, operators should review their operational procedures and identify possible changes or additional procedures/requirements that could mitigate the identified deficiencies and hazards. The proposed changes should be presented to their regulatory authority for authorization/approval.

3.1.9. The operator should ensure that subsequent operations are conducted in accordance with any restriction or limitation specified by the regulatory authority.

3.1.10. A number of manufacturers have obtained, or are in the process of obtaining, airworthiness certification for specific PBN operations. In such cases the aircraft eligibility assessment can be greatly simplified. It is anticipated that in the future all manufacturers will seek appropriate PBN airworthiness certification for new aircraft.

3.1.11. The AFM may include a statement of RNAV or RNP capability without any reference to PBN. In many of these cases, the basis upon which a statement is included in an AFM is not consistent with the PBN Manual because many of the terms, requirements, operating practices and other characteristics either differed or did not exist at the time the AFM was issued. Consequently, unless the AFM specifically references the relevant State regulatory documents consistent with PBN, additional information will need to be obtained to evaluate the relevance of the AFM statement.

3.1.12. In order to enable PBN operational approval, a number of OEMs provide additional information to support claims of PBN compliance and capability. Such supporting documentation may or may not be approved or endorsed by the State of Manufacture, and it may be necessary to contact the relevant authority to validate the manufacturer's claims.

3.1.13. Where there is insufficient evidence of airworthiness certification, the aircraft capability assessment must include an evaluation of the navigation functionality as well as control, display and alerting functions. Area navigation systems that were designed and installed before PBN implementation may not meet the minimum requirements, and avionics upgrades may be necessary.

3.2. STANDARD OPERATING PROCEDURES

3.2.1. Standard operating procedures (SOPs) must be developed to cover both normal and non-normal (contingency) procedures for the systems used in the PBN operation. Where possible, the practices and procedures should follow those laid down by the manufacturer and the air navigation service provider (ANSP) in whose airspace the PBN operations occur. The SOPs must be adequately documented in the OM.

3.2.2. Pre-flight planning requirements

- a) the flight plan should contain the appropriate statements of capability applicable to the PBN operations
- b) anticipated during the flight;
- c) the on-board navigation database, where applicable, must be current and must contain the appropriate procedures, routes, waypoints and NAVAIDS;
- d) a check must be carried out on the availability of appropriate NAVAIDS, including, where appropriate, RNP or RAIM prediction. Any relevant NOTAMs must be addressed;
- e) an alternate approach must be identified in the event of loss of PBN capability;
- f) the appropriate installed equipment must be serviceable.

3.2.3. Prior to commencing the PBN operation:

- a) if all the criteria are not met, the PBN procedure must not be requested;
- b) if offered a clearance for a procedure whose criteria cannot be met, ATC must be advised “UNABLE ...”;
- c) the loaded procedure must be checked against the chart;
- d) it must be confirmed that the correct sensor has been selected and any NAVAID de-selection is complete, if required;
- e) it must be confirmed that a suitable RNP value has been selected, if appropriate, and the navigation performance is adequate for the procedure;
- f) the contingency procedures must be reviewed.

3.2.4. During the PBN operation, the:

- a) manufacturer’s instructions/procedures must be adhered to;
- b) appropriate displays must have been selected;
- c) lateral and, where appropriate, vertical deviation must not exceed prescribed values;
- d) altitude and speed constraints must be observed;
- e) the procedure must be discontinued if there are integrity alerts, if the navigation display is flagged as invalid or if the integrity alerting function is not available.

3.2.5. In the event of a contingency:

ATC must be advised of any loss of PBN capability and a proposed course of action; where possible, documented procedures should be followed for:

1. navigation errors not associated with transitions from an inertial navigation mode to a radio navigation mode;
2. unexpected deviations in lateral or vertical flight path attributed to incorrect navigation data;
3. significant misleading information without failure warning;
4. total loss or multiple failures of the PBN navigation equipment;
5. problems with ground navigation facilities leading to significant

- navigation errors; or
- 6. a communications failure.

3.2.6. After-flight procedures

The required reporting of navigation errors or malfunctions should be completed as applicable.

3.3. Training

3.3.1. General

3.3.1.1. The navigation specifications cover a wide range of operations, and training needs to be appropriate to the particular circumstances. Moreover, although each navigation specification includes guidance on flight crew training, the guidance is not consistent, in detail or scope, across the range of navigation specifications, and there is much duplication. The amount and type of training required for flight crews will vary significantly depending upon a number of factors including:

- a) previous training and experience;
- b) complexity of operations;
- c) aircraft equipment.

It is therefore not possible to specify, for each of the navigation specifications, the particular training that will be required.

3.3.1.2. For en-route operations, ground training is usually sufficient to provide crews with the necessary knowledge. Delivery methods will vary, but classroom training, computer-based training or, in some cases, desktop simulation training is normally sufficient. Arrival and departure operations and approach operations, in particular, also require the use of flight simulation training devices in addition to ground training and briefings.

3.3.1.3. Dispatcher training, as applicable, should be implemented to achieve the necessary

competency in dispatch procedures related to PBN operations.

3.3.1.4. Consideration should also be given to the need for flight crews to demonstrate that competency standards are achieved and maintained and the means by which the operator documents the qualification.

3.3.2. Knowledge requirements

3.3.2.1. The following knowledge requirements apply to all PBN operations, although the content and complexity will vary depending upon the particular operations.

3.3.2.2. *Area navigation principles.* Area navigation is the basis for all PBN operations, and the same general knowledge is applicable to all navigation specifications. Pilots with previous experience with area navigation operations may not be familiar with some of the more advanced features such as radius to fix (RF) legs, fixed radius transitions, required time of arrival or the application of vertical navigation.

3.3.2.3. *Navigation system principles.* Flight crews should have a sound knowledge of the navigation system to be used. The relevance of the navigation system to the particular PBN operation should be clearly established. For example, knowledge of inertial navigation and updating is relevant to requirements for some oceanic and remote navigation specifications, as is knowledge of GNSS for RNP APCH operations.

3.3.2.4. *Equipment operation and functionality.* Considerable variation exists in the operation of navigation equipment, cockpit controls, displays and functionality. Crews with experience on one type of installation or aircraft may require additional training on another type of equipment. Special attention should be paid to the differences between stand-alone GNSS equipment and flight management systems with GNSS updating and degraded modes of operation such as loss of integrity or loss of GNSS.

3.3.2.5. *Flight planning.* Knowledge of the relevant aspects of each of the navigation specifications that relate to flight planning is required.

3.3.2.6. *Operating procedures.* The complexity of operating procedures varies considerably between different PBN operations. RNP APCH and RNP AR APCH require a detailed knowledge of standard operating procedures for both normal and non-normal operations.

3.3.2.7. *Performance monitoring and alerting.* Flight crew responsibilities with respect to performance monitoring and alerting provided by the navigation system must be clearly understood.

3.3.2.8. *Operating limitations.* Operating limitations (e.g. time limits, minimum equipment) vary both between and within the navigation specifications, and flight crews need to be able to recognize this and plan accordingly. Alternative means of navigation or other contingency procedures must be addressed. Flight crews need to be aware of the ATC procedures that may be applicable to the particular PBN operation.

3.3.3. Flight training requirements

3.3.3.1. Arrival, approach and departure operations require flight training and the demonstration of flight crew competency. The amount of flight training required varies with the anticipated operation, previous training and experience. In the course of operational approval evaluation, all relevant circumstances need to be considered and the training assessed for completeness and effectiveness. Ongoing and recurrent training should also be considered.

3.3.3.2. The following guidelines are intended to aid the assessment of the extent of training that might be required. These guidelines assume that flight crews have previous relevant experience and have completed a knowledge training curriculum.

3.3.3.3. *En-route* (oceanic, remote and continental). In general flight training is not required for en-route operations.

3.3.3.4. *Arrival and departure.* Because arrival and departure operations require strict adherence to track during periods of higher workload and may be associated with minimum terrain clearance and reduced route spacing, crews need to be fully conversant with the operation of the navigation system. Consequently, unless crews have significant appropriate operational experience,

simulator or flight training must be provided. Particular care should be taken when this type of operation is conducted with stand-alone GNSS equipment where functional limitations require crew intervention.

3.3.3.5. *RNP APCH*. Flight training for RNP APCH can be considered under two headings — stand-alone GNSS equipment and FMS equipment:

- a) the training for RNP APCH operations using stand-alone GNSS equipment, particularly in a single-pilot aircraft, normally requires multiple in-flight exercises, each with pre-flight and post-flight briefing. Considerable attention should be given to the programming and management of the navigation system, including in-flight re-programming, holding, multiple approaches, mode selection and recognition, human factors and the navigation system functionality;
- b) approaches conducted in FMS-equipped aircraft are generally much easier to manage because the aircraft are usually equipped with map displays which aid situational awareness. Normal operations are quite simple, and competency can be achieved with one or two approaches. Additional training should be provided to ensure familiarity and competency in operations which involve changes to the planned approach, system alerting and missed approaches. Attention should also be given to the method of vertical navigation to LNAV minima, to LNAV/VNAV minima and to LPV minima. Crews with previous relevant GNSS and area navigation experience can usually achieve competency during one full flight simulator training session with associated pre-flight and post flight briefing.

3.3.3.6. *RNP AR APCH*. RNP AR APCH operations require that all aspects of the operation are carefully addressed and appropriate attention is given to training. The safety of the RNP AR operation is often predicated upon the fact that the crew procedures provide a significant mitigation for a number of the hazards associated with the procedure. However, mitigations vary widely depending upon the cockpit displays and the RNP system functionality. Accordingly training for RNP AR APCH operations should be extremely thorough and should ensure that crews are able to manage all operations, including non-normal operations, safely. As a guide, crews without previous relevant experience (e.g. RNP APCH with baro- VNAV) may require a course in ground training plus simulator flight training in order to achieve competency.

3.4. Navigation Databases

The packed navigation databases should be delivered to the operator at least one week prior to the AIRAC effective date. The operator should have procedures in place for ensuring that:

- a) the correct version of the navigation database is loaded on the aircraft;
- b) any database errors/omissions reported by the suppliers are addressed expeditiously by flight crew briefing/removal of procedures, etc.;
- c) any database errors/omissions reported by the flight crew are addressed expeditiously by flight crew briefing/removal of procedures and reported back to the database suppliers;
- d) the version of the loaded navigation database is checked for validity by the flight crew prior to departure;
- e) prior to use after being loaded into the area navigation system, the procedure is checked against the chart, by the flight crew, for waypoint sequence, waypoint transition, leg length, magnetic bearing, altitude constraint and speed constraint.

CHAPTER 4 NAVIGATION SPECIFICATIONS

4.1. RNAV 10

4.1.1. General

4.1.1.1. RNAV 10 supports a 50 NM lateral and 50 NM longitudinal distance-based separation minima in oceanic or remote area airspace. Prior to the development of the PBN concept, RNAV 10 operations were authorized as RNP 10 operations. An RNAV 10 operational approval does not change any requirement nor does it affect operators that have already obtained an RNP 10 approval.

4.1.1.2. RNP 10 was developed and implemented at a time when the delineation between RNAV and RNP had not been clearly defined. Because the requirements for RNP 10 did not include a requirement for on-board performance monitoring and alerting, RNP 10 is more correctly described as an RNAV operation and hence is included in the PBN Manual as RNAV 10.

4.1.1.3. Recognizing that airspace, routes, airworthiness and operational approvals have been designated as RNP 10, further declaration of airspace, routes, and aircraft and operator approvals may continue to use the term RNP 10, while the application in the PBN Manual will be known as RNAV 10.

4.1.1.4. RNAV 10 is applicable to operations in oceanic and remote areas and does not require any ground-based navigation infrastructure or assessment.

4.1.2. System requirements

4.1.2.1. RNAV 10 is intended for use in oceanic and remote areas, and the navigation specification is based on the use of long range navigation systems (LRNSs). A minimum of two LRNSs is required for redundancy.

4.1.2.2. most common combinations of dual LRNSs are:

- a) dual INS;
- b) dual IRS;
- c) dual GNSS;
- d) GNSS/IRS (IRS updated by GNSS).

4.1.2.3. Inertial systems (unless updated by GNSS) are subject to a gradual loss of position accuracy with time (drift rate) and their use is time-limited in order to meet the RNAV 10 accuracy requirement. The basic time limit is 6.2 hours, but this may be extended by updating or by demonstration of reduced drift rate (less than 2 NM per hour).

4.1.2.4. GNSS position is continuously updated and not subject to any time limit.

4.1.2.5. In order to be approved for oceanic and remote applications a GNSS receiver must be capable of excluding a faulty satellite from the solution (fault detection and exclusion (FDE)) so that continuity of navigation can be provided. FDE is standard for TSO-C145()/146() GNSS receivers and is available as an option or modification on some TSO-C129() receivers. Consequently, where a TSO-C129() GNSS is used to satisfy the requirement for one or both of the LRNSs it must be capable of FDE and approved for oceanic/remote operations.

4.1.2.6. The FDE requirement notwithstanding, the satellite constellation may be such that there are not sufficient satellites for the FDE computation and in such situations FDE is not available. In order to limit the exposure to the potential loss of a navigation solution due to unavailability of FDE, a prediction of satellite availability is required. The maximum period during which FDE may be predicted to be unavailable is 34 minutes. The same time limit applies to an IRS/GNSS system.

4.1.2.7. These time limitations mean that an RNAV 10 operational approval is not universal for aircraft without GNSS where the operator must evaluate the route(s) to be flown to determine if the RNAV 10 requirement can be satisfied. Moreover, for aircraft with INS or IRS only, attention must be paid to radio updating. Aircraft equipped with a flight management system normally provide automatic radio updating of inertial position. Automatic updating is normally considered

adequate in such circumstances, provided the aircraft is within a reasonable distance of the radio aids at the point at which the last update is expected. If any doubt exists then the operator should be required to provide an analysis of the accuracy of the update. Manual updating is less common, and the operational approval needs to be based on a more detailed examination of the circumstances.

4.1.3. Operating procedures

4.1.3.1. The standard operating procedures adopted by operators flying on oceanic and remote routes should normally be generally consistent with RNAV 10 operations, although some additional provisions may need to be included. A review of the operator's procedure documentation against the requirements of the PBN Manual and the (State) regulatory requirements should be sufficient to ensure compliance.

4.1.3.2. The essential elements to be evaluated are:

- a) the aircraft is serviceable for RNAV 10 operations;
- b) RNAV 10 capability is indicated on the flight plan;
- c) route limitations are defined and observed (e.g. time limits);
- d) en-route loss of capability is identified and reported;
- e) procedures for alternative navigation are described.

4.1.3.3. GNSS-based operations also require the prediction of FDE availability. Many stand-alone GNSS service prediction programmes are based on a prediction at a destination and do not generally provide predictions over a route or large area. RNAV 10-specific route prediction services are available from commercial sources.

4.1.4. Pilot knowledge and training

4.1.4.1. Unless the operator is inexperienced in the use of area navigation, flight crews should possess the necessary skills to conduct RNAV 10 operations with minimal additional training.

4.1.4.2. Where GNSS is used, flight crews must be familiar with GNSS principles related to en-route navigation.



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4.1.4.3. Where additional training is required, this can normally be achieved by bulletin, computer-based training or classroom briefing. Flight training is not normally required.

RNAV 10 (DESIGNATED AND AUTHORIZED AS RNP 10) JOB AID APPLICATION TO CONDUCT RNP 10 OPERATIONS

1. Introduction

RNAV 10 maintains the designation RNP 10, as specified in the ICAO Performance-based Navigation (PBN) Manual (Doc 9613).

2. Purpose of the job aid

- a) To provide information on the relevant reference documents.
- b) To provide a record of the operator application, the inspector comments and the operator follow-up action for each relevant paragraph in the reference document(s).

3. Actions recommended for the inspector and operator

- a) At the pre-application meeting, the operator and the inspector review the approval process events and establish the form and content of the approval application.
- b) The operator records references to material in company documents for each relevant paragraph in the job aid.
- c) The operator submits to the inspector the completed job aid with the application.
- d) The inspector records his/her findings for each relevant paragraph in the job aid indicating compliance or necessary corrective action.
- e) The inspector informs the operator as soon as possible when a corrective action is required.
- f) The operator provides the inspector with the revised material when so requested.
- g) The CAAT provides the operator with the operations specifications (Ops Specs) or letter of authorization (LOA), as applicable, when the tasks and documents have been completed.



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Part	Topic	page
1	General information	
2	Aircraft and operator identification	
3	Operator application	
4	Contents of the operator application	
5	Basic pilot procedures	
6	Contingency procedures	

Reference documents

Publisher	Reference	Title
ICAO	Annex 2	Rules of the Air
	Annex 6	Operation of Aircraft
	Doc 4444	Procedure for Air Navigation Services — Air Traffic Management
	Doc 7030	Regional Supplementary Procedures
	Doc 9613	Performance-based Navigation (PBN) Manual
FAA	Order 8400.12()	Required Navigation Performance 10 (RNP 10) Operational Approval
	AC 20-130	Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors
	AC 20-138()	Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment
	14 CFR Part 121, Subpart G	Manual Requirements
EASA	AMC 20-12	Recognition of FAA Order 8400.12a for RNP 10 Operations
CASA	AC 91U-2(0)	Required Navigation Performance 10 (RNP 10) Operational Authorization



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ICAO (SAM)	AC 91-001	Aircraft and Operators Approval for RNAV 10 Operations (Designated and Authorized as RNP 10)
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PART 1. GENERAL INFORMATION BASIC EVENTS OF THE APPROVAL PROCESS

	Action by operator	Action by inspector
1	Establish the need for the authorization.	
2	Review the AFM, AFM supplement, TC data sheet, other appropriate documents (e.g. STCs, SBs, SLs) to determine aircraft eligibility. If necessary contact the aircraft and/or avionics OEM to confirm eligibility.	
3	Schedule a pre-application meeting with the inspector.	
4		During the pre- application meeting establish: <ul style="list-style-type: none">• <i>form and contents of the application;</i>• <i>documents required to support the application;</i>• <i>target date for the application submission;</i>• <i>requirement for flight validation.</i>
5	Submit the application at least XX days prior to start- up of the planned operations.	
6		Review submission.
7	Ensure that amendments to manuals, programmes and other relevant documents are complete; provide training to flight crews, flight dispatchers and maintenance personnel; if required, conduct a validation flight.	If required, participate in the validation flight.
8		Once the requirements have been met, issue operational approval.



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PART 2. IDENTIFICATION OF AIRCRAFT AND OPERATORS

Name of Operator: _____

Aircraft manufacturer, model and series	Registration number	Serial number	Long-range navigation system manufacturer, model and number	PBN specification

Date of pre-application meeting: _____

Date when application received by CAAT: _____

Date when operator intends to begin RNAV 10 operations: _____

Is the CAAT notification date appropriate? YES NO

PART 3. OPERATOR APPLICATION

Annex	Title	Inclusion by Operator	Comments by Inspector
A	Request for authorization		
B	Aircraft group Statement by the operator as to whether aircraft/LRNS combinations belong to a group of aircraft.		
C	Aircraft eligibility — airworthiness AFM, AFM revision, AFM supplement, TCDS showing that the aircraft RNAV systems are eligible.		
D	Aircraft eligibility — modifications (if applicable) Maintenance records documenting installation or modification of aircraft systems to achieve eligibility.		
E	RNP 10 time limit and area of operations (if applicable) For aircraft equipped with INS/IRU only, details of time limit and area of operations/routes for which the aircraft is eligible.		
F	Maintenance For aircraft with established LRNS maintenance practices, references to the maintenance document/ programme. For recently installed LRNSs, details of the full maintenance practices.		
G	Minimum equipment list Showing provisions for LRNS.		

H	<p>Training</p> <p>xxx91/GA operators or equivalent:</p> <ul style="list-style-type: none"> • <i>course completion records.</i> <p>xxx121/xxx135/CAT operators or equivalent:</p> <ul style="list-style-type: none"> • <i>training programmes for flight crew, flight dispatchers and maintenance personnel.</i> 		
I	<p>Operating policies and procedures</p> <p>xxx91/GA operators or equivalent:</p> <ul style="list-style-type: none"> • extracts from the operations manual corresponding to the application. <p>xxx121/xxx135/CAT operators or equivalent:</p> <ul style="list-style-type: none"> • <i>operations manual and checklists.</i> 		
J	<p>Performance record</p> <p>Evidence of previous problems, incidents or path-keeping errors, together with corrective action applied.</p>		
K	<p>Withdrawal of approval</p> <p>The need for follow-up action on navigation error reports, with the possibility of removal of approval.</p>		
L	<p>Validation flight plan</p> <p>As required.</p>		



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Contents of the application to be submitted by the operator

- *compliance documentation for the aircraft/navigation systems;*
- *operating procedures and policies;*
- *sections of the maintenance manual related to LRNS (if not previously reviewed).*

Note.—Documents may be grouped in a single binder or may be submitted as individual documents.

PART 4. CONTENTS OF THE OPERATOR APPLICATION

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter 1)	(GM part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Authorization request Statement of intent to obtain authorization.	1.3.3.2	1.2.2			
2a	Aircraft/navigation system eligibility Documents that establish eligibility For RNP 10 the eligibility method(s) used and a list of the airframes included in each method.	1.3.3.1 1.3.3.2.1	1.2.1			

	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter 1)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
2b	Dual LRNS At least 2 LRNSs with displays and functions suitable for oceanic operations.	1..3.4	1.3			
3	Time limit for aircraft equipped with INS/IRU and no GNSS	1.3.4.2.2 1.3.9.6	1.3.2.2 1.8.6			
4	Area of operation for aircraft equipped with INS/IRU and no GNSS	1.3.9.6	1.8.6			
5	Training Details of courses completed (xxx91 operators). Details of training programmes (xxx121 and xxx135 operators).	1.3.3.2.2.2 1.3.10	1.2.2.2 1.9			
6	Operating policies and procedures Extracts from the operations manual or other documentation (xxx91 operators). Operations manual and checklists (xxx121 and xxx135 operators).	1.3.3.2.2.3 1.3.5	1.2.2.3 1.4			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter 1)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
7	Maintenance practices Document references for established LRNS maintenance practices. Complete copy of appropriate maintenance practices for new LRNS installations.	1.3.3.2.2.5 1.3.11	1.2.2.5 1.10			
8	MEL update Applicable only to operations requiring a MEL.	1.3.3.2.2.4	1.2.2.4			
9	Past performance Record of operating history, including problems, incidents, track-keeping errors and corrective actions.	1.3.3.2.5	1.2.2.6			
10	Withdrawal of RNP 10 authority	1.3.12	1.11			
11	Validation flight plan If required.					

PART 5. OPERATING PROCEDURES

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter 1)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Flight planning					
1a	Verify that the aircraft is approved for RNP 10 operations.	1.3.7	1.6			
1b	Verify that two LRNSs are operational.	1.3.6	1.5			
1c	Verify that the RNP 10 time limit has been taken into account (INS/IRU only).	1.3.5.2	1.4.1			
1d	Verify that FDE is available (GNSS only).	1.3.5.2 1.3.8	1.4.1 1.7			
1e	Verify the FPL: "R" should appear in field 10 and PBN/A1 in field 18.	1.3.7	1.6			
1f	Verify operational restrictions as appropriate.	1.3.5.2	1.4.1			
1g	Verify the flight-planned route including diversions.	1.3.7	1.6			



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#	Topic	Specific ICAO	Specific State	Operator compliance	Inspector disposition/	Follow-up by inspector
		reference	guidance reference	description	comments	(Optional)
		(Doc 9613, Volume II, Part B, Chapter 1)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
2	Pre-flight					
2a	Verify equipment conditions: <ul style="list-style-type: none"> • <i>review flight technical records;</i> • <i>confirm that maintenance actions are complete.</i> 	1.3.5.3	1.4.2			
2b	Check the condition of navigation antennas and surrounding fuselage skin.	1.3.5.3	1.4.2			
2c	Review the emergency procedures for RNP 10 operations.	1.3.5.3	1.4.2			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter 1)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
3	En-route					
3a	Verify that both LRNSs are RNP 10 capable at the oceanic point of entry.	1.3.9.1	1.8.1			
3b	Prior to the oceanic point of entry, the aircraft position must be independently checked and updated if necessary.	1.3.9.2	1.8.2			
3c	Other mandatory navigation cross- checks.	1.3.9.3	1.8.3			
3d	ATC to be notified if unable to comply with RNP 10 requirements or of any deviation required for contingency procedures.	1.3.9.4	1.8.4			
3e	Follow route centre line within 5 NM.	1.3.9.5	1.8.5			
4	Update LRNS position	1.3.9.6	1.8.6			



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PART 6. CONTINGENCY PROCEDURES

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 444, Chapter5,15)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Contingencies	15.2.1, 15.2.2	9.1.1, 9.2.2			
1a	Inability to comply with ATC clearance due to meteorological conditions, aircraft performance or pressurization failure.	15.2.1.1	9.1.1.1			
1b	Weather deviation.	15.2.3	9.2.3			
1c	Air-ground communications failure.	5.4.2.6.3.2 15.3	9.3			

4.2. RNAV 5

4.2.1. General

4.2.1.1. RNAV 5 supports continental en-route operations using a range of different positioning sensors. Prior to the introduction of PBN, basic RNAV (B- RNAV) was introduced in Europe and the Middle East. The RNAV 5 requirements are based upon B-RNAV, and any B-RNAV approval meets the requirements of RNAV 5 without further examination.

4.2.1.2. RNAV 5 is intended for en-route navigation where not all the airspace users are equipped with GNSS and where there is adequate coverage of ground- based radio navigation aids permitting DME/DME or VOR/DME area navigation operations.

4.2.1.3. An RNAV 5 route is dependent upon an analysis of the supporting NAVAID infrastructure. This analysis is the responsibility of the air navigation service provider.

4.2.2. System requirements

The RNAV 5 system requirements are not complex:

- a) one single area navigation system is required;
- b) the following sensors may be used:
 - 1. VOR/DME;
 - 2. DME/DME;
 - 3. INS/IRS — if automatic radio updating is not carried out, a time limit of 2 hours usually applies from the last on-ground position update;
 - 4. GNSS — receivers must be approved in accordance with ETSO-C129a, FAA TSO-C129a or later (ETSO-C129 or FAA TSO-C129 is also applicable provided it includes pseudo-range step detection and
- c) health word checking functions); storage of a minimum of four waypoints is required. Manual data entry is permitted and a navigation database is not required;
- d) an area navigation system failure indication is required;

- e) continuous indication of aircraft position relative to track to be displayed to the pilot flying (and the pilot not flying) on a navigation display situated in the primary field of view;
- f) display of distance and bearing to the active (To) waypoint;
- g) display of ground speed or time to the active (To) waypoint;
- h) lateral deviation display must have scaling and FSD less than or equal to ± 5 NM for RNAV 5 — the maximum FTE permitted is 2.5 NM (1/2 FSD).

4.2.3. Operating procedures

4.2.3.1. Normal area navigation operating procedures will usually meet the requirements of RNAV 5. The essential elements to be evaluated are that the operator's procedures ensure that:

- a) the aircraft is serviceable for RNAV 5;
- b) RNAV 5 capability is indicated on the flight plan;
- c) en-route loss of capability is identified and reported;
- d) procedures for alternative navigation are addressed.

If the navigation system does not use a navigation database, manual waypoint entry significantly increases the potential for navigation errors. Operating procedures need to be robust to reduce the incidence of human error, including cross-checking of entry, checking of tracks/distances/bearings against published routes and general situational awareness and checking for reasonableness.

4.2.3.2. Because RNAV 5 operations are typically conducted in areas of adequate NAVAID coverage, contingency procedures will normally involve reversion to conventional radio navigation using VOR/DMEs, VORs and NDBs.

4.2.3.3. GNSS-based operations also require the prediction of FDE availability. Many stand-alone GNSS service prediction programmes are based on a prediction at a destination and do not generally provide predictions over a route or large area. RNAV 5-specific route prediction services are available from commercial sources.

4.2.4. Pilot knowledge and training

4.2.4.1. Unless the operator is inexperienced in the use of area navigation, flight crews should possess the necessary skills to conduct RNAV 5 operations with minimal additional training.

4.2.4.2. Where GNSS is used, flight crews must be familiar with GNSS principles related to en-route navigation. Where additional training is required, this can normally be achieved by bulletin, computer-based training or classroom briefing. Flight training is not normally required.

4.2.5. Operational approval

4.2.5.1. The operational approval process for RNAV 5 is generally straightforward, given that most aircraft are equipped with area navigation systems which exceed the minimum requirements for RNAV 5.

4.2.5.2. In most cases the AFM will document RNAV 5 capability; failing that, many OEMs have issued statements of compliance and only occasionally will it be necessary to conduct an evaluation of aircraft capability.

4.2.5.3. With the exception of an amendment to the operations manual, a State may decide that there is no further requirement for any additional documentation of RNAV 5 approval.



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RNAV 5 JOB AID

APPLICATION TO CONDUCT RNAV 5 OPERATIONS

1. Purpose of the job aid

- a) To provide information on the relevant reference documents.
- b) To provide a record of the operator application, the inspector comments and the operator follow-up action for each relevant paragraph in the reference document(s).

2. Actions recommended for the inspector and operator

- a) At the pre-application meeting, the operator and the inspector review the approval process events and establish the form and content of the approval application.
- b) The operator records references to material in company documents for each relevant paragraph in the job aid.
- c) The operator submits to the inspector the completed job aid with the application.
- d) The inspector records his/her findings for each relevant paragraph in the job aid indicating compliance or necessary corrective action.
- e) The inspector informs the operator as soon as possible when a corrective action is required.
- f) The operator provides the inspector with the revised material when so requested.
- g) The CAAT provides the operator with the operations specifications (Ops Specs) or a letter of authorization (LOA), as applicable, when the tasks and documents have been completed.



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Part	Topic	page
1	General information	
2	Aircraft and operator identification	
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4	Contents of the operator application	
5	Basic pilot procedures	
6	Contingency procedures	

Reference documents

Publisher	Reference	Title
ICAO	Annex 2	Rules of the Air
	Annex 6	Operation of Aircraft
	Doc 4444	Procedure for Air Navigation Services — Air Traffic Management
	Doc 7030	Regional Supplementary Procedures
	Doc 9613	Performance-based Navigation (PBN) Manual
FAA	AC 90-45()	Approval of Area Navigation Systems for Use in the U.S. National Airspace System
	AC 25-15	Approval of Flight Management Systems in Transport Category Airplanes
	AC 25-4	Inertial Navigation System (INS)
	14 CFR Part 121, Subpart G	Manual Requirements
EASA	AMC 20-4	Airworthiness Approval and Operational Criteria for the Use of Navigation Systems in European Airspace Designated for Basic RNAV Operations
	AMC 20-5	Airworthiness Approval and Operational Criteria for the use of NAVSTAR Global Positioning System (GPS)
CASA	DCAP B-RNAV-1	Approval of Australian Operators and Aircraft to Operate Under Instrument Flight Rules in European Airspace Designated for Basic Area Navigation
ICAO (SAM)	AC 91-002	Aircraft and Operators Approval for RNAV 5 Operations



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PART 1. GENERAL INFORMATION BASIC EVENTS OF THE APPROVAL PROCESS

	Action by operator	Action by Inspector
1	Establish the need for the authorization.	
2	Review the AFM, AFM supplement, TC data sheet, other appropriate documents (e.g. STCs, SBs, SLs) to determine aircraft eligibility. If necessary contact the aircraft and/or avionics OEM to confirm eligibility.	
3	Schedule a pre-application meeting with the inspector.	
4		During the pre-application meeting establish: <ul style="list-style-type: none">• <i>form and contents of the application;</i>• <i>documents required to support the application;</i>• <i>target date for the</i> application submission; <ul style="list-style-type: none">• <i>requirement for flight validation.</i>
5	Submit the application at least XX days prior to start- up of the planned operations.	
6		Review submission.
7	Ensure that amendments to manuals, programmes and other relevant documents are complete; provide training to flight crews, flight dispatchers and maintenance personnel; if required, conduct a validation flight.	If required, participate in the validation flight.
8		Once the requirements have been met, issue operational approval.



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PART 2. IDENTIFICATION OF AIRCRAFT AND OPERATORS

Name of Operator: _

Aircraft manufacturer, model and series	Registration number	Serial number	Long-range navigation system manufacturer, model and number	PBN specification

Date of pre-application meeting: _____

Date when application received by CAAT:

Date when operator intends to begin RNAV 5 operations: _____

Is the CAAT notification date appropriate? Yes No

PART 3. OPERATOR APPLICATION

Annex	Title	Inclusion by Operator	Comments by Inspector
A	Request for authorization		
B	Aircraft eligibility — airworthiness AFM, AFM revision, AFM supplement, TCDS showing that the aircraft RNAV systems are eligible.		
C	Aircraft eligibility — modifications (if applicable) Maintenance records documenting installation or modification of aircraft systems to achieve eligibility.		
D	Maintenance For aircraft with established LRNS maintenance practices, references to the maintenance document/ programme. For recently installed LRNSs, details of the full maintenance practices.		
E	Minimum equipment list		
F	Training xxx91/GA operators or equivalent: <ul style="list-style-type: none"> • <i>course completion records.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none"> • <i>training programmes for flight crew, flight dispatchers and maintenance personnel.</i> 		



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Annex	Title	Inclusion by Operator	Comments by Inspector
G	<p>Operating policies and procedures xxx91/GA operators or equivalent:</p> <ul style="list-style-type: none"> • <i>extracts from the operations manual corresponding to the application.</i> <p>xxx121/xxx135/CAT operators or equivalent:</p> <ul style="list-style-type: none"> • <i>operations manual and checklists.</i> 		

Contents of the application to be submitted by the operator

- *compliance documentation for the aircraft/navigation systems;*
- *operating procedures and policies;*
- *sections of the maintenance manual related to LRNS (if not previously reviewed).*

Note.— Documents may be grouped in a single binder or may be submitted as individual documents.

PART 4. CONTENTS OF THE OPERATOR APPLICATION

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter 2)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Authorization request Statement of intent to obtain authorization.					



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2	Aircraft/navigation system eligibility Documents that establish eligibility.	2.3.2.1 2.3.2.2.1	2.2.1 2.2.2.1			
3	Training Details of courses completed (xxx91 operators).	2.3.2.2.2 2.3.5	2.2.2.2 2.5			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter 2)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
	Details of training programmes (xxx121 and xxx135 operators).					
4	<p>Operating policies and procedures</p> <p>Extracts from the operations manual or other documentation (xxx91 operators).</p> <p>Operations manual and checklists (xxx121 and xxx135 operators).</p>	2.3.2.2.3	2.2.2.3 2.4			
	<p>Maintenance Practices</p> <p>Document references for navigation database maintenance practices</p>	3.3.2.3.5 3.3.6	2.2.2.5 2.6			
6	MEL update	2.3.2.2.4	2.2.2.4			

PART 5. OPERATING PROCEDURES

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter 2)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Flight planning					
1a	Verify that the aircraft is approved for RNAV 5 operations.	2.3.4.2.2	2.4.1 2.4.2.1			
1b	Verify RAIM availability (GNSS only).	2.3.4.3	2.4.3			
1c	Verify the availability of NAVAIDS (non-GNSS).	2.3.4.2.4	2.4.2.4			
1d	Verify that the navigation database (if carried) is current and appropriate for the region.	2.3.4.2.3	2.4.2.3			
1e	Verify the FPL: R” should appear in field 10 and PBN/B1- B5 (as appropriate) in field 18.	2.3.4.2.1	2.4.2.1			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter2)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
2	General operating procedures					
2a	Advise ATC if unable to comply.	2.3.4.4.1	2.4.4.1			
2b	Confirm that the navigation database is up to date (if	2.3.4.4.4	2.4.4.4			
2c	Cross-check the chart with the RNAV system display.	2.3.4.4.5	2.4.4.5			
2d	Cross-check with conventional NAVAIDS to monitor for navigational reasonableness.	2.3.4.4.6	2.4.4.6			
2e	Follow route centre lines within 2.5 NM.	2.3.4.4.8	2.4.4.8			
2f	Do not modify the flight plan in the RNAV system after ATC heading assignment until a clearance is received to re-join the route or a new clearance is confirmed.	2.3.4.4.9	2.4.4.9			



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PART 6. CONTINGENCY PROCEDURES

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter 2)*	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Contingencies					
1a	Advise ATC if unable to meet the requirements for RNAV 5.	2.3.4.5.1	2.4.5.1			
b	Air-ground communications failure.	2.3.4.5.2 (Doc 4444, Chapter 15, 15.3)	2.4.5.2			
1c	GNSS RAIM alert or loss of RAIM.	2.3.4.5.3	2.4.5.3			

*All references are to Doc 9613, Volume II, Part B, Chapter 2, unless otherwise indicated.

4.3. RNAV 1 and RNAV 2

4.3.1. General

4.3.1.1. RNAV 1 and RNAV 2 support operations in continental en-route, SIDs, STARs and approach transitions using GNSS or DME/DME positioning. The RNAV 1 and RNAV 2 specifications represent an attempt at the harmonization of European precision RNAV (P-RNAV) and United States RNAV (U.S.-RNAV) requirements.

4.3.1.2. The RNAV 1 and RNAV 2 specifications apply to:

- a) all ATS routes, including en-route;
- b) standard instrument departures and arrivals (SIDs/STARs); and
- c) instrument approach procedures up to the final approach fix (FAF)/final approach point (FAP).

4.3.1.3. Because RNAV 1 and RNAV 2 operations can be based on DME/DME or DME/DME IRU, the NAVAID infrastructure must be assessed to ensure adequate DME coverage. This is the responsibility of the ANSP and is not part of the operational approval.

4.3.1.4. A single RNAV 1 and RNAV 2 approval is issued. An operator with an RNAV 1 and RNAV 2 approval is qualified to operate on both RNAV 1 and RNAV 2 routes. RNAV 2 routes may be promulgated in cases where the NAVAID infrastructure is unable to meet the accuracy requirements for RNAV 1.

4.3.2. Operational approval

4.3.2.1. For operators holding either a P-RNAV approval or a U.S.-RNAV approval, the operational approval is relatively simple and minimal regulatory effort is required. Operators holding both P-RNAV and U.S.-RNAV approvals should qualify for an RNAV 1 and RNAV 2 operational approval without further examination. There are some small differences between the P-RNAV and U.S.-RNAV, and migration to RNAV 1 and RNAV 2 approval is not automatic unless the operator holds both U.S. and European approvals.

4.3.2.2. For operators holding only a P-RNAV approval or a U.S.-RNAV approval, it is necessary to ensure that any additional requirements for RNAV 1 and RNAV 2 are met as laid down in the PBN Manual (Part B, Chapter 3, 3.3.2.4).

4.3.2.3. Operators not holding a P-RNAV or U.S.-RNAV approval need to be evaluated to determine that they meet the requirements for RNAV 1 and RNAV 2.

4.3.2.4. There is no obligation to obtain an RNAV 1 and RNAV 2 approval or to migrate an existing approval to RNAV 1 and RNAV 2 if the existing approval is applicable to the area of operation. Operators that operate only in P-RNAV airspace or only in U.S.-RNAV airspace can continue to do so in accordance with a P-RNAV or U.S.-RNAV approval respectively.

4.3.3. System requirements

4.3.3.1. The RNAV 1 and RNAV 2 system requirements are as follows:

- a) a single area navigation system;
- b) the following sensors may be used:
 - 1. DME/DME — accuracy is based upon TSO-C66c; the system must be
 - 2. capable of auto-tuning multiple DME facilities, obtaining a position update within 30 seconds of tuning, maintaining continuous updating and performing reasonableness checks; DME/DME/IRU — IRU performance in accordance with U.S. 14 CFR Part 121, Appendix G, automatic position updating from the DME/DME position and must not allow VOR inputs to affect position accuracy;
 - 3. GNSS — receivers must be approved in accordance with ETSO-C129a, FAA TSO-C129a or later (ETSO-C129 or FAA TSO-C129 are also applicable provided they include pseudo-range step detection and health word checking functions);
- c) a navigation database containing the routes and procedures;
- d) an area navigation system failure indication;
- e) continuous indication of aircraft position relative to track to be displayed to the pilot flying (and the pilot not flying) on a navigation display situated in the primary

- field of view;
- f) display of distance and bearing to the active (To) waypoint;
- g) display of ground speed or time to the active (To) waypoint;
- h) display of active navigation sensor type;
- i) lateral deviation display must have scaling and FSD of less than or equal to ± 1 NM for RNAV 1 or less than or equal to ± 2 NM for RNAV 2 — the maximum FTE permitted is:
 1. 0.5 NM for RNAV 1;
 2. 1.0 NM for RNAV 2;

Note.— Some States have authorized TSO-C129() equipment with an FSD of ± 5 NM on RNAV 2

- j) automatic leg sequencing and fly-by or flyover turn functionality;
- k) execution of leg transitions and maintenance of tracks consistent with ARINC 424:
 1. CA;
 2. CF;
 3. DF;
 4. FM;
 5. IF;
 6. TF;
 7. VA;
 8. VI;
 9. VM

4.3.3.2. For the majority of air transport aircraft equipped with FMS, the required functionalities, with the exception of the provision of a non-numeric lateral deviation display, are normally available. For this category of aircraft lateral deviation is displayed on a map display, usually with a numeric indication of cross-track error in one-tenth of an NM. In some cases a numeric indication of cross-track error may be provided outside the primary field of view (e.g. CDU). Acceptable lateral tracking accuracy for both RNAV 1 and RNAV 2 routes is usually adequate provided the autopilot is engaged or the flight director is used.

4.3.3.3. Aircraft equipped with stand-alone GNSS navigation systems should have track guidance provided via a CDI or HSI (a navigation map display may also be used for RNAV 2 routes). A lateral deviation display is often incorporated in the unit, but is commonly not of sufficient size or suitable position to allow either pilot to maneuver and adequately monitor cross-track deviation.

Caution should be exercised in regard to the limitations of stand-alone GNSS systems with respect to ARINC 424 path terminators. Path terminators involving an altitude termination are not normally supported due to a lack of integration of the lateral navigation system and the altimetry system. For example, a departure procedure commonly specifies a course after take-off until reaching a specified altitude (CA path terminator). Using a basic GNSS navigation system it is necessary for the flight crew to manually terminate the leg on reaching the specified altitude and then navigate to the next waypoint, ensuring that the flight path is consistent with the departure procedure. This type of limitation does not preclude operational approval (as stated in the PBN Manual functional requirements) provided the operator's procedures and crew training are adequate to ensure that the intended flight path and other requirements can be met for all SID and STAR procedures.

4.3.4. Operating procedures

4.3.4.1. Operators with en-route area navigation experience will generally meet the basic requirements of RNAV 1 and RNAV 2, and the operational approval should focus on procedures associated with SIDs and STARs.

4.3.4.2. Particular attention should be placed on the selection of the correct procedure from the database, review of the procedures, connection with the en-route phase of flight and the management of discontinuities. Similarly an evaluation should be made of procedures management, selection of a new procedure, including change of runway, and any crew amendments such as insertion or deletion of waypoints.

4.3.4.3. GNSS-based operations also require the prediction of fault detection (FD) RAIM availability. Many stand-alone GNSS service prediction programmes are based on a prediction at a destination and do not generally provide predictions over a route or large area. RNAV 1 and RNAV 2 specific route prediction services are available from commercial sources.

4.3.4.4. RNAV 1 and RNAV 2 operations are typically conducted in areas of adequate NAVAID coverage; contingency procedures will normally involve reversion to conventional ground-based radio navigation.

4.3.5. Pilot knowledge and training

4.3.5.1. Most crews will already have some experience with area navigation operations, and much of the knowledge and training will have been covered in past training. Particular attention should be placed on the application of this knowledge to the execution of RNAV 1 and RNAV 2 SIDs and STARs, including connection with the en-route structure and transition to final approach. This requires a thorough understanding of the airborne equipment and its functionality and management.

4.3.5.2. Particular attention should be placed on:

- a) the ability of the airborne equipment to fly the designed flight path. This may involve pilot intervention where the equipment functionality is limited;
- b) management of changes;
- c) turn management (turn indications, airspeed and bank angle, lack of guidance in turns);
- d) route modification (insertion/deletion of waypoints, direct to waypoint);
- e) intercepting a route from radar vectors.

4.3.5.3. Flight training for RNAV 1 and RNAV 2 is not normally required, and the required level of competence can normally be achieved by classroom briefing, computer-based training, desktop simulator training, or a combination of these methods. Computer-based simulator programmes are available from a number of GPS manufacturers which provide a convenient method for familiarity with programming and operation of stand-alone GNSS systems.

4.3.5.4. Where VNAV is used for SIDs and STARs, attention should be given to the management of VNAV and specifically the potential for altitude constraints to be compromised in cases where the lateral flight path is changed or intercepted.



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RNAV 1 AND RNAV 2 JOB AID APPLICATION TO CONDUCT RNAV 1 AND 2 OPERATIONS

1. Purpose of the job aid

- a) To provide information on the relevant reference documents.
- b) To provide a record of the operator application, the inspector comments and the operator follow-up action for each relevant paragraph in the reference document(s).

2. Actions recommended for the inspector and operator

- a) At the pre-application meeting, the operator and the inspector review the approval process events and establish the form and content of the approval application.
- b) The operator records references to material in company documents for each relevant paragraph in the job aid.
- c) The operator submits to the inspector the completed job aid with the application.
- d) The inspector records his/her findings for each relevant paragraph in the job aid indicating compliance or necessary corrective action.
- e) The inspector informs the operator as soon as possible when a corrective action is required.
- f) The operator provides the inspector with the revised material when so requested.
- g) The CAAT provides the operator with the operations specifications (Ops Specs) or letter of authorization (LOA), as applicable, when the tasks and documents have been completed.

Part	Topic	page
1	General information	
2	Aircraft and operator identification	
3	Operator application	
4	Contents of the operator application	
5	Basic pilot procedures	



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6	Contingency procedures	
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Reference documents

Publisher	Reference	Title
ICAO	Annex 2	Rules of the Air
	Annex 6	Operation of Aircraft
	Doc 4444	Procedure for Air Navigation Services — Air Traffic Management
	Doc 7030	Regional Supplementary Procedures
	Doc 9613	Performance-based Navigation (PBN) Manual
FAA	AC 90-100()	U.S. Terminal and En Route Area Navigation (RNAV) Operations
	14 CFR Part 121, Subpart G	Manual Requirements
EASA	TGL No. 10	Airworthiness and Operational Approval for Precision RNAV Operations in Designated European Airspace
	AMC 20-5	Airworthiness Approval and Operational Criteria for the use of NAVSTAR Global Positioning System (GPS)
CASA	AC 91U-II-B-3 (draft)	Navigation Authorizations — RNAV 1 and RNAV 2
ICAO (SAM)	AC 91-003	Aircraft and Operators Approval for RNAV 1 and RNAV 2 Operations

PART 1. GENERAL INFORMATION BASIC EVENTS OF THE APPROVAL PROCESS

	Action by operator	Action by Inspector
1	Establish the need for the authorization.	
2	Review the AFM, AFM supplement, TC data sheet, other appropriate documents (e.g. STCs, SBs, SLs) to determine aircraft eligibility. If necessary contact the aircraft and/or avionics OEM to confirm eligibility.	
3	Schedule a pre-application meeting with the inspector.	
4		<p>During the pre-application meeting establish:</p> <ul style="list-style-type: none"> • <i>form and contents of the application;</i> • <i>documents required to support the application;</i> • <i>target date for the application submission;</i> • <i>requirement for flight</i>
5	Submit the application at least XX days prior to start- up of the planned operations.	
6		Review submission.
7	Ensure that amendments to manuals, programmes and other relevant documents are complete; provide training to flight crews, flight dispatchers and maintenance personnel; if required, conduct a validation flight.	If required, participate in the validation flight.
8		Once the requirements have been met, issue operational approval.



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PART 2. IDENTIFICATION OF AIRCRAFT AND OPERATORS

Name of Operator: _____

Aircraft manufacturer, model and series	Registration number	Serial number	Long-range navigation system manufacturer, model and number	PBN specification

Date of pre-application meeting: _____

Date when application received by CAAT: _____

Date when operator intends to begin RNAV 1 and RNAV 2 operations:

Is the CAAT notification date appropriate? Yes No



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PART 3. OPERATOR APPLICATION

Annex	Title	Inclusion by Operator	Comments by Inspector
A	Request for authorization		
B	Aircraft eligibility - airworthiness AFM, AFM revision, AFM supplement, TCDS showing that the aircraft RNAV systems are eligible.		
C	Aircraft eligibility — modifications (if applicable) Maintenance records documenting installation or modification of aircraft systems to achieve eligibility.		
D	Maintenance Navigation database maintenance practices.		
E	Minimum equipment list		
F	Training xxx91/GA operators or equivalent: <ul style="list-style-type: none">• <i>course completion records.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none">• <i>training programmes for flight crew, flight dispatchers and maintenance personnel.</i>		
G	Operating policies and procedures xxx91/GA operators or equivalent: <ul style="list-style-type: none">• <i>extracts from the operations manual corresponding to the application.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none">• <i>operations manual and checklists.</i>		



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Contents of the application to be submitted by the operator

- compliance documentation for the aircraft/navigation systems;
- operating procedures and policies;
- sections of the maintenance manual related to LRNS (if not previously reviewed).

Note.— Documents may be grouped in a single binder or may be submitted as individual documents.

PART 4. CONTENTS OF THE OPERATOR APPLICATION

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter 3)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Authorization request Statement of intent to obtain authorization.	3.3.2.1	3.2			
2	Aircraft/navigation system eligibility Documents that establish eligibility.	3.3.2.2 3.3.2.3.1	3.2.1			
3	Training Details of courses completed (xxx91 operators).	3.3.2.3.2 3.3.5	3.2.2.2 3.5			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter 3)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
	Detail of training programmes (xxx121 and xxx135 operators).					
4	Operating policies and procedures Extracts from the operations manual or other documentation (xxx91 operators). Operations manual and checklists (xxx121 and xxx135 operators).	3.3.2.3.3	3.2.2.3 3.4			
5	Maintenance practices Document references for navigation database maintenance practices	3.3.2.3.5 3.3.6	3.2.2.5 3.6			
6	MEL update	3.3.2.3.4	3.2.2.4			



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PART 5. OPERATING PROCEDURES

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter 3)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Flight planning					
1a	Verify that the aircraft is approved for RNAV 1 and RNAV 2 operations.	3.3.4.1	3.4.1			
1b	Verify RAIM availability (GNSS only).	3.3.4.2.3 3.3.4.2.4	3.4.2.3 3.4.2.4			
1c	Verify the availability of NAVAIDS (non-GNSS).	3.3.4.2.3 3.3.4.2.5	3.4.2.3 3.4.2.5			
1d	Verify that the navigation database (if carried) is current and appropriate for the region.	3.3.4.2.2 3.3.4.3.3	3.4.2.2 3.4.3.3			
1e	Verify the FPL: R" should appear in field 10 and PBN/C1- D4 (as appropriate) in field 18.	3.3.4.2.1	3.4.2.1			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter3)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
2	General operating procedures					
2a	Verify the flight-planned route.	3.3.4.3.3	3.4.3.3			
2b	Advise ATC if unable to comply with the requirements for RNAV 1/RNAV 2.	3.3.4.3.2	3.4.3.2			
2c	Confirm that the navigation database is up to date.	3.3.4.3.3	3.4.3.3			
2d	Retrieve SIDs/STARs only from the database.	3.3.4.3.4	3.4.3.4			
2e	Cross-check the chart with the RNAV system display.	3.3.4.3.3 3.3.4.3.6	3.4.3.3 3.4.3.6			
2f	Cross-check with conventional NAVAIDS to monitor for navigational reasonableness.	3.3.4.3.7	3.4.3.7			
2g	Use an appropriate display.	3.3.4.3.8 3.3.4.3.9	3.4.3.8 3.4.3.9			
2h	Use appropriate scaling.	3.3.4.3.10	3.4.3.10			
2i	Follow route centre line within 1 or 0.5 NM.	3.3.4.3.11	3.4.3.11			

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter3)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
2	Do not modify the flight plan in the RNAV system after ATC heading assignment until a clearance is received to re-join the route or a new clearance is	3.3.4.3.12	3.4.3.12			
3	RNAV SID requirements					
3a	Prior to take-off check the RNAV system, aerodrome and procedure loaded and the displayed position.	3.3.4.4.1	3.4.4.1			
3b	Engage LNAV no later than 500 ft above aerodrome elevation.	3.3.4.4.2	3.4.4.2			
3c	If DME/DME only, do not use RNAV until within adequate DME coverage.	3.3.4.4.4	3.4.4.4			
3d	If DME/DME/IRU only, confirm navigation position within 0.17 NM of the start of the take-off roll.	3.3.4.4.5	3.4.4.5			
3e	If GNSS, acquire signal before start of take-off roll.	3.3.4.4.6	3.4.4.6			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part B, Chapter3)*	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
4	RNAV STAR requirements					
4a	Verify that the correct STAR is loaded and displayed.	3.3.4.5.1	3.4.5.1			
4b	Contingency preparations.	3.3.4.5.3	3.4.5.3			
4c	Procedure modification in response to ATC instructions.	3.3.4.5.4	3.4.5.4			
4d	Observance of speed and altitude constraints.	3.3.4.5.6	3.4.5.6			
1.	Contingencies					
1a	Advise ATC if unable to comply with the requirements for RNAV 1/RVAV 2.	3.3.4.6.1	3.4.6.1			
1b	Air-ground communications failure.	3.3.4.6.2 (Doc 4444 Chapter 15, 15.3)	3.4.6.2			

*All references are to Doc 9613, Volume II, Part B, Chapter 3, unless otherwise indicated.

4.4. RNP 4

4.4.1. General

RNP 4 supports 30 NM lateral and 30 NM longitudinal distance-based separation minima in oceanic or remote area airspace. Operators holding an existing RNP 4 operational approval do not need to be re-examined because the navigation specification is based upon U.S. FAA Order 8400.33.

4.4.2. System requirements

4.4.2.1. The RNP 4 system requirements are as follows

- a) two long-range navigation systems;
- b) at least one GNSS receiver with FDE;
- c) a navigation database containing the routes and procedures;
- d) an area navigation system failure indication;
- e) continuous indication of aircraft position relative to track to be displayed to the pilot flying (and the pilot not flying) on a navigation display situated in the primary field of view;
- f) display of distance and bearing to the active (To) waypoint;
- g) display of ground speed or time to the active (To) waypoint;
- h) display of active navigation sensor type;
- i) lateral deviation display must have scaling and FSD of ± 4 NM — the maximum FTE permitted is 2 NM;
- j) automatic leg sequencing and fly-by turn functionality;
- k) parallel off-set;
- l) ability to fly direct to a fix;
- m) ability to fly a course to a fix.

For the majority of air transport aircraft equipped with FMS, the required functionalities, with the exception of the provision of a non-numeric lateral deviation display, are normally available. For this category lateral deviation is not normally displayed on a CDI or HSI, but is commonly available on a map display, usually with a numeric indication of cross-track error in one-tenth of an NM. In some cases a numeric indication of cross-track error may be provided outside the primary field of view (e.g. CDU).

4.4.2.2. Aircraft equipped with stand-alone GNSS navigation systems should provide track guidance via a CDI, HSI, or a navigation map display. The CDI/HSI must be coupled to the area navigation route providing a direct indication of lateral position with reference to the flight-planned track. This type of unit in en-route mode (nominally outside 30 NM from departure and destination airports) defaults to a CDI/HSI full-scale display of ± 5 NM, with RAIM alerting defaulting to 2 NM, which is adequate for RNP 4. A lateral deviation display is often incorporated in the unit and may be suitable if of sufficient size and position, to allow either pilot to maneuver and monitor cross-track deviation.

4.4.2.3. The default method for area navigation systems to manage turns at the intersection of “straight” route segments is to compute, based on ground speed and assumed angle of bank, a position at which the turn should commence so that the resulting radius will turn inside the angle created by the two consecutive segments. For aircraft fitted with a stand-alone GNSS system or an FMS, fly-by transitions are a standard function and should not require specific evaluation. However a stand-alone GNSS receiver may require a pilot action to initiate the turn. All turns are limited by the physical capability of the aircraft to execute a turn of suitable radius. In normal cases where the angle between track is small there is seldom a problem, but operators need to be aware that large angle turns, particularly at high altitude where TAS is high and bank angle is commonly limited, can be outside the aircraft capability. While this condition is rare, flight crews need to be aware of the aircraft and avionics limitations.

4.4.3. Operating procedures

4.4.3.1. Some additional provisions may need to be added to the standard operating procedures to specifically address RNP 4 operations.

4.4.3.2. A review of the operator's procedure documentation against the requirements of the PBN Manual and the (State) regulatory requirements should be sufficient to ensure compliance.

4.4.3.3. The essential elements to be evaluated are that the operator's procedures ensure that:

- a) the aircraft is serviceable for RNP 4 operations;
- b) RNP 4 capability is indicated on the flight plan;
- c) en-route loss of capability is identified and reported;
- d) procedures for alternative navigation are described.

4.4.3.4. GNSS-based operations also require the prediction of FDE RAIM availability. The maximum period during which FDE may be predicted to be unavailable is 25 minutes. Many stand-alone GNSS prediction programmes are based on a prediction at a destination and do not generally provide predictions over a route or large area. RNP 4- specific route prediction services are available from commercial sources.

4.4.4. Pilot knowledge and training

4.4.4.1. Unless the operator is inexperienced in the use of area navigation, flight crews should possess the necessary skills to conduct RNP 4 operations with minimal additional training.

4.4.4.2. Where additional training is required, this can normally be achieved by bulletin, computer-based training or classroom briefing. Flight training is not normally required.



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RNP 4 JOB AID

APPLICATION TO CONDUCT RNP 4 OPERATIONS

1. Purpose of the job aid
 - a) To provide information on the relevant reference documents.
 - b) To provide a record of the operator application, the inspector comments and the operator follow-up action for each relevant paragraph in the reference document(s).

2. Actions recommended for the inspector and operator
 - a) At the pre-application meeting, the operator and the inspector review the approval process events and establish the form and content of the approval application.
 - b) The operator records references to material in company documents for each relevant paragraph in the job aid.
 - c) The operator submits to the inspector the completed job aid with the application.
 - d) The inspector records his/her findings for each relevant paragraph in the job aid indicating compliance or necessary corrective action.
 - e) The inspector informs the operator as soon as possible when a corrective action is required.
 - f) The operator provides the inspector with the revised material when so requested.
 - g) The CAAT provides the operator with the operations specifications (Ops Specs) or a letter of authorization (LOA), as applicable, when the tasks and documents have been completed.

Part	Topic	page
1	General information	
2	Aircraft and operator identification	
3	Operator application	
4	Contents of the operator application	
5	Basic pilot procedures	
6	Contingency procedures	

Reference documents

Publisher	Reference	Title
ICAO	Annex 2	Rules of the Air
	Annex 6	Operation of Aircraft
	Doc 4444	Procedure for Air Navigation Services — Air Traffic Management
	Doc 7030	Regional Supplementary Procedures
	Doc 9613	Performance-based Navigation (PBN) Manual
FAA	Order 8400.33	Procedures for Obtaining Authorization for RNP 4 Oceanic and Remote Area Operations
	AC 20-130	Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors
	AC 20-138A	Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment
	Order 7110.82	Monitoring of Navigation/Altitude Performance in Oceanic Airspace
	14 CFR Part 121, Subpart G	Manual Requirements
EASA	TBA	TBA
CASA	AC 91U-3(0)	Required Navigation Performance 4 (RNP 4) Operational Authorization
ICAO (SAM)	AC 91-004	Aircraft and Operators Approval for RNP 4 Operations

PART 1. GENERAL INFORMATION BASIC EVENTS OF THE APPROVAL PROCESS

	Action by operator	Action by Inspector
1	Establish the need for the authorization.	
2	Review the AFM, AFM supplement, TC data sheet, other appropriate documents (e.g. STCs, SBs, SLs) to determine aircraft eligibility. If necessary contact the aircraft and/or avionics OEM to confirm eligibility.	
3	Schedule a pre-application meeting with the inspector.	
4		<p>During the pre-application meeting establish:</p> <ul style="list-style-type: none"> • <i>form and contents of the application;</i> • <i>documents required to support the application;</i> • <i>target date for the application submission;</i> • <i>requirement for flight validation.</i>
5	Submit the application at least XX days prior to start- up of the planned operations.	
6		Review submission.
7	Ensure that amendments to manuals, programmes and other relevant documents are complete; provide training to flight crews, flight dispatchers and maintenance personnel; if required, conduct a validation flight.	If required, participate in the validation flight.
8		Once the requirements have been met, issue operational approval.



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PART 2. IDENTIFICATION OF AIRCRAFT AND OPERATORS

Name of Operator: _____

Aircraft manufacturer, model and series	Registration number	Serial number	Long-range navigation system manufacturer, model and number	PBN specification

Date of pre-application meeting: _____

Date when application received by CAAT: _____

Date when operator intends to begin RNP 4 operations: _____

Is the CAAT notification date appropriate? Yes No

PART 3. OPERATOR APPLICATION

Annex	Title	Inclusion by Operator	Comments by Inspector
A	Request for authorization		
B	Aircraft group Statement by the operator to which group the aircraft/RNP system combinations belong.		
C	Aircraft eligibility —airworthiness AFM, AFM revision, AFM supplement, TCDS showing that the aircraft RNAV systems are eligible.		
D	Aircraft eligibility — modifications (if applicable) Maintenance records documenting installation or modification of aircraft systems to achieve eligibility.		
E	Maintenance References to the RNP 4 maintenance document/ programme.		
F	Minimum equipment list		
G	Training xxx91/GA operators or equivalent: <ul style="list-style-type: none"> • <i>course completion records.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none"> • <i>training programmes for flight crew, flight dispatchers and maintenance personnel.</i> 		



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Annex	Title	Inclusion by Operator	Comments by Inspector
H	Operating policies and Procedures xxx91/GA operators or equivalent: <ul style="list-style-type: none">• <i>extracts from the operations manual corresponding to the application.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none">• <i>operations manual and checklists.</i>		
I	Validation flight plan As required.		

Contents of the application to be submitted by the operator

- *compliance documentation for the aircraft/navigation systems;*
- *operating procedures and policies;*
- *sections of the maintenance manual related to LRNS (if not previously reviewed).*

Note.— Documents may be grouped in a single binder or may be submitted as individual documents.

PART 4. CONTENTS OF THE OPERATOR APPLICATION

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 1)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	<p>Authorization request</p> <p>Statement of intent to obtain authorization.</p>					
2	<p>Aircraft/navigation system eligibility</p> <p>Documents that establish eligibility.</p> <p>For RNP 4, the eligibility groups(s) used and a list of the airframes included in each group.</p>	1.3.2.2	4.2.1			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 1)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
3	Training Details of courses completed (xxx91 operators). Details of training programmes (xxx121 and xxx135 operators).	1.3.2.3.2 1.3.5	4.2.2.2 4.5			
4	Operating policies and procedures Extracts from the operations manual or other documentation (xxx91 operators). Operations manual and checklists (xxx121 and xxx135 operators).	1.3.2.3.3	4.2.2.3 4.4			
5	Maintenance practices Document references for RNP 4 maintenance practices.	1.3.2.3.5	4.2.2.5			
6	MEL update	1.3.2.3.4	4.2.2.4			

PART 5. OPERATING PROCEDURES

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 1)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Flight planning					
1a	Verify that the aircraft is approved for RNP 4 operations.	1.3.4.1	4.4.1			
1b	Verify that the navigation database is current	1.3.4.2.1	4.4.2.1			
1c	Verify the availability of FDE	1.3.4.3	4.4.3			
1d	Verify the FPL: R" should appear in field 10 and PBN/L1 in field 18.	1.3.4.2.1	4.4.2.1			
1e	Verify equipment conditions: <ul style="list-style-type: none"> • <i>review flight technical records;</i> • <i>confirm that maintenance actions are complete.</i> 	1.3.4.2.2	4.4.2.2			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 1)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
2	En-route					
2a	Both LRNSs must be RNP 4 capable at the oceanic point of entry.	1.3.4.4.1	4.4.4.1			
2b	Other mandatory navigation cross- checks.	1.3.4.4.2	4.4.4.2			
2c	ATC notified if unable to comply with the requirements for RNP or of any deviation required for a	1.3.4.4.3	4.4.4.3			
2d	Follow route centre line within 2 NM.	1.3.4.4.4	4.4.4.4			
1	Contingencies	(Doc 4444 Chapter 15)				
1a	Inability to comply with ATC clearance due to meteorological conditions, aircraft performance or pressurization failure.	15.2.1.1	9.1.1.1			
1b	Weather deviation.	15.2.3	9.2.3			
1c	Air-ground communications failure.	15.3	9.3			

4.5. RNP 2

4.5.1. General

4.5.1.1.RNP 2 is a navigation specification primarily intended to provide a means to develop routes in areas with little or no ground-based navigation aid (NAVAID) infrastructure.

4.5.1.2.The RNP 2 navigation specification is applicable to fixed or flexible routes in Continental En-route and Oceanic/Remote flight phases.

4.5.1.3.RNP 2 requires Global Navigation Satellite System (GNSS) as the primary navigation sensor, either as a stand-alone aviation system or as part of a muti-sensor system. Where multi-sensor systems incorporating GNSS are used, positioning data from non-GNSS navigation sensors may be integrated with the GNSS data provided the non-GNSS data do not cause position errors exceeding the total system error budget. Otherwise a means should be provide to deselect the non-GNSS navigation sensor types.

4.5.1.4.RNP 2 operations in Oceanic and Remote airspace require dual independent long-range navigation systems. RNP 2 operations in Continental EN-route airspace may use a single GNSS area navigation system providing an alternate means of navigation is available if required by the category of operation.

- RNAV 1 and RNAV 2

4.5.1.5.The standards applicable to RNP 2 oceanic / remote also meet the requirements for:

*RNP 4, and
RNAV 5; and
RNAV 1 and RNAV 2*

Note: RNP 2 is applicable to area navigation routes defined by straight segments. Fixed Radius Transitions may be applied to RNP 2 routes.

4.5.2. AIRCRAFT ELIGIBILITY

4.5.2.1. An aircraft is eligible for a RNP 2 navigation authorization if:

The AFM, an AFM supplement, or OEM service letter states that the aircraft navigation system is approved for RNP 2 operations; or

The aircraft is equipped with GNSS stand-alone system certified by the manufacturer for en-route operations in accordance with AC 21-36(0) (utilizing either TSO-C129 Class A1 or A2 or TSO-C146 / ETSO-C146 Class Gamma and Operational Class 1, 2 or 3) or equivalent;

The aircraft is equipped with a multi-sensor system (e.g. FMS) with GNSS equipment certified by the manufacturer for en-route operations in accordance with AC 21-37 (0) (utilizing either TSO/ETSO-C129(a) sensor Class B or C, TSO/ETSO-C145 Class 1, 2 or 3 or TSO-C196) and the requirements of ETSO-C115b FMS or equivalent.

The aircraft is demonstrated to comply with the requirements for RNP 2 contained in ICAO Doc 9613 PBN Manual, Volume II, Part C, Chapter 2, Implementing RNP 2.

4.5.3. SYSTEM PERFORMANCE, MONITORING AND ALERTING

System performance, monitoring and alerting requirements for RNP 2 operations are as stated in ICAO Doc 9613 PBN Manual, Volume II, Part C, Chapter 2, Implementing RNP 2.

4.5.4. SYSTEM FUNCTIONALITY

System functionality requirements for RNP 2 operations are as stated in ICAO Doc 9613 PBN Manual, Volume II, Part C, Chapter 2, Implementing RNP 2.

4.5.5. OPERATING STANDARDS

4.5.5.1. Flight Planning

Prior to flight, consider conditions that may affect RNP 2 operations, including:

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Verify that the aircraft and operating crew are approved for RNP 2;
Confirm that the aircraft can be operated in accordance with the RNP 2 requirements for the planned route(s) including the route/s to any alternate aerodrome(s) and minimum equipment requirements;
Check availability of the NAVAID infrastructure required for the intended routes, including any non-RNAV contingencies, for the period of the intended operation;
Confirm that the navigational database is current and appropriate for the region of intended operation and includes the NAVAIDs and waypoints required for the route; and
Consider any operating restrictions, including time limits if applicable. Insert the appropriate identifier in the flight plan to indicate RNP 2 as set out in the Aeronautical Information Publication.

4.5.5.2. GNSS Integrity Availability

GNSS navigation systems are equipped with a means of monitoring the integrity of the position solution. Integrity may be assured by a number of methods including Receiver Autonomous Integrity Monitor and proprietary hybrid inertial / GNSS systems.

The availability of the integrity monitoring function can be predicted and can be obtained from a variety of sources such as Notice to Airmen (NOTAM), and prediction services. Operators should be familiar with the prediction information available for the intended route. Prediction services are available from Air Navigation Service Provider (ANSPs), avionic manufacturers, other entities or through an on-board prediction capability.

Integrity availability prediction should take into account the latest satellite constellation NOTAM and the integrity system used by the aircraft avionics.

In the event of a predicted, continuous loss of the integrity function more than 5 minutes for any part of the RNP 2 operation, the flight plan should be revised (i.e. delaying the departure or planning a different route).

Note: *Some RNP systems, typically multi-sensor systems with tightly coupled GNSS/IRS, provide a global RNP capability based on a minimum number of available GPS satellites and IRS coasting capability e.g.: 'For instrument approach procedures requiring GPS PRIMARY...GPS*

PRIMARY is available worldwide if 24 satellites or more are operative. If the number of satellites is 23 or less check GPS PRIMARY availability using an approved ground based prediction software'. This equates to a global RNP capability of RNP 0.3 provided there is a minimum number of 24 serviceable GPS satellites. In such cases a prediction is not required unless operations below the stated RNP value are planned or the minimum number of serviceable satellites is reached.

Operators, pilots and ANSPs need to be aware, that a prediction of integrity availability, an unplanned failure of GNSS elements can result in a loss of integrity monitoring capability, and in some cases a complete loss of the navigation function whilst airborne, which may require reversion to an alternative means of navigation. Pilots should, therefore, assess their capability to navigate (potentially to an alternate destination) in the case of failure of GNSS navigation.

For aircraft navigating with Space Based Augmentation System (SBAS) receivers (all TSO-C145/C146), check GPS INTEGRITY availability in areas where SBAS is unavailable.

4.5.5.3. Flight Procedures

- a) Comply with any instructions or procedures identified by the manufacturer as being necessary to comply with the performance requirements of the navigation specification.
- b) At system initialization, confirm the navigation database is current and verify that the aircraft position has been entered correctly. Verify proper entry of the Air Traffic Control (ATC) assigned route upon initial clearance from ATC to conduct the relevant RNAV route. Ensure the waypoints sequence, depicted by the navigation system, matches the route depicted on the appropriate chart/s and the assigned route.
- c) Cross-check the cleared flight plan by comparing charts or other applicable resources with the navigation system textual display and the aircraft map display, if applicable. If required, confirm the exclusion of specific navigation aids.

Note: *Small differences between charted navigation information and displayed navigation data may be noted. Differences of 3 degrees or less due to the equipment manufacturer's application of magnetic variation and are operationally acceptable.*

- d) During flight, where feasible, confirm navigation reasonableness by cross-reference to available data from ground-based aids.
- e) For RNP 2 routes, a lateral deviation indicator, navigation map display, flight director or autopilot in the lateral navigation mode is recommended.
- f) In lieu of a lateral deviation indicator, a navigation map display with equivalent functionality to a lateral deviation indicator, as described in ICAO Doc 9613, Volume II, Part C, Chapter 2, Implementing RNP 2 is acceptable for RNP 2 operations.
- g) Select lateral deviation display scaling suitable for the navigation accuracy associated with the route (e.g. full scale deflection ± 2 NM for RNP 2 or ± 5 NM for TSO-C129 equipment).
- h) Select navigation map scale to enable monitoring of tracking accuracy applicable to RNP 2.

Note: Map scaling selection is dependent upon a number of factors including display size, resolution, any numeric cross-track indications and route complexity. Typically a 10 NM display scaling may be used.

- i) Maintain route centerlines, as depicted by lateral deviation indicators and/or flight guidance, unless authorized to deviate by ATC or under emergency conditions.
- j) The standard for limitation of cross-track error/deviation (the difference between the computed path and the displayed aircraft position) is 1/2 the navigation accuracy (i.e. 1 NM for RNP 2).

Note: Brief deviations from this standard during and immediately after turns, are normally considered acceptable. As accurate cross-track information may not be provided during turns, crew procedures and training need to emphasize observance of turn anticipation commands and management of rate of turn.

k) If ATC issues a heading assignment taking the aircraft off a route, do not modify the flight plan until clearance is received to rejoin the route or the controller confirms a new clearance.

l) Manually selecting aircraft bank-limiting functions may reduce the aircraft's ability to maintain its desired track and is therefore not recommended. Pilots should recognise that manually selectable aircraft bank-limiting functions might reduce their ability to satisfy ATC flight path expectations, especially when executing large angle turns. This should not be construed as a requirement to deviate from approved aircraft flight manual procedures; rather pilots should be encouraged to limit the selection of such functions within accepted procedures.

4.5.5.4. Contingency Procedures

Notify ATC when the RNP performance ceases to meet the requirements for RNP 2.

4.5.6. Flight Crew Knowledge and Training

4.5.6.1. Flight crew knowledge elements include:

The meaning and proper use of aircraft equipment/navigation suffixes;

The capabilities and limitations of the RNP system installed;

The operations and airspace for which the RNP system is approved to operate;

The NAVAID limitations with respect to the RNP system to be used for RNP 2 operations;

Required navigation equipment for operation on RNP 2 routes;

The flight planning requirements for the RNP 2 operation;

The radio/telephony phraseology for the airspace, in accordance with ICAO Doc 4444 -

Procedures for Air Navigation Services – Air Traffic Management (PANS/ATM) and Doc 7030

- Regional Supplementary Procedures, as appropriate;

Contingency procedures for RNP system failures;

RNP system-specific information, including:

- Levels of automation, mode annunciations, changes, alerts, interactions, reversions and degradation;

- Functional integration with other aircraft systems;
- Types of navigation sensors (e.g. Distance Measuring Equipment, Inertial Reference Unit and GNSS) utilized by the RNP system and associated system prioritization/weighting/logic;
- Aircraft configuration and operational conditions required to support RNP2 operations i.e. appropriate selection of lateral deviation display scaling;
- Pilot procedures consistent with the operation;
- The meaning and appropriateness of route discontinuities and related flight crew procedures;
- Monitoring procedures for each phase of the flight (e.g. monitor PROG or LEGS page);
- Turn anticipation with consideration to speed and altitude effects; and
- Interpretation of electronic displays and symbols.

4.5.6.2. Flight crew training elements include:

- Verify that the aircraft navigation data is current and valid;
 - Verify the successful completion of RNP system self-tests;
 - Initialize RNP system position;
 - Perform a manual or automatic update (with take-off point shift, if applicable); Verify waypoints and flight plan programming;
 - Resolve route discontinuities;
 - Fly direct to waypoint;
 - Fly a course/track to waypoint;
 - Intercept a course/track;
 - Vector off track and rejoin a procedure;
 - Fly radar vectors and re-joining an RNP 2 route from a 'heading' mode; Determine cross-track error/deviation;
 - Determine allowable deviation limits and maintain flight within those limits;
- Remove and reselect navigation sensor input;

Perform gross navigation error checks using conventional aids;

Confirm exclusion of a specific navigation aid or navigation aid type;

*Change arrival airport and alternate airport;
Perform parallel offset function if capability exists. Advise ATC if this functionality is not available; and
Contingency procedures for RNP 2 failures.*

Note : *Where crews have the required standard of knowledge based on previous training or experience a separate training course may not be necessary, provided the applicant details the relevant knowledge and training elements that are contained in other training programmes.*

4.5.7. Minimum Equipment List

The operator's MEL must identify any unserviceability that affects the conduct of a RNP 2 operation.

4.5.8. Navigation Data Base

4.5.8.1.A navigation database should be obtained from a supplier that complies with Radio Technical Commission for Aeronautics DO-200A/ European Organization for Civil Aircraft Equipment document ED-76, Standards for Processing Aeronautical Data and should be compatible with the intended function of the equipment (see ICAO Annex 6, Part 1, Chapter 7). A Letter of Acceptance (LOA), issued by an appropriate regulatory authority to each of the participants in the data chain, demonstrates compliance with this requirement

(e.g. Federal Aviation Administration (FAA) LOA issued in accordance with FAA AC 20-153 or European Aviation Safety Agency (EASA) LOA issued in accordance with EASA Implementing Rule 21 subpart G).

Note: *While a LOA provides assurance of minimum standards for the supply of a navigation data, errors may still occur and all operators should consider the need to conduct periodic checks to ensure database integrity.*

4.5.8.2.Any discrepancy in data is to be reported to the navigation database supplier and resolved prior to operational use by:

- *re-issue of the navigation database;*
- *prohibition of the route; or*

- *instructions to flight crew.*

4.5.9. Navigation Errors

4.5.9.1. It is the responsibility of the operator to take immediate action to rectify any condition that has led to navigation error.

4.5.9.2. A report to CAAT, including an initial analysis of the causal factors and the measures being taken to prevent a recurrence is due within 72 hours.

4.5.9.3. Navigation errors exceeding the following limits are reportable.

*a lateral navigational error of at least 2 NM for RNP 2;
a longitudinal navigational error of at least 2 NM for RNP 2; or
a navigation system failure. A navigation system failure is defined as meaning that the aircraft cannot meet the required performance for the current route.*

RNP 2 JOB AID

APPLICATION TO CONDUCT RNP 2 OPERATIONS

1) Purpose of the job aid

- a) To provide information on the relevant reference documents.
- b) To provide a record of the operator application, the inspector comments and the operator follow-up action for each relevant paragraph in the reference document(s).

2) Actions recommended for the inspector and operator

- a) At the pre-application meeting, the operator and the inspector review the approval process events and establish the form and content of the approval application.
- b) The operator records references to material in company documents
- c) for each relevant paragraph in the job aid.
- d) The operator submits to the inspector the completed job aid with the application.
- e) The inspector records his/her findings for each relevant paragraph in the job aid indicating compliance or necessary corrective action.
- f) The inspector informs the operator as soon as possible when a corrective action is required.
- g) The operator provides the inspector with the revised material when
- h) so requested.
- i) The CAAT provides the operator with the operations specifications (Ops Specs) or letter of authorization (LOA), as applicable, when the tasks and documents have been completed.



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Part	Topic	page
1	General information	
2	Aircraft and operator identification	
3	Operator application	
4	Contents of the operator application	
5	Basic pilot procedures	
6	Contingency procedures	

Reference documents

Publisher	Reference	Title
ICAO	Annex 2	Rules of the Air
	Annex 6	Operation of Aircraft
	Doc 4444	Procedure for Air Navigation Services — Air Traffic Management
	Doc 7030	Regional Supplementary Procedures
	Doc 9613	Performance-based Navigation (PBN) Manual
FAA	TBA	TBA
EASA	TBA	TBA
CASA	AC 91U-II-C-2	Navigation Authorizations – RNP 2

PART 1. GENERAL INFORMATION BASIC EVENTS OF THE APPROVAL PROCESS

	Action by operator	Action by inspector
1	Establish the need for the authorization.	
2	Review the AFM, AFM supplement, TC data sheet, other appropriate documents (e.g. STCs, SBs, SLs) to determine aircraft eligibility. If necessary contact the aircraft and/or avionics OEM to confirm eligibility.	
3	Schedule a pre-application meeting with the inspector.	
		<p>During the pre-application meeting establish:</p> <ul style="list-style-type: none"> • <i>form and contents of the application;</i> • <i>documents required to support the application;</i> • <i>target date for the application submission;</i> • <i>requirement for flight validation.</i>
5	Submit the application at least XX days prior to start- up of the planned operations.	
6		Review submission.
7	Ensure that amendments to manuals, programmes and other relevant documents are complete; provide training to flight crews, flight dispatchers and maintenance personnel; if required, conduct a validation flight.	If required, participate in the validation flight.
8		Once the requirements have been met, issue operational approval.



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PART 2. IDENTIFICATION OF AIRCRAFT AND OPERATORS

Name of Operator: _____

Aircraft manufacturer, model and series	Registration number	Serial number	Long-range navigation system manufacturer, model and number	PBN specification

Date of pre-application meeting: _____

Date when application received by CAAT: _____

Date when operator intends to begin RNP 2 operations: _____

Is the CAAT notification date appropriate? Yes No



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PART 3. OPERATOR APPLICATION

Annex	Title	Inclusion by Operator	Comments by Inspector
A	Request for authorization		
B	Aircraft group Statement by the operator to which group the aircraft/RNP system combinations belong.		
C	Aircraft eligibility — airworthiness AFM, AFM revision, AFM supplement, TCDS showing that the aircraft RNAV systems are eligible.		
D	Aircraft eligibility — modifications (if applicable) Maintenance records documenting installation or modification of aircraft systems to achieve eligibility.		
E	Maintenance References to the RNP 2 maintenance document/programme.		
F	Minimum equipment list		



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Annex	Title	Inclusion by Operator	Comments by Inspector
G	Training xxx91/GA operators or equivalent: <ul style="list-style-type: none">• <i>course completion records.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none">• <i>training programmes for flight crew, flight dispatchers and maintenance personnel.</i>		
H	Operating policies and procedures xxx91/GA operators or equivalent: <ul style="list-style-type: none">• <i>extracts from the operations manual corresponding to the application.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none">• <i>operations manual and checklists.</i>		
I	Validation flight plan As required.		

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Contents of the application to be submitted by the operator

- *compliance documentation for the aircraft/navigation systems;*
- *operating procedures and policies;*
- *sections of the maintenance manual related to LRNS (if not previously reviewed).*

Note.— Documents may be grouped in a single binder or may be submitted as individual documents.

PART 4. CONTENTS OF THE OPERATOR APPLICATION

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 2)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Authorization request Statement of intent to obtain authorization.					
2	Aircraft/navigation system eligibility Documents that establish eligibility.	2.3.2.2	5.2.1			



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		(Doc 9613, Volume II, Part C, Chapter 2)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
3	Training Details of courses completed (xxx91 operators). Details of training programmes (xxx121 and xxx135 operators).	2.3.2.3.2 2.3.5	5.2.2.2 5.5			
4	Operating policies and procedures Extracts from the operations manual or other documentation (xxx91 operators). Operations manual and checklists (xxx121 and xxx135 operators).	2.3.2.3.3	5.2.2.3 5.4			
5	Maintenance practices Document references for RNP 2 maintenance practices.	2.3.2.3.5	5.2.2.5			
6	MEL update	2.3.2.3.4	5.2.2.4			

PART 5. OPERATING PROCEDURES

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition /comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 2)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Flight planning					
1a	Verify that the aircraft is approved for RNP 2 operations.	2.3.4.1 2.3.4.4.2	5.4.1 5.4.4.2			
1b	Verify that the navigation database is current	2.3.4.2.2 2.3.4.4.3	5.4.2.2 5.4.4.3			
1c	Verify the availability of FDE	2.3.4.3	5.4.3			
1d	Verify the FPL: R" should appear in field 10 and PBN/TBA in field 18.	2.3.4.2.1	5.4.2.1			
1e	Verify equipment conditions:	2.3.4.2.2	5.4.2.2			

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition / comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 2)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
2	En-route					
	Use an appropriate display.	2.3.3.6	5.4.4.6			
	Use appropriate scaling	2.3.3.6	5.4.4.6			
2c	ATC notified if unable to comply with the requirements for RNP or of any deviation required for a contingency.	2.3.4.5	5.4.5			
2d	Follow route centre line within 1 NM.	2.3.4.4.7	5.4.4.7			
	Do not modify the flight plan in the RNAV system after ATC heading assignment until a clearance is received to re-join the route or a new clearance is	2.3.4.4.9	5.4.4.9			
1	Contingencies	(Doc 4444 chapter 15)				
1a	Inability to comply with ATC clearance due to meteorological conditions, aircraft performance or	15.2.1.1	9.1.1.1			
1b	Weather deviation.	15.2.3	9.2.3			
1c	Air-ground communications failure.	15.3	9.3			

4.6. RNP1

4.6.1. General

4.6.1.1. RNP 1 is intended to support arrival and departure procedures using GNSS positioning only.

4.6.1.2. Other than the sole requirement for GNSS there is no significant difference between the RNAV 1 and RNAV 2 specification and RNP 1.

4.6.2. Maintaining 1 NM scaling

4.6.2.1. Stand-alone basic GNSS receiver

4.6.2.1.1. The most basic qualifying system is a stand-alone GNSS receiver (TSO C129(a) or equivalent) which should be coupled to a CDI or HSI display providing course guidance and cross-track deviation indications. The receiver normally incorporates a self-contained control and display unit, but the interface may also be provided by a separate CDU.

4.6.2.1.2. In this arrangement the RNP 1 capability is provided when in terminal mode. In terminal mode:

- a) cross-track deviation display scaling is automatically set at ± 1 NM full-scale deflection;
- b) alert is automatically set to 1 NM (RAIM alert limit).

4.6.2.1.3. In the default mode (en-route) CDI scaling increases to ± 5 NM and HAL increases to 2 NM. Terminal mode cannot be manually selected but will be system-selected provided certain conditions exist.

4.6.2.1.4. For departure, provided the current flight plan includes the departure airport (usually the ARP), terminal mode will be active and annunciated. In the general case terminal mode will automatically switch to en-route mode at 30 NM from the departure ARP. If the RNP

1 SID extends past 30 NM, the CDI scaling will no longer be adequate to support the required FTE limit (± 0.5 NM), and flight crew action will be necessary to manually select ± 1 NM CDI scaling.

4.6.2.1.5. On arrival, provided the current flight plan route includes the destination airport (ARP), the receiver will automatically switch from en-route to terminal mode at 30 NM from the ARP. If the STAR commences at a distance greater than 30 NM radius from the destination, then en-route CDI scaling of ± 5 NM is inadequate for RNP 1 and must be manually selected to ± 1 NM.

Note 1. Manual selection of ± 1 NM CDI scaling (terminal scaling) does not change the mode, and en-route RAIM alert limits apply.

Note 2.— If manual selection of ± 1 NM is not available, crew procedures to maintain FTE at ± 0.5 NM may be considered an acceptable means of compliance.

4.6.2.2. FMS systems

4.6.2.2.1. Aircraft equipped with an FMS normally integrate positioning from a number of sources (radio NAVAIDS and GNSS) with the IRS.

4.6.2.2.2. In such systems, the navigation capability, alerting and other functions are based upon an RNP value, which may be a default value for a given operation, a pilot selected value or a value extracted from the navigation database.

4.6.2.2.3. There is normally no automatic mode switching (as in the case of a stand-alone receiver), although the default RNP may vary with the phase of flight, and numerical across-track deviation displays may be deemed acceptable.

4.6.3. De-selection of radio updating

There is a possibility of position errors caused by the integration of GNSS data with other positioning data and the potential need for de-selection of other navigation sensors. While it is unlikely that any reduction in positioning accuracy will be significant in proportion to the required RNP 1 navigation accuracy, this should be confirmed. Otherwise, a means to deselect other sensors should be provided and the operating procedures should reflect this.

RNP 1 JOB AID

APPLICATION TO CONDUCT RNP 1 OPERATIONS

1. Purpose of the job aid
 - a) To provide information on the relevant reference documents.
 - b) To provide a record of the operator application, the inspector comments and the operator follow-up action for each relevant paragraph in the reference document(s).

2. Actions recommended for the inspector and operator
 - a) At the pre-application meeting, the operator and the inspector review the approval process events and establish the form and content of the approval application.
 - b) The operator records references to material in company documents for each relevant paragraph in the job aid.
 - c) The operator submits to the inspector the completed job aid with the application.
 - d) The inspector records his/her findings for each relevant paragraph in the job aid indicating compliance or necessary corrective action.
 - e) The inspector informs the operator as soon as possible when a corrective action is required.
 - f) The operator provides the inspector with the revised material when so requested.
 - g) The CAAT provides the operator with the operations specifications (Ops Specs) or letter of authorization (LOA), as applicable, when the tasks and documents have been completed.



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Part	Topic	page
1	General information	
2	Aircraft and operator identification	
3	Operator application	
4	Contents of the operator application	
5	Basic pilot procedures	
6	Contingency procedures	

Reference documents

Publisher	Reference	Title
ICAO	Annex 2	Rules of the Air
	Annex 6	Operation of Aircraft
	Doc 4444	Procedure for Air Navigation Services — Air Traffic Management
	Doc 7030	Regional Supplementary Procedures
	Doc 9613	Performance-based Navigation (PBN) Manual
FAA	AC 90-105()	Approval of Area Navigation Systems for Use in the U.S. National Airspace System
	14 CFR Part 121, Subpart G	Manual Requirements
EASA	AMC 20-5 (Revised material expected in 2015)	Airworthiness Approval and Operational Criteria for the use of NAVSTAR Global Positioning System (GPS)
CASA	AC 91U-II-C-3 (draft)	Navigation Authorizations — RNP 1
ICAO (SAM)	AC 91-006	Aircraft and Operators Approval for Basic-RNP 1 Operations



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PART 1. GENERAL INFORMATION BASIC EVENTS OF THE APPROVAL PROCESS

	Action by operator	Action by Inspector
1	Establish the need for the authorization.	
2	Review the AFM, AFM supplement, TC data sheet, other appropriate documents (e.g. STCs, SBs, SLs) to determine aircraft eligibility. If necessary contact the aircraft and/or avionics OEM to confirm eligibility.	
3	Schedule a pre-application meeting with the inspector.	
4		During the pre-application meeting establish: <i>form and contents of the application;</i> <i>documents required to support the application;</i> <i>target date for the application submission;</i> <i>requirement for flight validation.</i>
5	Submit the application at least XX days prior to start-up of the planned operations.	
6		Review submission.
7	Ensure that amendments to manuals, programmes and other relevant documents are complete; provide training to flight crews, flight dispatchers and maintenance personnel; if required, conduct a validation flight.	If required, participate in the validation flight.
8		Once the requirements have been met, issue operational approval.



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PART 2. IDENTIFICATION OF AIRCRAFT AND OPERATORS

Name of Operator: _____

Aircraft manufacturer, model and series	Registration number	Serial number	Long-range navigation system manufacturer, model and number	PBN specification

Date of pre-application meeting: _____

Date when application received by CAAT: _____

Date when operator intends to begin RNP 1 operations: _____

Is the CAAT notification date appropriate? Yes No



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PART 3. OPERATOR APPLICATION

Annex	Title	Inclusion by Operator	Comments by Inspector
A	Request for authorization		
B	Aircraft eligibility airworthiness AFM, AFM revision, AFM supplement, TCDS showing that the aircraft RNAV systems are eligible.		
C	Aircraft eligibility - modifications (if applicable) Maintenance records documenting installation or modification of aircraft systems to achieve eligibility.		
D	Maintenance Navigation database maintenance practices.		
E	Minimum equipment list		
F	Training xxx91/GA operators or equivalent: <ul style="list-style-type: none">• <i>course completion records.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none">• <i>training programmes for flight crew, flight dispatchers and maintenance personnel.</i>		
G	Operating policies and procedures xxx91/GA operators or equivalent: <ul style="list-style-type: none">• <i>extracts from the operations manual corresponding to the application.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none">• <i>operations manual and checklists.</i>		

Contents of the application to be submitted by the operator

- *compliance documentation for the aircraft/navigation systems;*
- *operating procedures and policies;*
- *sections of the maintenance manual related to LRNS (if not previously reviewed).*

Note.— Documents may be grouped in a single binder or may be submitted as individual documents.

PART 4. CONTENTS OF THE OPERATOR APPLICATION

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 3)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Authorization request Statement of intent to obtain authorization.					
2	Aircraft/navigation system eligibility Documents that establish eligibility.	3.3.2.3.2 3.3.5	6.2.1			
3	Training Details of courses completed (xxx91 operators). Details of training programmes (xxx121 and xxx135 operators).	3.3.2.3.2 3.3.5	6.2.2.2 6.5			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 3)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
4	Operating policies and procedures Extracts from the operations manual or other documentation (xxx91 operators). Operations manual and checklists (xxx121 and xxx135 operators).	3.3.2.2.3	6.2.2.3 6.4			
5	Maintenance practices Document references for navigation database maintenance practices.	3.3.2.3.5 3.3.6	6.2.2.5			
6	MEL update	3.3.2.3.4	6.2.2.4			

PART 5. OPERATING PROCEDURES

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 3)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Flight planning					
1a	Verify that the aircraft is approved for RNP 1 operations.	3.3.5.1	6.4.1			
1b	Verify RAIM availability	3.3.5.2.3 3.3.5.3	6.4.3			
1d	Verify that the navigation database is current	3.3.5.2.2	6.4.3			
1e	Verify the FPL: R" should appear in field 10 and PBN/O2 in field 18.	3.3.5.2.1	6.4.2.1			
2	General operating procedures		6.4			
2a	Comply with the manufacturer's instructions/procedures.	3.3.5.4.1	6.4.4.1			
2b	Advise ATC if unable to comply with the requirements for RNP 1	3.3.5.4.2	6.4.4.2			
2c	Verify aircraft position and entry of assigned	3.3.5.4.3	6.4.4.3			
2d	Retrieve SIDs/STARs only from the database.	3.3.5.4.4	6.4.4.4			
2e	Cross-check the chart with the RNAV system display.	3.3.5.4.5	6.4.4.5			

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter3)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
2f	Cross-check with conventional NAVAIDS to monitor for navigational reasonableness.	3.3.5.4.6	6.4.4.6			
2g	Use an appropriate display.	3.3.5.4.7	6.4.4.7			
2h	Use appropriate scaling.	3.3.5.4.7	6.4.4.7			
2i	Follow route centre line within 0.5 NM.	3.3.5.4.8	6.4.4.8			
2j	Do not modify the flight plan in the RNAV system after ATC heading assignment until a clearance is received to re-join the route or a new clearance is confirmed.	3.3.5.4.9	6.4.4.9			
2	If RNP input is required, select RNP 1 or lower.	3.3.5.5	6.4.5			
3	RNP 1 SID requirements					
3a	Prior to take-off check the RNAV system, aerodrome and procedure loaded and the displayed position.	3.3.5.6.1	6.4.6.1			
3b	Engage LNAV no later than 500 ft above aerodrome elevation.	3.3.5.6.2	6.4.6.2			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter3)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
3c	Use an authorized method to achieve RNP 1 (AP/FD/Map/L/DEV indicator).	3.3.5.6.3 3.3.5.6.5	6.4.6.3 6.4.6.5			
3d	If GNSS, signal must be acquired before start of take- off roll.	3.3.5.6.4	6.4.6.4			
3e	RNP 1 STAR requirements					
4a	Verify that the correct STAR is loaded and displayed.	3.3.5.7.1	6.4.7.1			
4b	Contingency preparations.	3.3.5.7.3	6.4.7.3			
4c	Procedure modifications in response to ATC instructions.	3.3.5.7.4	6.4.7.4			
4d	Verify the correct operation of the navigation system and that the correct procedure, transition and runway are loaded.	3.3.5.7.5	6.4.7.5			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter3)*	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
4e	Observance of speed and altitude constraints.	3.3.5.7.6	6.4.7.6			
4f	If the procedure is more than 30 NM from ARP use FD/AP or set FSD to 1 NM.	3.3.5.7.7	6.4.7.7			
1	Contingencies					
1a	Advise ATC if unable to comply with the requirements for RNP 1.	3.3.5.8.1	6.4.8.1			
1b	Air-ground communications failure.	3.3.5.8.2 (Doc 4444 Chapter 15, 15.3)	6.4.8.2			

**All references are to Doc 9613, Volume II, Part C, Chapter 3, unless otherwise indicated.*

4.7. RNP APCH

4.7.1.1.1. General

4.7.1.2.RNP APCH is the general designator for PBN approach procedures that are not authorization required operations

4.7.1.3.GNSS is used for all RNP APCH applications as follows:

- a) RNP APCH – LNAV — lateral positioning with GNSS (basic constellation);
- b) RNP APCH – LNAV/VNAV — lateral positioning with GNSS, vertical positioning with barometric inputs;
- c) RNP APCH – LPV — lateral and vertical positioning with SBAS;
- d) RNP APCH – LP — lateral positioning with SBAS.

4.7.1.4.The current version of the PBN Manual addresses only LNAV and LNAV/VNAV procedures; the next version will include LP and LPV procedures.

4.7.1.5.The published RNP APCH OCA/H are treated as:

- a) MDA/H for LNAV and LP minima;
- b) DA/H for LNAV/VNAV and LPV minima.

Operators currently approved to conduct RNAV(GNSS) approaches should qualify for RNP APCH LNAV without further examination.

4.7.2. System requirements

4.7.2.1.The RNP APCH system requirements are as follows:

- a) a single area navigation system;
- b) GNSS sensor only — receivers must be approved in accordance with ETSO-C129(a), TSO-C129(a) or later;

- c) a navigation database containing the approach procedures;
- d) continuous indication of aircraft position relative to track to be displayed to the pilot flying (and the pilot not flying) on a navigation display situated in the primary field of view;
- e) identification of active waypoint;
- f) display of distance and bearing to the active (To) waypoint;
- g) display of ground speed or time to the active (To) waypoint;
- h) lateral deviation display must have scaling and FSD suitable for RNP APCH — the maximum FTE permitted is:
 - 1. 0.5 NM for initial, intermediate and missed approach;
 - 2. 0.25 NM for final approach;

Note. — Angular display systems may be considered.

- i) automatic leg sequencing and fly-by or flyover turn functionality;
- j) execution of leg transitions and maintenance of tracks consistent with ARINC 424:
 - 1. CA/FA;
 - 2. CF;
 - 3. DF;
 - 4. HM;
 - 5. IF;
 - 6. TF;
- k) area navigation system failure indication;
- l) indication when NSE alert limit is exceeded.

4.7.3. RNP APCH systems

There are two categories of RNP APCH systems. Although both types of navigation systems have similar capabilities there are significant differences in functionality, cockpit displays and flight crew procedures.

4.7.3.1. Stand-alone systems

4.7.3.1.1. These types of systems are commonly represented by a panel-mounted, self-contained unit comprising a GNSS receiver incorporating a control unit, a lateral deviation indicator and an annunciator panel. In some cases the unit may also include a map display.

4.7.3.1.2. Mode switching from en-route, to terminal and to approach is automatic, provided a suitable flight plan is loaded which enables the receiver to identify the destination airport. CDI scaling automatically reduces from ± 5 NM en-route mode scaling to ± 1 NM terminal mode scaling at 30 NM from the ARP. The RAIM alert limit reduces similarly from 2 NM en-route mode to 1 NM terminal mode.

4.7.3.1.3. At 2 NM from the FAF, the receiver checks that approach RAIM will be available, and the CDI scaling gradually reduces to ± 0.3 NM. Any off-track deviation as the FAF is approached will be exaggerated as CDI scaling changes, and the flight crew can be misled if the aircraft is not flown accurately or if the effect of scale change is not understood.

4.7.3.1.4. If “approach” is not annunciated before crossing the FAF the approach must be discontinued.

4.7.3.1.5. During the approach, distance to run is given to the “next WPT” in the flight plan and not to the runway. Minimum altitudes are commonly specified at a waypoint or at a distance from a waypoint. Situational awareness can be difficult, and it is not uncommon for pilots to confuse the current segment and descend prematurely.

4.7.3.1.6. cross-track deviation should be limited to a one-half scale deflection (0.5 NM) on initial/intermediate/ missed approach segments and 0.25 NM on final. A missed approach should be conducted if these limits are exceeded.

4.7.3.1.7. At the MAPt, which is commonly located at the runway threshold, waypoint sequencing is inhibited, on the assumption that the aircraft is landing. If a missed approach is conducted, pilot action is normally required to sequence to the missed approach. Depending on the procedure design, track guidance may not be provided in the missed approach. Crews need to understand the navigation indications that are provided and the appropriate technique for managing the missed approach.

4.7.3.1.8. The receiver automatically reverts to terminal mode when the missed approach is sequenced.

4.7.3.1.9. FMS LNAV systems

4.7.3.1.10. Positioning data, including GNSS, is commonly combined with IRS and radio position to compute an FMS position. The GNSS receiver, which may be separate or part of a multi-mode receiver, provides position data input but does not drive automatic mode switching or CDI scaling. Navigation system integrity may be based on RAIM, but more commonly is provided by a hybrid IRS/GNSS system, which can provide significantly improved integrity protection and availability.

4.7.3.1.11. Most FMS aircraft are not equipped with a CDI-type, non-numerical lateral deviation indicator, although some manufacturers offer a lateral deviation indicator as an option. Where a lateral deviation indicator is provided, the scaling is determined by the manufacturer and may be either a fixed-scale or a non-scaled system. Lateral deviation scales may be available (either automatic or selectable) only for certain phases of flight. Automatic scaling similar to stand-alone systems is not provided.

4.7.3.1.12. Lateral deviation in this type of system is commonly displayed as a digital cross-track deviation on a map display. Digital cross-track deviation is normally displayed in one-tenth of an NM, although one-hundredth of an NM is often available as an option. Digital cross-track deviation may also be subject to rounding. For example where the display threshold is set at 0.15 NM on a display capable of only 1 decimal place, the first digital indication of cross-track deviation is displayed as 0.2 NM. In the same example, as cross-track deviation is reduced, the lowest value displayed is 0.1 NM rounded down when the actual deviation reaches 0.15 NM.

4.7.3.1.13. Monitoring of deviations within the limits of the navigation specification (0.15 NM on final approach) using digital cross-track indications alone can be difficult in some cases. In the example in the previous paragraph the first digital indication of cross-track error is displayed at 0.2 NM (although this indication is initiated at 0.15). However, a relative or graphical indication of cross-track error can be derived from the relative position of the aircraft symbol to the flight plan track on the navigation display. For this method to be satisfactory, the size and resolution of the map display needs to be sufficient, and a suitable map scale must be selected.

4.7.3.1.14. A go-around should be conducted if the cross-track error reaches 1 x RNP unless the pilot has in sight the visual references required to continue the approach.

4.7.3.1.15. Modern, large-screen (10 inch), multi-function displays at 10 NM range are generally satisfactory, and small deviations can be estimated sufficiently accurately to provide good initial indication of track divergence. Older and smaller displays, including LCD-type displays, can be less effective and subject to variation (jumping) in displayed position.

4.7.3.1.16. Additional cross-track deviation information may also be available on the CDU/MCDU which, although outside the normal field of view, can be monitored by the PM. In such cases the evaluation of cockpit displays must also take into consideration the crew operation procedures, callouts, etc.

4.7.3.1.17. In the evaluation cross-track deviation monitoring, it should be noted that use of autopilot or flight director for normal operations results in little or no cross-track deviation. The evaluation should therefore concentrate on determining whether the crew has sufficient indications to detect and manage any deviation in that unlikely event.

4.7.3.1.18. Navigation system alerting varies between aircraft systems and, unlike stand-alone systems, is driven by logic determined by the OEM. The basics of the alerting system must be understood, and the operator's flight crew procedures and training must be consistent with the particular aircraft system.

4.7.3.1.19. The most common method to manage RNP is to select RNP 0.3 prior to the IAF and retain that selection throughout the approach and missed approach. In some cases a default RNP for approaches may apply, and it is sufficient that the crew confirms the correct RNP is available. In other cases crew selection of RNP 0.3 prior to commencement of the approach will be necessary. Changing the RNP after passing the IAF is not recommended because it increases crew workload, introduces the opportunity for error (forgetting to change the RNP) and provides little or no operational advantage. For RNP 0.3 operations, availability is normally close to 100 per cent, and although RNP 0.3 may not be required for the majority of the approach (initial/intermediate segments), the probability of an alert due to the selection of a lower than necessary RNP is extremely low, especially as prediction for RNP 0.3 availability is required to conduct an approach.

4.7.3.1.20. Some systems allow the RNP to be automatically extracted from the navigation database.

4.7.3.2. FMS LNAV/VNAV systems

4.7.3.2.1. Barometric VNAV (baro-VNAV) is commonly available on FMS- equipped aircraft. SBAS equipment can also provide a VNAV functionality. Aircraft in the general aviation, commuter and light airline categories are generally not equipped with an integrated LNAV/VNAV system.

4.7.3.2.2. Most RNP APCH – LNAV approach procedures are published with an optimum approach gradient (normally 3 degrees) which clears all minimum obstacle clearance altitudes. Navigation database coding normally supports a flight path angle where identified on the instrument approach chart. It is recommended that VNAV is used, where available, as a vertical advisory to manage the approach and assist in flying a stabilized constant descent final approach.

4.7.3.2.3. Use of VNAV in this way does not absolve the crew from the responsibility to ensure obstacle clearance is maintained through the strict adherence to minimum attitudes by use of the pressure altimeter. Descent is made to the LNAV minima which is an MDA.

4.7.3.2.4. Where an LNAV/VNAV minimum is published, the procedure has been designed as a vertically guided approach and shall be flown only by approved LNAV/VNAV-equipped aircraft. Descent is made to the LNAV/VNAV minimum, which is a DA.

4.7.3.2.5. RNP APCH – LNAV/VNAV procedures are currently based upon the use of baro-VNAV. If the design is suitable for SBAS-equipped aircraft it will be annotated on the chart.

4.7.3.2.6. The design of the vertical flight path takes account of the cold temperature effects on barometric altimetry as well as the effect of any along- track error in the determination of the vertical path (horizontal coupling effect). The minimum temperature for which the procedure has been designed is promulgated on the chart.

4.7.3.2.7. Temperature-compensated VNAV systems, which enable the designed vertical flight path to be flown irrespective of temperature, do exist but such equipment is not widespread.

4.7.3.2.8. When conducting an LNAV/VNAV approach adherence to the vertical flight path within reasonable tolerance is required. Vertical deviations from the defined path should be limited to ± 75 ft. Transient deviations above +75 ft, associated with aircraft configuration changes are acceptable; however any deviation below -75 ft on final approach requires an immediate go-around unless the pilot has in sight the visual references required to continue the approach.

Note.— Many approvals have been granted on the basis of a +100 ft/-50 ft vertical FTE requirement from Doc 9613, first edition.

4.7.3.2.9. The operational approval needs to carefully examine the aircraft capability, VNAV functionality, mode selection and annunciation, mode reversion, operating procedures and crew knowledge and training. Because the flight path guidance provided by a barometric VNAV system is directly affected by the barometric pressure subscale setting, particular attention needs to be paid to pressure setting procedures and associated aircraft systems.

4.7.4. GNSS availability prediction

4.7.4.1. The availability of RNP APCH operations depends upon the availability of FD RAIM with 0.3 NM HPL. The prediction should be based on the latest satellite health data, which is readily available, and may take into account other factors such as high terrain. On-board prediction programmes are generally unsatisfactory in that they are unable to take account of satellite NOTAMs. Prediction services are available from commercial sources.

4.7.4.2. An operation is not available or should be discontinued when an alert is displayed to the flight crew. While satellite prediction services are normally accurate and reliable, it should be noted that an unpredicted loss of service can occur at any time.

4.7.5. Radio updating

4.7.5.1. The navigation specification permits the integration of other navigation sensor information with GNSS, provided the TSE is not exceeded. Where the effect of radio updating cannot be established, inhibiting of radio updating is required.

4.7.5.2. If it can be determined that radio updating has no detrimental effect on the accuracy of the computed position, then no action is required.

4.7.6. Operating procedures

Most manufacturers have developed recommended procedures for RNAV(GPS)/RNAV(GNSS) procedures. Although the manufacturer's recommendations should be followed, the operational approval should include an independent evaluation of the operator's proposed procedures. RNP APCH operating procedures should be consistent with the operator's normal procedures where possible in order to minimize any human factors elements associated with the introduction of PBN operations.

4.7.6.1. Procedure selection and review

4.7.6.1.1. Operating procedures should address the selection of the approach from the navigation database and the verification and review of the displayed data.

4.7.6.1.2. The instrument approach chart will contain, for example, RNAV(GNSS)z RW20R in the title and the clearance issued will be to RNAVz RWY20R. Due to avionics limitations the available approaches may be displayed in an abbreviated format, e.g. RNVZ. In some cases the multiple indicators (x, y and z) may not be supported. Flight crew procedures must take these limitations into account to ensure that the correct procedure is selected and then checked.

4.7.6.2. Use of autopilot and flight director

The manufacturer's guidance will normally provide recommendations on the use of auto-pilot and/or flight director.

4.7.6.3. GNSS updating

4.7.6.3.1. RNP APCH procedures are dependent on GNSS positioning, and the availability of GNSS (as well as the available level of RNP) should be checked prior to commencement of an approach.

4.7.6.3.2. The failure of a GNSS receiver (i.e. an equipment failure) should be annunciated. Where dual GNSS receivers are installed, the approach can continue normally using the serviceable receiver.

4.7.6.3.3. A loss of GNSS updating due to a loss of signal may occur at any time, but an alert will not normally be generated immediately. Where position integrity can be maintained following the loss of GNSS, a valid position will continue to be displayed.

4.7.6.3.4. When the required performance cannot be sustained, an alert will be generated. A go-around should be initiated unless the approach can be completed visually.

4.7.6.3.5. Inspectors should be familiar with the alerting system applicable to the specific aircraft under consideration to ensure that operating procedures and crew knowledge and training are consistent with the system functionality.

4.7.7. Flight crew knowledge and training

Successful RNP APCH – LNAV and LNAV/VNAV approach operations depend on sound flight crew knowledge and training. The type of navigation system has a significant effect on the conduct of this type of procedure, and flight training must take this factor into account. Crews operating aircraft equipped with basic stand-alone systems typically require significantly more flight training than crews operating FMS-equipped aircraft. The amount of training will vary depending on the flight crew's previous area navigation experience. However the following is provided as a guide.

4.7.7.1. Ground training

Ground training, including computer-based training and classroom briefings, should comprise all elements of the syllabus stated in the PBN Manual.

4.7.7.2.Simulator training

Simulator training shall include all new elements required for the intended operation. For FMS systems operated by crews with experience in the use of the FMS for the conduct of conventional approach procedures, a pre-flight briefing session and one simulator session of 2 to 4 hours per crew may be sufficient. For operators of stand-alone systems, simulator or flight training may require 2 or more training sessions. Proficiency may be achieved in normal uncomplicated operations in a short period of time; however additional flight time needs to be scheduled to ensure competency in the management of approach changes, go-around, holding and other functions, including due consideration of human factors. Where necessary, initial training should be supplemented by operational experience in VMC or under supervision.

4.7.8. Navigation database

4.7.8.1.RNP APCH operations are critically dependent on valid data.

4.7.8.2.Although the navigation database should be obtained from a qualified source, operators must also have procedures in place for the management of data. Experienced area navigation operators who understand the importance of reliable data will normally have such procedures established; however less experienced operators may not fully understand the need for comprehensive management procedures and may need to develop or improve existing procedures.

4.7.8.3.It should be noted that despite the requirement for the database supplier to comply with RTCA DO- 200A/EUROCAE ED-76, data errors will still occur.

RNP APCH (PART A) JOB AID APPLICATION TO CONDUCT RNP APCH OPERATIONS

1. Purpose of the job aid
 - a) To provide information on the relevant reference documents.
 - b) To provide a record of the operator application, the inspector comments and the operator follow-up action for each relevant paragraph in the reference document(s).

2. Actions recommended for the inspector and operator
 - a) At the pre-application meeting, the operator and the inspector review the approval process events and establish the form and content of the approval application.
 - b) The operator records references to material in company documents for each relevant paragraph in the job aid.
 - c) The operator submits to the inspector the completed job aid with the application.
 - d) The inspector records his/her findings for each relevant paragraph in the job aid indicating compliance or necessary corrective action.
 - e) The inspector informs the operator as soon as possible when a corrective action is required.
 - f) The operator provides the inspector with the revised material when so requested.
 - g) The CAAT provides the operator with the operations specifications (Ops Specs) or letter of authorization (LOA), as applicable, when the tasks and documents have been completed.



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Part	Topic	page
1	General information	
2	Aircraft and operator identification	
3	Operator application	
4	Contents of the operator application	
5	Basic pilot procedures	
6	Contingency procedures	

Reference documents

Publisher	Reference	Title
ICAO	Annex 2	Rules of the Air
	Annex 6	Operation of Aircraft
	Doc 4444	Procedure for Air Navigation Services — Air Traffic Management
	Doc 7030	Regional Supplementary Procedures
	Doc 9613	Performance-based Navigation (PBN) Manual
FAA	AC 90-105()	Approval Guidance for RNP Operations and Barometric Vertical Navigation in the U.S. National Airspace System
	14 CFR Part 121, Subpart G	Manual Requirements
EASA	AMC 20-27	Airworthiness and Operational Criteria for RNP APPROACH (RNP APCH) Operations Including APV BARO-VNAV Operations
CASA	AC 91U-II-C-5 (draft) AS 91U-II-Attachment (draft)	Navigation Authorizations — RNP APCH Navigation Authorizations — APV baro-VNAV
ICAO (SAM)	AC 91-008 AC 91-010	Aircraft and Operators Approval for RNP Approach (RNP APCH) Operations Aircraft and Operators Approval for Approach Operations with Vertical Guidance/Barometric Vertical Navigation (APV/baro- VNAV)



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PART 1. GENERAL INFORMATION BASIC EVENTS OF THE APPROVAL PROCESS

	Action by operator	Action by Inspector
1	Establish the need for the authorization.	
2	Review the AFM, AFM supplement, TC data sheet, other appropriate documents (e.g. STCs, SBs, SLs) to determine aircraft eligibility. If necessary contact the aircraft and/or avionics OEM to confirm eligibility.	
3	Schedule a pre-application meeting with the inspector.	
4		During the pre-application meeting establish: <i>form and contents of the application;</i> <i>documents required to support the application;</i> <i>target date for the application submission;</i> <i>requirement for flight validation.</i>
5	Submit the application at least XX days prior to start-up of the planned operations.	
6		Review submission.
7	Ensure that amendments to manuals, programmes and other relevant documents are complete; provide training to flight crews, flight dispatchers and maintenance personnel; if required, conduct a validation flight.	If required, participate in the validation flight.
8		Once the requirements have been met, issue operational approval.



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PART 2. IDENTIFICATION OF AIRCRAFT AND OPERATORS

Name of Operator: _____

Aircraft manufacturer, model and series	Registration number	Serial number	Long-range navigation system manufacturer, model and number	PBN specification

Date of pre-application meeting: _____

Date when application received by CAAT: _____

Date when operator intends to begin RNP APCH operations: _____

Is the CAAT notification date appropriate? Yes No

PART 3. OPERATOR APPLICATION

Annex	Title	Inclusion by Operator	Comments by Inspector
A	Request for authorization		
B	Aircraft eligibility — airworthiness AFM, AFM revision, AFM supplement, TCDS showing that the aircraft RNAV systems are eligible.		
C	Aircraft eligibility — modifications (if applicable) Maintenance records documenting installation or modification of aircraft systems to achieve eligibility.		
D	Maintenance Navigation database maintenance practices.		
E	Minimum equipment list		
F	Training xxx91/GA operators or equivalent: <ul style="list-style-type: none"> • <i>course completion records.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none"> • <i>training programmes for flight crew, flight dispatchers and maintenance personnel.</i> 		
G	Operating policies and procedures xxx91/GA operators or equivalent: <ul style="list-style-type: none"> • <i>extracts from the operations manual corresponding to the application.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none"> • <i>operations manual and checklists.</i> 		



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Contents of the application to be submitted by the operator

- compliance documentation for the aircraft/navigation systems;
- operating procedures and policies;
- sections of the maintenance manual related to LRNS (if not previously reviewed).

Note.— Documents may be grouped in a single binder or may be submitted as individual documents.

PART 4. CONTENTS OF THE OPERATOR APPLICATION

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 5)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Authorization request Statement of intent to obtain authorization.					
2	Aircraft/navigation system eligibility Documents that establish eligibility.	5.3.2.2 5.3.2.3.1	7.2.1 7.2.2.1			
3	Training Details of courses completed (xxx91 operators).	5.3.2.3.2 5.3.5	7.2.2.2 7.5			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 5)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
	Details of training programmes (xxx121 and xxx135 operators).					
4	Operating policies and procedures Extracts from the operations manual or other documentation (xxx91 operators). Operations manual and checklists (xxx121 and xxx135 operators).	5.3.2.2.3	7.2.2.3 7.4			
5	Maintenance practices Document references for navigation database maintenance practices	5.3.2.3.5 5.3.9	7.2.2.5 7.6			
6	MEL update	5.3.2.3.4	7.2.2.4			



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PART 5. OPERATING PROCEDURES

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 5)	(GM Part2)			
1	Flight planning					
1a	Verify that the aircraft is approved for RNP APCH operations to LNAV or LNAV/VNAV minima.	5.3.4	7.4.1			
1b	Verify RAIM availability	5.3.4.1.3 5.3.4.2	7.4.2.3 7.4.3			
1c	Verify that the navigation database is current	5.3.4.1.1 5.3.4.1.2 a)	7.4.2.1 7.4.2.2 a)			
1d	Verify the FPL: R" should appear in field 10 and PBN/S1 (as appropriate) in field 18.	5.3.4.1.1	7.4.2.1			
2	Prior to commencing procedure					
2a	Verify that the correct procedure is loaded.	5.3.4.3.1	7.4.4.1			
2b	Cross-check the chart with the RNAV system display.	5.3.4.3.2	7.4.4.2			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 5)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
2c	Verify the GNSS sensor in use (only multi-sensor systems).	5.3.4.3.3	7.4.4.3			
2d	Input the barometric altimeter setting (only ABAS requires barometric input).	5.3.4.3.4	7.4.4.4			
2e	Perform a RAIM availability check if ETA is more than 15 minutes different from the FPL ETA (only for ABAS).	5.3.4.3.5	7.4.4.5			
2f	Do not modify the flight plan in the RNAV system after ATC heading assignment until a clearance is received to re-join the route or a new clearance is confirmed. "Direct to" clearances accepted up to IF, provided that the resulting track change at the IF does not exceed 45 degrees.	5.3.4.3.6	7.4.4.6			
2g	Do not modify the final approach segment.	5.3.4.3.7	7.4.4.7			

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 5)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
3	During procedure					
3a	Establish the aircraft on the final approach course before starting descent.	5.3.4.4.1	7.4.5.1			
3b	Verify that the approach mode is activated 2 NM prior to FAF.	5.3.4.4.2	7.4.5.2			
3c	Use an appropriate display.	5.3.4.4.3	7.4.5.3			
3d	Discontinue the approach if: <ul style="list-style-type: none"> • <i>the navigation display is flagged invalid;</i> • <i>loss of integrity alert;</i> • <i>loss of integrity alerting</i> • <i>function prior to the FAF;</i> • <i>FTE is excessive.</i> 	5.3.4.4.4	7.4.5.4			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 5)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
3e	Do not use the RNP system in missed approach if the: <ul style="list-style-type: none"> • <i>RNP system is not operational; or</i> • <i>Missed approach is not loaded from the database.</i> 	5.3.4.4.5	7.4.5.5			
3f	Follow the route centre line within 0.5/0.15/0.5 NM.	5.3.4.4.6	7.4.5.6			
3g	If baro-VNAV is used, follow vertical path ± 75 ft.	5.3.4.4.7	7.4.5.7			
3h	Execute a missed approach if the lateral or vertical deviations exceed the limits in 3f and 3g above.	5.3.4.4.8	7.4.5.8			
4	General operating procedures					
4a	Advise ATC if unable to meet the requirements for an RNP APCH.	5.3.4.5.1	7.4.6.1			
4b	Comply with the manufacturer's instructions/procedures.	5.3.4.5.2	7.4.6.2			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 5)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
4c	If the missed approach is based on conventional means, appropriate navigation equipment must be installed and serviceable.	5.3.4.5.3	7.4.6.3			
4d	Use FD or AP if available.	5.3.4.5.4	7.4.6.4			

PART 6. CONTINGENCY PROCEDURES

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 5)*	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Contingencies					
1a	Advise ATC if unable to comply with the requirements for an RNP APCH.	5.3.4.6.1	7.4.7.2			
1b	Air-ground communications failure.	5.3.4.6.2 (Doc 4444 Chapter 15, 15.3)	7.4.7.3			

**All references are to Doc 9613, Volume II, Part C, Chapter 5, unless otherwise indicated.*

4.8. RNP AR OPERATIONS

4.8.1. General

4.8.1.1. RNP AR APCH is the designator for PBN approach procedures that require additional levels of scrutiny, control and authorization. RNP AR APCH applications can range from simple straight-in approaches, with a minimum track-keeping accuracy requirement of RNP 0.3 in final approach and RNP 1 at all other times, to complex curved approaches with RF legs used in the final and the missed approach and minimum track-keeping accuracies as low as RNP 0.1. Moreover, in addition to the RNP AR APCH procedures designed according to ICAO Doc 9905, there are a number of RNP AR APCH procedures in commercial use which have been designed according to private, proprietary criteria.

4.8.1.2. GNSS, an inertial reference system and a VNAV system are required for all RNP AR APCH applications. DME/DME updating may be used as a reversionary system if the required navigation accuracy can be maintained in a specific operation, although explicit authorization is required. VOR updating shall not be used.

4.8.1.3. The published RNP AR APCH OCA/H is treated as DA/H.

4.8.2 System requirements

The RNP AR APCH system requirements are as follows:

- a) sufficient area navigation systems to meet the requirement that the probability of the aircraft exiting the lateral and/or vertical extent of the obstacle clearance volume does not exceed 10^{-7} . Loss of lateral guidance is a major failure. Loss of vertical guidance is a minor failure. Display of misleading lateral or vertical guidance is a severe, major failure for navigation accuracy less than RNP 0.3;
- b) GNSS sensors must be approved in accordance with AC 20-138() or AC 20-130(). In the event of a latent satellite failure, the probability that the aircraft will remain within the obstacle clearance volume used to evaluate the procedure must be greater than 95 per cent (both laterally and vertically);

- c) inertial reference systems must meet the criteria of U.S. 14 CFR Part 121, Appendix G; OEMs may demonstrate, and get credit for, improved performance;
- d) Class A terrain awareness and warning system (TAWS) operating independently of the captain's altimeter sub-scale setting;
- e) 95 per cent lateral system error (across track and along track) less than applicable accuracy value (0.1 NM to 1 NM);
- f) for RNP less than 0.3 (optional) and/or missed approach less than 1 (optional), dual GNSS, dual FMS, dual ADS, dual AP and at least one IRU are required; loss of display is hazardous (severe/major) condition; loss of vertical or lateral guidance is a major failure; flight guidance to stay in LNAV at go-around initiation; must be able to couple AP/FD by 400 ft AGL; must automatically revert to another means of navigation that complies with navigation accuracy on go-around following loss of GNSS;
- g) final approach vertical paths defined by flight path angle to a fix and an altitude; a 99.7 per cent vertical system error less than defined vertical error budget (VEB); where temperature-compensated systems are used, VNAV guidance must comply with RTCA/DO-236B;
- h) a navigation database containing the approach procedures, with resolution error for waypoints less than or equal to 60 ft and vertical angles less than or equal to 0.01 degrees;
- i) altitude and speed constraints for a procedure extracted from the database;
- j) magnetic variation for CF and FA legs extracted from the procedure in the database;
- k) capability to define vertical path by flight path angle to a fix and between altitude constraints at two sequential fixes;
- l) capability to display flight path angles and altitude restrictions to the pilot;
- m) capability to define a path from current position to a vertically constrained fix;
- n) continuous indication of aircraft position (lateral and vertical) relative to track to be displayed to the pilot flying (and the pilot not flying) on a navigation display situated in the primary field of view;
- o) identification of the active waypoint;
- p) display of distance and bearing to the active (To) waypoint;
- q) display of ground speed or time to the active (To) waypoint;
- r) non-numeric lateral and vertical deviation displays that must have FSDs which are

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- suitable for the lateral navigation accuracy and the 75 ft vertical accuracy — the pilot must be able to distinguish excursions beyond 1 x RNP and 75 ft;
- s) numeric display of vertical and lateral deviation; resolution 10 ft vertically, 0.1 NM for RNP greater than or equal to 0.3, 0.01 NM for RNP less than 0.3. Numeric display without a deviation indicator is not normally accepted for RNP less than 0.3;
 - t) display of barometric altitude from two independent altimetry sources, one each in the primary field of view;
 - u) display of current navigation sensor in use;
 - v) automatic leg sequencing and fly-by or flyover turn functionality;
 - w) execution of leg transitions and maintenance of tracks consistent with ARINC 424:
 - FA;
 - CF;
 - DF;
 - IF;
 - RF (optional) — electronic map display required; AP/FD command bank angle of up to 8 degrees below 400 ft AGL and up to 25 degrees above 400 ft AGL; flight guidance to stay in LNAV at go-around initiation;
 - TF;
 - x) changes in alert from one navigation accuracy value to a smaller value achieved by the time the fix is reached;
 - y) area navigation system failure indication; aa) indication when NSE alert limit is exceeded.

4.8.2. RNP AR APCH operations

4.8.2.1. Pre-flight

4.8.2.1.1. Most manufacturers have developed recommended procedures for RNP AR APCH procedures. Although the manufacturer's recommendations should be followed, the operational approval should include an independent evaluation of the operator's proposed procedures. RNP AR APCH operating procedures should be consistent with the operator's normal procedures where possible in order to minimize any human factors elements associated with the introduction of PBN operations.

4.8.2.1.2. RNP AR APCH procedures are designed as vertically guided approaches and shall be flown only by suitably qualified aircraft and approved crews. The MEL shall clearly identify the required equipment which may include dual GNSS, dual FMS, dual ADS, dual AP, at least one IRU and a Class A TAWS.

4.8.2.1.3. A pre-flight prediction of the anticipated RNP availability at the destination aerodrome is required. The prediction should be based on the latest satellite health data and a mask angle of at least 5 degrees, which should be increased, as necessary, to cater for high terrain.

4.8.2.1.4. Crew procedures must be established to exclude NAVAID facilities in accordance with NOTAMs.

4.8.2.1.5. The navigation database must be current and the procedure must have been validated for use by the operator.

4.8.2.2. Procedure selection and review

4.8.2.2.1. Operating procedures should address the selection of the approach from the navigation database and the verification and review of the displayed data.

4.8.2.2.2. The instrument approach chart will contain, for example, RNAV(RNP)*z* RW20R in the title and the clearance issued will be to RNAV*z* RWY20R. Due to avionics limitations the available approaches may be displayed in an abbreviated format, e.g. RNVZ. In some cases the multiple indicators (*x*, *y* and *z*) may not be supported. Flight crew procedures must take these limitations into account to ensure that the correct procedure is selected and then checked. Attention should also be paid to the desired navigation accuracy — if the RNP is not automatically extracted from the database, there should be a crew procedure for entering it manually. The minimum navigation accuracy set must be compatible with the aircraft/crew qualification and briefed decision altitude.

Note.— An ICAO Circular is being developed which will provide guidance to assist States and other stakeholders with the transition from RNAV to RNP approach chart identification.

4.8.2.2.3. The lateral path of the procedure shall not be modified with the exception of direct to clearances to waypoints prior to the FAF that are not the start of an RF leg. Altitude and speed constraints may be altered to comply with ATC instructions.

4.8.2.3. GNSS updating

4.8.2.3.1. RNP AR APCH procedures are dependent on GNSS positioning, and the availability of GNSS (as well as the available level of RNP) should be checked prior to commencement of an approach.

4.8.2.3.2. The failure of a GNSS receiver (i.e. an equipment failure) should be annunciated. Where dual GNSS receivers are installed, the approach can usually continue normally using the serviceable receiver.

4.8.2.3.3. A loss of GNSS updating due to a loss of signal may occur at any time, but an alert will not normally be generated immediately. Where position integrity can be maintained following the loss of GNSS a valid position will continue to be displayed.

4.8.2.3.4. When the required performance cannot be sustained, an alert will be generated. A go-around should be initiated unless the approach can be completed visually.

4.8.2.3.5. Inspectors should be familiar with the alerting system applicable to the specific aircraft under consideration to ensure that operating procedures and crew knowledge and training are consistent with the system functionality.

4.8.2.4. Radio updating

Although RNP AR APCH procedures are based upon GNSS positioning, it may be possible to use DME/DME as a reversionary system if there is adequate cover and the aircraft is qualified. VOR updating is not authorized and may need to be inhibited.

4.8.2.5. Track deviation monitoring

4.8.2.5.1. Lateral deviation shall be limited to one-half RNP on straight legs and RF legs; brief deviations up to a maximum of 1 x RNP are allowed during fly- by and flyover turns. The pilot must ensure that the appropriate scaling is selected in the lateral deviation indicator when the means for selection are available.

4.8.2.5.2. Vertical deviations from the defined path should be limited to ± 75 ft. Transient deviations above +75 ft, associated with aircraft configuration changes are acceptable; however, with the exception of vertical fly-bys, any deviation below -75 ft on final approach requires an immediate go-around unless the pilot has in sight the visual references required to continue the approach. Vertical fly- by guidance at a fix may result in momentary deviations of up to 100 ft.

4.8.2.5.3. For RNP less than 0.3, the pilot must check that the lateral and vertical guidance are consistent with other independent data sources.

4.8.2.5.4. If the deviation exceeds 1 x RNP, or -75 ft, and the pilot does not have adequate visual references in sight, a missed approach must be executed.

4.8.2.5.5. The design of the vertical flight path takes account of the cold temperature effects on barometric altimetry as well as the effect of any along- track error in the determination of the vertical path (horizontal coupling effect). The minimum temperature for which the procedure has been designed is promulgated on the chart.

4.8.2.5.6. Temperature-compensated VNAV systems and systems using GNSS for vertical navigation (SBAS and GBAS) enable the designed vertical flight path to be flown irrespective of temperature. The pilot must be aware of the effects of cold temperature correction on intercepting the compensated path.

4.8.2.6. Altimeter settings

Current local QNH must be set prior to the FAF. A cross-check between the two pilots' altimeters, prior to the FAF but no earlier than the IAF, must agree within 100 ft. If the cross-check fails the procedure must be abandoned. A manual cross- check is not required if this is performed automatically by the system.

4.8.2.7. Airspeed

Pilots must not exceed the maximum airspeed promulgated for the aircraft category or published with the procedure. This is particularly important when flying RF legs and/or low RNP legs.

4.8.2.8. Missed approach

In aircraft where LNAV disengages at TOGA activation, the pilot shall ensure that LNAV is re-engaged as soon as possible thereafter. The operator should demonstrate that crew detection and reaction times ensure that the lateral excursion is contained within 1 x RNP wherever the go-around is initiated (this should be demonstrated in particular in the most stringent RF leg of the intended procedures).

4.8.3. Flight crew knowledge and training

Successful RNP AR APCH operations depend on sound flight crew knowledge and training. The type of navigation system has a significant effect on the conduct of this type of procedure, and flight training must take this factor into account. The amount of training will vary depending on the flight crew's previous area navigation experience; however the following is provided as a guide.

4.8.3.1. Ground training

Ground training including computer-based training and classroom briefings shall include all required elements of the syllabus detailed in the PBN Manual.

4.8.3.2. Simulator training

Briefings and simulator sessions should cover all elements of the intended operation or the minimum number of approaches stipulated in the PBN Manual. Proficiency may be achieved in normal uncomplicated operations in a short period of time; however additional flight time needs to be scheduled to ensure competency in the management of approach changes, go-around, holding and other functions, including due consideration of human factors. Where necessary

initial training should be supplemented by operational experience in VMC or under supervision. The minimum functionality of the flight simulation training device used for RNP AR APCH simulator training is listed in the Attachment to this chapter.

4.8.4. Navigation database

4.8.4.1.RNP AR APCH operations are critically dependent on valid data.

4.8.4.2.Any RNP AR APCH in the database must first be validated formally by the operator by:

- a) comparing the data in the database with the procedure published on the chart;
- b) flying the entire procedure either in a simulator or in the actual aircraft in VMC to ensure that there is complete consistency and there are no disconnects;
- c) comparing subsequent database updates with the validated master
- d) to ensure that there are no discrepancies.

4.8.4.3.The navigation database shall be obtained from a qualified source, and operators must also have procedures in place for the management of data.

4.8.4.4.Even qualified database suppliers who comply with RTCA DO-200A/ EUROCAE ED/76 cannot guarantee that the databases will be error-free. Operators must have procedures in place to ensure, for every AIRAC, that the RNP AR procedure in the database is exactly the same as the RNP AR procedure that was initially validated.

4.8.4.5.The RNP AR procedure design criteria in ICAO Doc 9905 assume that any event leading the aircraft to exit the lateral (2 x RNP) or vertical (VEB) extent of the obstacle clearance volume may have hazardous repercussions. In order to ensure that the TLS of the intended operation is met, the acceptability of the repercussions of aircraft failures with respect to the RNP AR application must be addressed (PBN Manual, Volume 2, RNP AR navigation specifications, 6.3.3.2.7 and 6.3.3.4.1.2.)

4.8.4.6.Demonstration of compliance with those requirements may be part of the aircraft qualification criteria assessed during the airworthiness approval or may be the subject of a

demonstration as part of the operational approval.

4.8.4.7. Whatever the methodology followed, operational approval stakeholders should ensure that the aircraft compliance documented in the airworthiness approval or the demonstrated compliance performed during the operational approval properly satisfies the 10–7 RNP AR lateral and vertical airspace containment limits. The applicant should demonstrate that any contingency procedures and operational limitations used to satisfy this objective are well understood and are applied by the applicant’s flight crews. Furthermore, when States have decided to implement a “State-wide” RNP AR operational approval process, stakeholders should ensure that any demonstration is representative and is applicable to all public RNP AR procedures, including the most challenging ones.

4.8.4.8. The CAAT should ensure that a clear statement is available from the applicant as to whether the aircraft State of Design approval has included the demonstration of compliance in the airworthiness approval of the aircraft or whether demonstration of compliance will be the operator’s responsibility to be satisfied during the operational approval.

- a) If the published RNP AR value in the applicant’s AFM includes the potential degradation of performance under aircraft failures and if the RNP AR level at which the aircraft has been qualified satisfies the RNP AR level required by the intended application, no additional failure demonstration should be required during the operational approval process, provided the applicant is able to give evidence through documentation obtained from the aircraft manufacturer qualification dossier.
- b) If the published RNP AR value in the applicant’s AFM does not include the potential degradation of performance under aircraft failures or if the RNP AR level at which the aircraft has been qualified does not satisfy the RNP AR level required by the intended application, the CAAT must require a demonstration from the applicant, additional to the RNP AR aircraft qualification, that the containment criteria are satisfied (including consideration of engine failure in addition to system failures) for the intended application. To do so, the applicant needs to obtain from the aircraft manufacturer the detailed list of failures that may degrade the RNP AR performance. The applicant then has to assess the effect of those failures with respect to the intended operation using simulation means qualified as representative of the aircraft configuration approved for RNP AR.

In both cases, all contingency procedures and operational limitations required to support the demonstration that the TLS of the intended application is satisfied must be applied during the training programme.

4.8.5. Flight operational safety assessment (FOSA)

In certain circumstances, such as for RNP < 0.3 applications, approaches in areas of high terrain and other difficult conditions, or approaches in complex high traffic density environments, a flight operational safety assessment (FOSA) may need to be completed. Further guidance on how to conduct a FOSA is provided at Appendix E.

4.8.6. Documentation supporting the application for approval

4.8.6.1. Support data and information collated during the AR qualification and compliance assessment may include inputs from one or all of the following: aircraft manufacturer, avionics supplier and operator.

4.8.6.2. Support documentation will vary in form and location of content depending on the governing regulations, business processes and procedures, and other practices that may apply. Each is an acceptable means of compliance. The result is there will not be a 1 for 1 correlation between one manufacturer's documentation and another's, or one operator and another. However, what should be clear from any documentation set is what is relevant and applicable to the PBN application and the associated operational approval, e.g. this could range from a single document whose content clearly addresses RNP AR requirements only for regulatory approval, to a documentation set comprised of multiple documents with clearly identified sections for RNP AR indexed to the application requirements.

ATTACHMENT TO CHAPTER 4

FLIGHT SIMULATION TRAINING DEVICE FUNCTIONALITY AND QUALIFICATION FOR RNP AR APCH

1. A statement of compliance is required that attests to the fact that the simulation of the navigation systems (i.e. EGPWS, GPS, IRS, FMS) and flight guidance systems accurately replicate the operator's equipment and is based on original equipment manufacturer's (OEM) or aircraft manufacturer's design data. A statement of compliance template should be made available by the regulatory authority.
2. While there are no requirements for airport-specific models (e.g. FAA 14 CFR Part 60, Class I or Class II models) to be used in the qualification of a flight simulation training device (FSTD) for RNP AR APCH training, any visual model must employ real-world terrain modelling. Furthermore, approved RNP AR APCH applications must be used. Generic airport models may be approved for use in training where airport recognition in the visual segment portion of the RNP/AR approach is not critical to completion of the training task. In these cases, a generic airport with a real-world visual terrain model may be utilized. In addition, any terrain awareness and warning system (TAWS/EGPWS) must provide correct terrain feedback (Class A terrain display) and warnings consistent with the specific approach being trained.
3. Evidence must be provided that the FSTD is equipped and operated in accordance with a valid aircraft cockpit configuration and complies with all applicable software versions or limitations. The operator should ensure that the simulator has the capabilities to support the simulation of any manufacturer required, or operator adapted, normal and non-normal procedures, including appropriate aircraft/system-specific failures and relevant operating conditions (obtained from the appropriate OEM or vendor), for inclusion in the flight training programme.
4. The following items should be addressed in the statement of compliance:

Simulator PBN RNP AR capability

- Airframe
 - Model
 - Engines
 - Winglets
 - Other airframe unique options
- Flight guidance and flight management system
 - Part numbers for all software and hardware components
- Autoflight options
- Autothrust
- Air data system
- PFD
- Flight mode annunciation
- TAWS
 - GPS position as a direct input to keep terrain on navigation display
 - Peaks and obstacle function
 - Database currency

Operator and crew policies and procedures

- AFM or equivalent documentation providing all training assumptions taken in the framework of RNP AR qualification of the aircraft
- FCOMs
- QRH
- Checklist

Ability to generate failures and degradation

- GPS faults
- CDU faults and failures

- Display unit failures
- Flight guidance system failures
- Loss of NAV or approach modes
- Loss of deviation or performance information
- Loss of TAWS data or display
- TAWS terrain discrepancies
- Dual loss of GPS sensors
- FMS/GPS position disagreements
- FMS failures or downgrades

Visuals

- Ability to add airports to the visual database
- Use of generic airport with TAWS (possibility to set a generic visual with “flat terrain” in a way so as to avoid spurious GPWS warning or crash simulator generated by an inaccurate generic visual terrain)
- Runway coordinates must match AIP
- Visual terrain is accurate and does not cause spurious TAWS alerts (or flat terrain option in visual settings)

Navigation database considerations

- Procedure service provider/developer test databases and loading media
- Coordination required with multiple parties associated with process
 - Aircraft OEM
 - FMS/FGS vendor
 - Operator
 - FSTD vendor
 - Navigation database packing service provider
 - Flight training provider

Evaluation criteria

- Normal performance and functionality:
 - Up-to-date database with display of validity period
 - Operable Class A TAWS identical to the aircraft
 - Dual FMSs, dual GPSs, dual autopilots and at least a single IRU and all must be operable
 - Statement of compliance with the OEM systems included in the eligible configuration of RNP AR
 - aircraft qualification
 - Ability to load the entire RNP/AR approach procedure to be flown from the on-board navigation
 - database
 - Ability to verify the RNP/AR procedure to be flown through a review of the individual waypoints
 - Either an equipment capability or an operational procedure to provide a direct means of inhibiting
 - sensor updating (VOR/DME), if required
 - FSTD autopilot/flight director able to fly an RF leg, comply with the aircraft's bank angle limits, able to maintain lateral track navigation without exceeding the RNP value while encountering strong tailwinds
 - Upon initiating a go-around or missed approach (through activation of TOGA or other means), the lateral flight guidance mode should remain in LNAV. If the aircraft cannot remain in LNAV after TOGA is selected, then procedures to re-engage LNAV while remaining within 1 x RNP must be demonstrated and verified in the FSTD. The FSTD must permit re-engagement of LNAV by 400 ft AGL.
- Non-normal performance and functionality:
 - The navigation system must have the ability to monitor the achieved navigation performance and to alert the pilot when the RNP requirements are not being met (i.e. "UNABLE RNP")
 - The instructor's operating panel must have the capability to induce

the malfunction of an “UNABLE RNP” alert or other alert message that would cause a missed approach during an RNP AR APCH (e.g. FMS failure, GPS failure, AP failure, loss of guidance, loss of FD/FDE, engine failure, extreme wind/turbulence). The malfunction must appear realistic to the pilots.

- Demonstration mode:
 - The ability to demonstrate cockpit effects induced by remote or very remote failure combinations at a faster rate than real time would be advantageous, the objective being to illustrate and consolidate the theoretical knowledge received during the ground course. The FTSD should clearly indicate that the training situation is not in real time (“demo mode” displayed in front of the visual scene). Example effects could include:
- FMS/GPS position disagree
- FMS 1/FMS 2 position disagree
- Inconsistency between the terrain display and one or both FMS FPL displays
- Effect of position radio navigation update
- High/low temperature impact on non-compensated baro-VNAV FPA
- Loss of GPS, GPS primary lost, navigation accuracy downgraded
- IRS drift effect.



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RNP AR APCH JOB AID APPLICATION TO CONDUCT RNP AR APCH OPERATIONS

1. Purpose of the job aid
 - a) To provide information on the relevant reference documents.
 - b) To provide a record of the operator application, the inspector comments and the operator follow-up action for each relevant paragraph in the reference document(s).

2. Actions recommended for the inspector and operator
 - a) At the pre-application meeting, the operator and the inspector review the approval process events and establish the form and content of the approval application.
 - b) The operator records references to material in company documents for each relevant paragraph in the job aid.
 - c) The operator submits to the inspector the completed job aid with the application.
 - d) The inspector records his/her findings for each relevant paragraph in the job aid indicating compliance or necessary corrective action.
 - e) The inspector informs the operator as soon as possible when a corrective action is required.
 - f) The operator provides the inspector with the revised material when so requested.
 - g) The CAAT provides the operator with the operations specifications (Ops Specs) or letter of authorization (LOA), as applicable, when the tasks and documents have been completed.



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Part	Topic	page
1	General information	
2	Aircraft and operator identification	
3	Operator application	
4	Contents of the operator application	
5	Basic pilot procedures	
6	Contingency procedures	

Reference documents

Publisher	Reference	Title
ICAO	Annex 2	Rules of the Air
	Annex 6	Operation of Aircraft
	Doc 4444	Procedure for Air Navigation Services — Air Traffic Management
	Doc 7030	Regional Supplementary Procedures
	Doc 9613	Performance-based Navigation (PBN) Manual
FAA	AC 90-1-1()	Approval Guidance for RNP Procedures with SAAAR
	14 CFR Part 121, Subpart G	Manual Requirements
EASA	AMC 20-26	Airworthiness Approval and Operational Criteria for RNP Authorizations Required (RNP AR) Operations
CASA	AC 91U-II-C-6 (draft)	Navigation Authorizations — RNP AR Operations
ICAO (SAM)	AC 91-009	Aircraft and Operators Approval for RNP Authorization Required Approach (RNP AR APCH) Operations



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PART 1. GENERAL INFORMATION BASIC EVENTS OF THE APPROVAL PROCESS

	Action by operator	Action by Inspector
1	Establish the need for the authorization.	
2	Review the AFM, AFM supplement, TC data sheet, other appropriate documents (e.g. STCs, SBs, SLs) to determine aircraft eligibility. If necessary contact the aircraft and/or avionics OEM to confirm eligibility.	
3	Schedule a pre-application meeting with the inspector.	
4		During the pre-application meeting establish: <i>form and contents of the application;</i> <i>documents required to support the application;</i> <i>target date for the application submission;</i> <i>requirement for flight validation.</i>
5	Submit the application at least XX days prior to start-up of the planned operations.	
6		Review submission.
7	Ensure that amendments to manuals, programmes and other relevant documents are complete; provide training to flight crews, flight dispatchers and maintenance personnel; if required, conduct a validation flight.	If required, participate in the validation flight.
8		Once the requirements have been met, issue operational approval.



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PART 2. IDENTIFICATION OF AIRCRAFT AND OPERATORS

Name of Operator: _____

Aircraft manufacturer, model and series	Registration number	Serial number	Long-range navigation system manufacturer, model and number	PBN specification

Date of pre-application meeting: _____

Date when application received by CAAT: _____

Date when operator intends to begin RNP AR APCH operations: _____

Is the CAAT notification date appropriate? Yes No



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PART 3. OPERATOR APPLICATION

Annex	Title	Inclusion by Operator	Comments by Inspector
A	Request for authorization		
B	Aircraft eligibility —airworthiness AFM, AFM revision, AFM supplement, TCDS showing that the aircraft RNAV systems are eligible.		
C	Aircraft eligibility — modifications (if applicable) Maintenance records documenting installation or modification of aircraft systems to achieve eligibility.		
D	Maintenance For aircraft with established LRNS maintenance practices, references to the maintenance document/ programme. For recently installed LRNSs, details of the full maintenance practices.		
E	Minimum equipment list		
F	Training xxx91/GA operators or equivalent: <ul style="list-style-type: none">• <i>course completion records.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none">• <i>training programmes for flight crew, flight dispatchers and maintenance personnel.maintenance personnel.</i>		
G	Operating policies and procedures xxx91/GA operators or equivalent: <ul style="list-style-type: none">• <i>extracts from the operations manual corresponding to the application.</i> xxx121/xxx135/CAT operators or equivalent: <ul style="list-style-type: none">• <i>operations manual and checklists.</i>		



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Annex	Title	Inclusion by Operator	Comments by Inspector
H	Navigation database Validation programme and procedures.		
I	Withdrawal of approval Possibility of withdrawal of approval following navigation error reports.		
J	Validation flight plan Formal plan to validate proposed operation.		
K	Monitoring programme Data collection plan.		
L	Flight operational safety assessment (FOSA) An established methodology for a formal safety assessment of the proposed operation.		



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Contents of the application to be submitted by the operator

- compliance documentation for the aircraft/navigation systems;
- operating procedures and policies;
- sections of the maintenance manual related to LRNS (if not previously reviewed).

Note.— Documents may be grouped in a single binder or may be submitted as individual documents.

PART 4. CONTENTS OF THE OPERATOR APPLICATION

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 6)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
1	Authorization request Statement of intent to obtain authorization.					
2	Aircraft/navigation system eligibility Documents that establish eligibility.	6.3.2.5	8.2.1			
3	Training Details of courses completed (xxx91 operators). Details of training	6.3.2.6.2 6.3.5	8.2.2.2 8.5			



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PART 5. OPERATING PROCEDURES

#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 6)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
	programmes (xxx121 and xxx135 operators).					
1	Flight planning					
1a	Verify that the aircraft and crew are approved for RNP AR operations	6.3.4	8.2			
1b	Verify MEL and AP/FD availability.	6.3.4.1.1 6.3.4.1.2	8.4.1.1 8.4.1.2			
1c	Verify RNP availability.	6.3.4.1.3	8.4.1.3			
1d	Verify procedures for NAVAID exclusion.	6.3.4.1.4	8.4.1.4			
1e	Verify that the navigation database is current.	6.3.4.1.5	8.4.1.5			
	Review contingency procedures/options.	6.3.4.2.20 6.3.4.2.21	8.4.2.20 8.4.2.21			
1d	Verify the FPL: R" should appear in field 10 and PBN/T1 or T2 in field 18.					



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 6)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
2	Prior to commencing procedure					
2a	Verify that the correct procedure is loaded.	6.3.4.2.1 6.3.4.2.6	8.4.2.1 8.4.2.6			
2b	Verify correct RNP accuracy requirements.	6.3.4.2.3	8.4.2.3			
2b	Cross-check the chart with the RNAV system display.	6.3.4.2.1 6.3.4.2.6	8.4.2.1 8.4.2.6			
2c	Cross-check the chart with the RNAV system display.	6.3.4.2.1 6.3.4.2.6	8.4.2.1 8.4.2.6			
2d	Verify GNSS sensor in use (only for multi-sensor systems).	6.3.4.2.4	8.4.2.4			
2e	Inhibit specific NAVAIDS as required.	6.3.4.2.5	8.4.2.5			
2f	Modify only to accept direct to waypoint before FAF and not preceding an RF leg or to change altitude/speed constraints in initial, intermediate or missed approach segments.	6.3.4.2.1	8.4.2.1			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 6)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
2g	Confirm that the aircraft is capable of complying with the missed approach climb gradient.	6.3.4.2.16	8.4.2.16			
3	During procedure					
3a	Maintain centre line; monitor track deviation; lateral deviation limited to \pm one- half navigation accuracy (up to 1 x RNP in fly-by turns). Execute missed approach if 1 x RNP is exceeded.	6.3.4.2.7	8.4.2.7			
3b	Maintain vertical path; monitor vertical deviation — limited to \pm 75 ft. Execute a missed approach if \pm 75 ft is exceeded.	6.3.4.2.8	8.4.2.8			
3c	For RNP < 0.3, cross-check lateral and vertical guidance against other data sources.	6.3.4.2.10	8.4.2.10			
3d	Do not exceed aircraft category speeds in RF turns.	6.3.4.2.11	8.4.2.11			



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#	Topic	Specific ICAO reference	Specific State guidance reference	Operator compliance description	Inspector disposition/ comments	Follow-up by inspector (Optional)
		(Doc 9613, Volume II, Part C, Chapter 6)	(GM Part2)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)
3e	Apply temperature compensation as appropriate.	6.3.4.2.12	8.4.2.12			
3f	Ensure that the local QNH is set before FAF.	6.3.4.2.13	8.4.2.13			
3g	Cross-check altimeters after IAF and before FAF (± 100 ft).	6.3.4.2.14	8.4.2.14			
3h	Do not exceed ± 100 ft vertical deviation at VNAV capture.	6.3.4.2.15	8.4.2.15			
3i	If LNAV is disengaged at TOGA, re-engage as quickly as possible.	6.3.4.2.18	8.4.2.18			
3j	Manage speed to maintain track in any go-around.	6.3.4.2.19	8.4.2.19			
3k	Comply with the manufacturer's instructions/procedures.	6.3.4.2.5	8.4.1.1			
3l	Use FD and/or AP.	6.3.4.2.7	8.4.1.2			
1	Contingencies	(Doc 444 Chapter 15)				
1a	Advise ATC if unable to comply with the requirements for an RNP AR APCH.	15.2.1.1	9.1.1.1			
1b	Air-ground communications failure.	15.3	9.3			



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PART 2: IMPLEMENTING RNAV AND RNP

CHAPTER 1 IMPLEMENTING RNAV10

1.1. Background

1.1.1. This section identifies the airworthiness and operational requirements for RNP 10 operations. Operational compliance with these requirements must be addressed through national operational regulations, and may require a specific operational approval in some cases. For example, some States require operators to apply to their national authority (State of the Operator/Registry) for operational approval.

1.1.2. This chapter addresses only the lateral part of the navigation system.

1.2. Approval process

This navigation specification does not in itself constitute regulatory guidance material against which either the aircraft or the operator will be assessed and approved. Aircraft are certified by their State of manufacture. Operators are approved in accordance with their national operating rules. The navigation specification provides the technical and operational criteria, and does not imply a need for recertification.

The following steps must be completed before conducting RNP 10 operations:

- a) aircraft equipment eligibility must be determined and documented;
- b) operating procedures for the navigation systems to be used and the operator navigation database process must be documented;
- c) pilot training based upon the operating procedures must be documented, if necessary;
- d) the above material must be accepted by the state regulatory authority; and
- e) operational approval must then be obtained in accordance with national operating rules.

1.2.1. Aircraft eligibility

The aircraft eligibility must be determined through demonstration of compliance against the relevant airworthiness criteria and the requirements of 1.3. The OEM or the holder of installation approval for the aircraft, e.g. STC holder, will demonstrate compliance to their

national airworthiness authority (NAA) (e.g. EASA, FAA) and the approval can be documented in manufacturer documentation (e.g. service letters). Aircraft flight manual (AFM) entries are not required provided the State accepts manufacturer documentation.

Many aircraft and navigation systems currently in use in oceanic or remote area operations will qualify for RNP 10 based on one or more provisions of the existing certification criteria. Thus, additional aircraft certification action may not be necessary for the majority of RNP 10 operational approvals. Additional aircraft certification will only be necessary if the operator chooses to claim additional performance beyond that originally certified or stated in the aircraft flight manual but cannot demonstrate the desired performance through data collection. Three methods of determining aircraft eligibility have been defined.

1.2.1.1. Method 1 — RNP certification

Method 1 can be used to approve aircraft that have been formally certificated and approved for RNP operations. RNP compliance is documented in the flight manual and is typically not limited to RNP 10. The flight manual addresses RNP levels that have been demonstrated to meet the certification criteria and any related provisions applicable to their use (e.g. NAVAID sensor requirements). Operational approval will be based upon the performance stated in the flight manual.

Airworthiness approval specifically addressing RNP 10 performance may be obtained. Sample wording that could be used in the flight manual, when an RNP 10 approval is granted for a change in the INS/IRU certified performance, is as follows:

“The XXX navigation system has been demonstrated to meet the criteria of [State’s guidance material document] as a primary means of navigation for flights up to YYY hours’ duration without updating. The determination of flight duration starts when the system is placed in navigation mode. For flights which include airborne updating of navigation position, the operator must address the effect that updating has on position accuracy and any associated time limits for RNP operations pertinent to the updating NAVAID facilities used and the area, routes or procedures to be flown. Demonstration of performance in accordance with the provisions of [State’s guidance material document] does not constitute approval to conduct RNP operations.”

Note. —

The above wording is based upon performance approval by the aviation authority and is only

one element of the approval process. Aircraft with this wording in their flight manual will be eligible for approval through issuance of operations specifications or a Letter of Approval, if all other criteria are met. The YYY hours specified in the flight manual do not include updating. When the operator proposes a credit for updating, the proposal must address the effect the updating has on the position accuracy and any associated time limits for RNP operations pertinent to the updating of the NAVAID facilities used and the area, routes or procedures to be flown.

1.2.1.2.Method 2 — Aircraft eligibility through prior navigation system certification

Method 2 can be used to approve aircraft whose level of performance, under other/previous standards, can be equated to the RNP 10 criteria. The standards listed in 1.3.4 can be used to qualify an aircraft. Other standards may also be used if they are sufficient to ensure that the RNP 10 requirements are met. If other standards are to be used, the applicant must propose an acceptable means of compliance.

1.2.1.3.Method 3 — Aircraft eligibility through data collection

Method 3 requires that operators collect data to gain an RNP 10 approval for a specified period of time. The data collection programme must address the appropriate navigational accuracy requirements for RNP 10. The data collection must ensure that the applicant demonstrate to the aviation authority that the aircraft and the navigation system provide the pilot with navigation situational awareness relative to the intended RNP 10 route. The data collection must also ensure that a clear understanding of the status of the navigation system is provided and that failure indications and procedures are consistent with maintaining the navigation performance.

There are two data collection methods for Method 3:

- a) The sequential method is a data collection programme meeting the provisions of FAA Order 8400.12A (as amended), Appendix 1. This method allows the operator to collect a set of data and plot it against the “pass-fail” graphs to determine whether the operator’s aircraft system will meet the RNP 10 requirements for the length of time needed by the operator; and

- b) The periodic method of data collection uses of a hand-held GNSS receiver as a baseline for collected inertial navigation system (INS) data (as described in FAA Order 8400.12A (as amended), Appendix 6 (Periodic Method)). The data collected are then analysed as described in Appendix 6 to determine whether the system is capable of maintaining the navigation performance for the length of time needed by the operator.

Relevant documentation for the selected qualification method must be available to establish that the aircraft is equipped with long-range navigation systems (LRNSs) which meet the requirements of RNP 10 (e.g. the flight manual). The applicant must provide a configuration list that details pertinent components and equipment to be used for long-range navigation and RNP 10 operations. The applicant's proposed RNP 10 time limit for the specified INS or IRU must be provided. The applicant must consider the effect of headwinds in the area in which RNP 10 operations are intended to be carried out (see 1.3) to determine the feasibility of the proposed operation.

1.2.2. Operational Approval

This navigation specification does not in itself constitute regulatory guidance material against which either the aircraft or the operator will be assessed and approved. Aircraft are certified by their State of Manufacture. Operators are approved in accordance with their national operating rules. This navigation specification provides the technical and operational criteria, and does not necessarily imply a need for recertification.

Notes:

- 1. Detailed information on operational approvals is provided in Doc 9613 Volume I, Attachment C*
- 2. Where appropriate, States may refer to previous operational approvals in order to expedite this process for individual operators where performance and functionality is applicable to the current request for operational approval.*

1.2.2.1.1. Description of aircraft equipment

The operator must have a configuration list and, if necessary, a Minimum Equipment List (MEL)

detailing the required aircraft equipment for RNAV 10 operations.

1.2.2.2. Training documentation

Commercial operators must have a training programme addressing the operational practices, procedures and training items related to RNAV 10 operations (e.g. initial, upgrade or recurrent training for pilots, dispatchers or maintenance personnel).

Note: Operators need not establish a separate training programme or regimen if they already integrate RNAV training as an element of their training programme. However, the operator should be able to identify the aspects of RNAV 10 covered within their training programme.

Private operators must be familiar with the practices and procedures in paragraph 1.9, “Pilot knowledge and training”.

1.2.2.3. Operations manuals and checklists

Operations manuals and checklists for commercial operators must address information/guidance on the standard operating procedures detailed in 1.4. The appropriate manuals should contain navigation operating instructions and contingency procedures, where specified. When required by the State of Operator/Registry, the operator must submit their manuals and checklists for review as part of the application process.

Private operators should operate using the practices and procedures in paragraph 1.9, “Pilot knowledge and training”.

1.2.2.4. Minimum Equipment List (MEL) considerations

Any Minimum Equipment List (MEL) revisions necessary to address RNAV 10 provisions must be approved. Operators must adjust the MEL, or equivalent, and specify the required dispatch conditions.

1.2.2.5. Continuing Airworthiness

The operator must submit the continuing airworthiness instructions applicable to the aircraft's configuration and the aircraft's qualification for this navigation specification. Additionally, there is a requirement for the operator to submit their maintenance programme, including a reliability programme for monitoring the equipment.

Note: The operator should confirm with the OEM, or the holder of installation approval for the aircraft, that acceptance of subsequent changes in the aircraft configuration e.g. service bulletins, does not invalidate current operational approvals.

1.2.2.6.Past performance

An operating history of the operator must be included in the application. The applicant must address any events or incidents related to navigation errors for that operator (e.g. as reported on a State's navigation error investigation form), that have been covered by training, procedures, and maintenance, or the aircraft/navigation system modifications which are to be used.

1.3. Aircraft requirements

RNP 10 requires that aircraft operating in oceanic and remote areas be equipped with at least two independent and serviceable LRNSs comprising an INS, an IRS FMS or a GNSS, with an integrity such that the navigation system does not provide an unacceptable probability of misleading information.

1.3.1. On-Board Performance monitoring and alerting

Accuracy: During operations in airspace or on routes designated as RNP 10, the lateral total system error must be within ± 10 NM for at least 95 per cent of the total flight time. The along-track error must also be within ± 10 NM for at least 95 per cent of the total flight time.

Notes:

1. For RNP 10, operational approval of aircraft capable of coupling the area navigation (RNAV) system to the flight director or autopilot, a navigational positioning error is considered to be the dominant contributor to cross-track and along-track error. Flight technical error, path definition error and display errors are considered to be insignificant for the purposes of RNP 10 approval.

2. When the data collection method described in Appendix 1 of FAA Order 8400.12A (as amended) is used as the basis for an RNP 10 operational approval, these error types are included in the analysis. However, when the data collection method described in Appendix 6 of FAA Order 8400.12A is used, these errors are not included since that method is more conservative. The Appendix 6 method uses radial error instead of cross-track and along-track error.

Integrity: Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness regulations (i.e. 10^{-5} per hour).

Continuity: Loss of function is classified as a major failure condition for oceanic and remote navigation. The continuity requirement is satisfied by the carriage of dual independent LRNSs (excluding signal-in-space).

Signal-in-space: If using GNSS, the aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 20 NM exceeds 10^{-7} per hour.

1.3.2. Criteria for specific navigation services

1.3.2.1. Aircraft incorporating dual GNSS

Aircraft approved to use GNSS as a primary means of navigation for oceanic and remote operations, in accordance with the appropriate aviation authority's requirements, also meet the RNP 10 requirements without time limitations.

Multi-sensor systems integrating GNSS with FDE that are approved using the guidance contained in United States FAA Advisory Circular AC 20-130A, or its equivalent, also meet RNP 10 requirements without time limitations.

FAA Advisory Circular AC 20-138A provides an acceptable means of complying with installation requirements for aircraft that use GNSS but do not integrate it with other sensors. FAA AC 20-130A describes an acceptable means of compliance for multi-sensor navigation systems that incorporate GNSS. Aircraft that intend to use GNSS as the only navigation system (e.g. no INS or

IRS) on RNP 10 routes or in RNP 10 airspace must also comply with the regulations and related advisory documentation of the relevant aviation authority, except for specific GNSS requirements described in this guidance material. This includes use of GNSS approved for primary oceanic/remote performance.

The flight manual must indicate that a particular GNSS installation meets the appropriate aviation authority's requirements. Dual TSO-approved GNSS equipment must be fitted and an approved FDE availability prediction programme must be used. The maximum allowable time for which FDE capability is projected to be unavailable is 34 minutes for any one occasion. The maximum outage time must be included as a condition of the RNP 10 approval.

Note.— If predictions indicate that the maximum FDE outage time for the intended RNP 10 operation will be exceeded, then the operation must be rescheduled when FDE is available, or RNP 10 must be predicated on an alternate means of navigation.

1.3.2.2. Aircraft incorporating dual inertial navigation systems (INS) or inertial reference units (IRU) — standard time limit

Aircraft equipped with dual INS or IRU systems approved in accordance with any of the following standards have been determined to meet RNP 10 requirements for up to 6.2 hours of flight time:

- a) United States 14 CFR, Part 121, Appendix G (or a State's equivalent);
- b) minimum navigation performance specifications (MNPS); and
- c) approved for RNAV operations in Australia.

The timing starts from when the systems are placed in navigation mode or at the last point at which the systems are updated.

Note: The 6.2 hours of flight time are based on an inertial system with a 95 per cent radial position error rate (circular error rate) of 3.7 km/h (2.0 NM/h), which is statistically equivalent to individual 95 per cent cross-track and 95 per cent along-track position error rates (orthogonal error rates) of 2.9678 km/h (1.6015 NM/h) each, and 95 per cent cross-track and 95 per cent along-track position error limits of 18.5 km (10 NM) each (e.g. 18.5 km (10 NM)/2.9678 km/h (1.6015 NM/h) = 6.2 hours)).

If the systems are updated en route, the operator must show the effect that the accuracy of the

update has on the time limit (see FAA Order 8400.12.A, paragraph 12.e for information on the adjustment factors for systems that are updated en route).

Note: FAA Order 8400.12.A, paragraph 12.d provides information on acceptable procedures for operators who wish to increase the 6.2 hour time limitation specified.

1.3.2.3. Aircraft incorporating dual inertial navigation systems (INS) or inertial reference units (IRU) — extended time limit

For aircraft with INS certified under United States 14 CFR, Part 121, Appendix G, additional certification is only necessary for operators who choose to certify INS accuracy to better than 3.7 km (2 NM) per hour radial error (2.9678 km (1.6015 NM) per hour cross-track error). However, the following conditions apply:

- a) the certification of INS performance must address all issues associated with maintaining the required accuracy, including accuracy and reliability, acceptance test procedures, maintenance procedures and training programmes; and
- b) the operator must identify the standard against which the INS performance is to be demonstrated. This standard may be a regulatory (i.e. Appendix G), an industry or an operator-unique specification. A statement must be added to the flight manual identifying the accuracy standard used for certification (see FAA Order 8400.12.A, paragraph 12.a.2).

1.3.2.4. Aircraft equipped with a single INS or IRU and a single GPS approved for primary means of navigation in oceanic and remote areas

Aircraft equipped with a single INS or IRU and a single GNSS meet the RNP 10 requirements without time limitations. The INS or IRU must be approved to 14 CFR, Part 121, Appendix G. The GNSS must be TSO-C129a-authorized and must have an approved FDE availability prediction programme. The maximum allowable time for which the FDE capability is projected to be unavailable is 34 minutes on any one occasion. The maximum outage time must be included as a condition of the RNP 10 approval. The flight manual must indicate that the particular INS, IRU or GPS installation meets the appropriate aviation authority's requirements.

1.4. Operating procedures

To satisfy the requirements for RNP 10 operations in oceanic and remote areas, an operator must also comply with the relevant requirements of Annex 2 — Rules of the Air.

1.4.1 Flight planning

During flight planning, the pilot should pay particular attention to conditions affecting operations in RNP 10 airspace (or on RNP 10 routes), including:

- a) verifying that the RNP 10 time limit has been accounted for;
- b) verifying the requirements for GNSS, such as FDE, if appropriate for the operation; and
- c) accounting for any operating restriction related to RNP 10 approval, if required for a specific navigation system.

1.4.1. Pre-flight procedures

The following actions should be completed during pre-flight:

- a) review maintenance logs and forms to ascertain the condition of the equipment required for flight in RNP 10 airspace or on an RNP 10 route. Ensure that maintenance action has been taken to correct defects in the required equipment;
- b) during the external inspection of an aircraft, if possible check the condition of the navigation antennas and the condition of the fuselage skin in the vicinity of each of these antennas (this check may be accomplished by a qualified and authorized person other than the pilot, e.g. a flight engineer or maintenance person); and
- c) review the emergency procedures for operations in RNP 10 airspace or on RNP 10 routes. These are no different than normal oceanic emergency procedures with one exception — crews must be able to recognize when the aircraft is no longer able to navigate to its RNP 10 approval capability and ATC must be advised.

1.5. Navigation equipment

1.5.1. All aircraft operating in RNP 10 oceanic and remote airspace must be fitted with two fully serviceable independent LRNSs with integrity such that the navigation system does not

provide misleading information.

1.5.2. A State authority may approve the use of a single LRNS in specific circumstances (e.g. North Atlantic MNPS and 14 CFR 121.351(c) refer). An RNP 10 approval is still required.

1.6. Flight plan designation

Operators should use the appropriate ICAO flight plan designation specified for the RNP route flown. The letter “R” should be placed in block 10 of the ICAO flight plan to indicate the pilot has reviewed the planned route of flight to determine RNP requirements and the aircraft and operator have been approved on routes where RNP is a requirement for operation. Additional information needs to be displayed in the remarks section that indicates the accuracy capability, such as RNP 10 versus RNP 4.

1.7. Availability of NAVAIDs

1.7.1. At dispatch or during flight planning, the operator must ensure that adequate NAVAIDs are available en route to enable the aircraft to navigate to RNP 10 for the duration of the planned RNP 10 operation.

1.7.2. For GNSS systems, the operator should ensure during dispatch or flight planning that adequate navigation capability is available en route for the aircraft to navigate to RNP 10, including the availability of FDE, if appropriate for the operation.

1.8. En route

1.8.1. At least two LRNSs capable of satisfying this navigation specification must be operational at the oceanic entry point. If this is not the case, then the pilot should consider an alternate route which does not require that particular equipment or having to make a diversion for repairs.

1.8.2. Before entering oceanic airspace, the position of the aircraft must be checked as accurately as possible by using external NAVAIDs. This may require DME/DME and/or VOR

checks to determine navigation system errors through displayed and actual positions. If the system must be updated, the proper procedures should be followed with the aid of a prepared checklist.

1.8.3. Operator in-flight operating drills must include mandatory cross-checking procedures to identify navigation errors in sufficient time to prevent aircraft from inadvertent deviation from ATC-cleared routes.

1.8.4. Crews must advise ATC of any deterioration or failure of the navigation equipment below the navigation performance requirements or of any deviations required for a contingency procedure.

1.8.5. Pilots should use a lateral deviation indicator, flight director, or autopilot in lateral navigation mode on RNP 10 operations. All pilots are expected to maintain route centrelines, as depicted by on-board lateral deviation indicators and/or flight guidance, during all RNP operations described in this manual unless authorized to deviate by ATC or under emergency conditions. For normal operations, cross-track error/deviation (the difference between the RNAV system computed path and the aircraft position relative to the path) should be limited to $\pm\frac{1}{2}$ the navigation accuracy associated with the route (i.e. 5 NM). Brief deviations from this standard (e.g. overshoots or undershoots) during and immediately after route turns, up to a maximum of one-times the navigation accuracy (i.e. 10 NM), are allowable.

Note: Some aircraft do not display or compute a path during turns. Pilots of these aircraft may not be able to adhere to the $\pm\frac{1}{2}$ accuracy standard during route turns, but are still expected to satisfy the standard during intercepts following turns and on straight segments.

1.8.6. Route evaluation for RNP 10 time limits for aircraft equipped only with INS or IRU

1.8.6.1. An RNP 10 time limit must be established for aircraft equipped only with INS or IRU. When planning operations in areas where RNP 10 is applied, the operator must establish that the aircraft will comply with the time limitation on the routes that it intends to fly.

1.8.6.2. In making this evaluation, the operator must consider the effect of headwinds and, for aircraft not capable of coupling the navigation system or flight director to the autopilot, the operator may choose to make this evaluation on a one-time basis or on a per-flight basis. The

operator should consider the points listed in the following subsections in making this evaluation.

1.8.6.3.Route evaluation, the operator must establish the capability of the aircraft to satisfy the RNP 10 time limit established for dispatch or departure into RNP 10 airspace.

1.8.6.4.Start point for calculation, the calculation must start at the point where the system is placed in navigation mode or the last point at which the system is expected to be updated.

1.8.6.5.Stop point for calculation: The stop point may be one of the following:

- a) the point at which the aircraft will begin to navigate by reference to ICAO standard NAVAIDs (VOR, DME, non-directional radio beacon (NDB)) and/or comes under ATS surveillance; or
- b) the first point at which the navigation system is expected to be updated.

1.8.6.6.Sources of wind component data: The headwind component to be considered for the route may be obtained from any source acceptable to the aviation authority. Acceptable sources for wind data include: the State’s Bureau of Meteorology, National Weather Service, Bracknell, industry sources such as Boeing Winds on World Air Routes, and historical data supplied by the operator.

1.8.6.7.One-time calculation based on 75 per cent probability wind components: Certain sources of wind data establish the probability of experiencing a given wind component on routes between city pairs on an annual basis. If an operator chooses to make a one-time calculation of RNP 10 time limit compliance, the operator may use the annual 75 per cent probability level to calculate the effect of headwinds (this level has been found to be a reasonable estimation of wind components).

1.8.6.8.Calculation of time limit for each specific flight: The operator may choose to evaluate each individual flight using flight plan winds to determine if the aircraft will comply with the specified time limit. If it is determined that the time limit will be exceeded, then the aircraft must fly an alternate route or delay the flight until the time limit can be met. This evaluation is a flight

planning or dispatch task.

1.8.7. Effect of en-route updates

Operators may extend their RNP 10 navigation capability time by updating. Approvals for various updating procedures are based upon the baseline for which they have been approved minus the time factors shown below:

- a) automatic updating using DME/DME = baseline minus 0.3 hours (e.g. an aircraft that has been approved for 6.2 hours can gain 5.9 hours following an automatic DME/DME update);
- b) automatic updating using DME/DME/VHF omnidirectional radio range (VOR) = baseline minus 0.5 hours; and
- c) manual updating using a method similar to that contained in FAA Order 8400.12A (as amended), Appendix 7 or approved by the aviation authority = baseline minus 1 hour.

1.8.8. Automatic radio position updating

Automatic updating is any updating procedure that does not require the pilot to manually insert coordinates. Automatic updating is acceptable provided that:

- a) procedures for automatic updating are included in an operator's training programme; and
- b) pilots are knowledgeable of the updating procedures and of the effect of the update on the navigation solution.

An acceptable procedure for automatic updating may be used as the basis for an RNP 10 approval for an extended time as indicated by data presented to the aviation authority. This data must present a clear indication of the accuracy of the update and the effect of the update on the navigation capabilities for the remainder of the flight.

1.8.9. Manual radio position updating

If manual updating is not specifically approved, manual position updates are not permitted in

RNP 10 operations. Manual radio updating may be considered acceptable for operations in airspace where RNP 10 is applied provided that:

- a) the procedures for manual updating are reviewed by the aviation authority on a case-by-case basis. An acceptable procedure for manual updating is described in FAA Order 8400.12A (as amended), Appendix 7 and may be used as the basis for an RNP 10 approval for an extended time when supported by acceptable data;
- b) operators show that their updating and training procedures include measures/cross-checking to prevent human factors errors and the pilot qualification syllabus is found to provide effective pilot training; and
- c) the operator provides data that establish the accuracy with which the aircraft navigation system can be updated using manual procedures and representative NAVAIDs. Data should show the update accuracy achieved in in-service operations. This factor must be considered when establishing the RNP 10 time limit for INS or IRU.

1.9. Pilot knowledge and training

1.9.1. The following items should be standardized and incorporated into training programmes and operating practices and procedures. Certain items may already be adequately standardized in existing operator programmes and procedures. New technologies may also eliminate the need for certain crew actions. If this is found to be the case, then the intent of this attachment can be considered to have been met.

Note: This guidance material has been written for a wide variety of operator types, therefore, certain items that have been included may not apply to all operators.

1.9.2. Commercial operators should ensure that pilots have been trained so that they are knowledgeable of the topics contained in this guidance material, the limits of their RNP 10 navigation capabilities, the effects of updating, and RNP 10 contingency procedures.

1.9.3. Non-commercial operators should show the aviation authority that their pilots are knowledgeable of RNP 10 operations. However, some States might not require non-commercial operators to have formal training programmes for some types of operations (e.g. FAA Order 8700.1, General Aviation Operations Inspector's Handbook). The aviation authority, in determining whether a non-commercial operator's training is adequate, might:

- a) accept a training centre certificate without further evaluation;
- b) bevaluate a training course before accepting a training centre certificate from a specific centre;
- c) accept a statement in the operator's application for an RNP 10 approval that the operator has ensured and will continue to ensure that pilots are knowledgeable of the RNP 10 operating practices and procedures; and
- d) accept an operator's in-house training programme.

1.10. Navigation database

If a navigation database is carried, it must be current and appropriate for the operations and must include the NAVAIDs and waypoints required for the route.

1.11. Oversight of operators

1.11.1. An aviation authority may consider any navigation error reports in determining remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment or operational procedure may result in cancellation of the operational approval, pending replacement or modifications to the navigation equipment or changes in the operator's operational procedures.

1.11.2. Information that indicates the potential for repeated errors may require modification of an operator's training programme, maintenance programme or specific equipment certification. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training or crew licence review.

CHAPTER 2 IMPLEMENTING RNAV5

2.1. Background

2.1.1. This section identifies the operational requirements for RNAV 5 operations. Operational compliance with these requirements should be addressed through national operational regulations, and may require specific operational approval in some cases. Operators will be approved against their national operating rules. For example, in ECAC, EU OPS requires operators to apply to their national authority for operational approval. The equivalence of the technical requirements of RNAV 5 and B-RNAV means that equipment approved against existing national rules for B-RNAV will not normally require further technical approval.

2.1.2. RNAV 5 does not require the carriage of a navigation database. Because of the specific limitations (e.g. workload and potential for data input errors) associated with manual insertion of waypoint coordinate data, RNAV 5 operations should be restricted to the en-route phase of flight.

2.2. Approval process

This navigation specification does not in itself constitute regulatory guidance material against which either the aircraft or the operator will be assessed and approved. Aircraft are certified by their State of Manufacture. Operators are approved in accordance with their national operating rules. This navigation specification provides the technical and operational criteria, and does not necessarily imply a need for recertification.

Notes:

- 1. Detailed information on operational approvals is provided in Doc 9613 Volume I, Attachment C*
- 2. Where appropriate, States may refer to previous operational approvals in order to expedite this process for individual operators where performance and functionality is applicable to the current request for operational approval.*

2.2.1. Aircraft Eligibility

The aircraft eligibility must be determined through demonstration of compliance against the

relevant airworthiness criteria and the requirements of 2.3.3. The OEM or the holder of installation approval for the aircraft, e.g. STC holder, will demonstrate compliance to their national airworthiness authority (NAA) (e.g. EASA, FAA) and the approval can be documented in manufacturer documentation (e.g. service letters). Aircraft flight manual (AFM) entries are not required provided the State accepts manufacturer documentation.

2.2.2. Operational Approval

2.2.2.1. Description of aircraft equipment

The operator must have a configuration list and, if necessary, a Minimum Equipment List (MEL) detailing the required aircraft equipment for RNAV 5 operations.

2.2.2.2. Training documentation

Commercial operators must have a training programme addressing the operational practices, procedures and training items related to RNAV 5 operations (e.g. initial, upgrade or recurrent training for pilots, dispatchers or maintenance personnel).

Note: Operators need not establish a separate training programme or regimen if they already integrate RNAV training as an element of their training programme. However, the operator should be able to identify the aspects of RNAV 5 covered within their training programme.

Private operators must be familiar with the practices and procedures in paragraph 2.3.5, "Pilot knowledge and training".

2.2.2.3. Operations manuals and checklists

Operations manuals and checklists for commercial operators must address information/guidance on the standard operating procedures detailed in 2.3.4. The appropriate manuals should contain navigation operating instructions and contingency procedures, where specified. When required by the State of Operator/Registry, the operator must submit their manuals and checklists for review as part of the application process.

Private operators should operate using the practices and procedures in paragraph 2.3.5, “Pilot knowledge and training”.

2.2.2.4. Minimum Equipment List (MEL) considerations

Any Minimum Equipment List (MEL) revisions necessary to address RNAV 5 provisions must be approved. Operators must adjust the MEL, or equivalent, and specify the required dispatch conditions.

2.2.2.5. Continuing airworthiness

The operator must submit the continuing airworthiness instructions applicable to the aircraft’s configuration and the aircraft’s qualification for this navigation specification. Additionally, there is a requirement for the operator to submit their maintenance programme, including a reliability programme for monitoring the equipment.

Note: The operator should confirm with the OEM, or the holder of installation approval for the aircraft, that acceptance of subsequent changes in the aircraft configuration e.g. service bulletins, does not invalidate current operational approvals.

2.2.2.6. Migration path to RNAV 5

The requirements of B-RNAV are identical to RNAV 5. National regulatory material is expected to take this equivalence into account. No additional migration path is required. This does not relieve the operator of the responsibility, in relation to all operations, to consult and comply with regional and national specific procedures or regulations.

2.3. Aircraft requirements

RNAV 5 operations are based on the use of RNAV equipment which automatically determines the aircraft position using input from one or a combination of the following types of position sensors, together with the means to establish and follow a desired path:

- a) VOR/DME;
- b) DME/DME;

- c) INS or IRS; and
- d) GNSS.

2.3.1. On-Board Performance monitoring and alerting

2.3.1.1.*Accuracy*: During operations in airspace or on routes designated as RNAV 5, the lateral total system error must be within 5 NM for at least 95 per cent of the total flight time. The along-track error must also be within ± 5 NM for at least 95 per cent of the total flight time.

2.3.1.2.*Integrity*: Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness regulations (i.e. 10^{-5} per hour).

2.3.1.3.*Continuity*: Loss of function is classified as a minor failure condition if the operator can revert to a different navigation system and proceed to a suitable airport.

2.3.1.4.*Signal-in-space*: If using GNSS, the aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 10 NM exceeds 10^{-7} per hour.

Note: The minimum level of integrity and continuity required for RNAV 5 systems for use in airspace designated for RNAV 5 would normally be met by a single installed system comprising one or more sensors, an RNAV computer, a control display unit and navigation display(s) (e.g. ND, HSI or CDI), provided that the system is monitored by the pilot and that in the event of a system failure the aircraft retains the capability to navigate relative to ground-based NAVAIDs (e.g. VOR/DME or NDB).

2.3.2. Criteria for specific navigation services

2.3.2.1. Inertial navigation system (INS)/inertial reference system (IRS)

- a) Inertial systems may be used either as a stand-alone inertial navigation system (INS) or an inertial reference system (IRS) acting as part of a multi-sensor RNAV system, where inertial sensors provide augmentation to the basic position sensors, as well as a reversionary position data source when out of cover of radio navigation sources.

- b) INS without automatic radio updating of aircraft position, but approved in accordance with AC 25-4, and when complying with the functional criteria of this specification, may be used only for a maximum of 2 hours from the last alignment/position update performed on the ground. Consideration may be given to specific INS configurations (e.g. triple mix) where either equipment or the aircraft manufacturer’s data justify extended use from the last position update.

- c) INS with automatic radio updating of aircraft position, including those systems where manual selection of radio channels is performed in accordance with flight crew procedures, should be approved in accordance with AC-90-45A, AC 20-130A or equivalent material.

2.3.2.2. Very high frequency (VHF) omnidirectional radio range (VOR);

VOR accuracy can typically meet the accuracy requirements for RNAV 5 up to 60 NM (75 NM for Doppler VOR) from the NAVAID. Specific regions within the VOR coverage may experience larger errors due to propagation effects (e.g. multipath). Where such errors exist, this can be resolved by prescribing areas where the affected VOR may not be used. Alternative action could be to take account of lower VOR performance in the setting up of the proposed RNAV routes by, for example, increasing additional route spacing. Account must be taken of the availability of other NAVAIDs that can provide coverage in the affected area and that not all aircraft may be using the VOR concerned and may therefore not exhibit the same track-keeping performance.

2.3.2.3. Distance measuring equipment (DME)

DME signals are considered sufficient to meet the requirements of RNAV 5 whenever the signals are received and there is no closer DME on the same channel, regardless of the published coverage volume. When the RNAV 5 system does not take account of published “Designated Operational Coverage” of the DME, the RNAV system must execute data integrity checks to confirm that the correct DME signal is being received.

The individual components of the NAVAID infrastructure must meet the performance

requirements detailed in Annex 10, Volume I. NAVAIDs that are not compliant with Annex 10 should not be published in the State AIP.

2.3.2.4. Global navigation satellite system (GNSS)

The use of GNSS to perform RNAV 5 operations is limited to equipment approved to ETSO-C129(), ETSO-C145(), ETSO-C146(), FAA TSO-C145(), TSO-C146(), and TSO-C129() or equivalent, and include the minimum system functions specified in 2.3.3.

Integrity should be provided by SBAS GNSS or receiver autonomous integrity monitoring (RAIM) or an equivalent means within a multi-sensor navigation system. In addition, GPS stand-alone equipment should include the following functions:

- a) pseudo-range step detection; and
- b) ii) health word checking.

Note: These two additional functions are required to be implemented in accordance with TSO-C129a / ETSO-C129a or equivalent criteria.

Where approval for RNAV 5 operations requires the use of traditional navigation equipment as a back-up in the event of loss of GNSS, the required NAVAIDs, as defined in the approval (i.e. VOR, DME and/or ADF), will need to be installed and be serviceable.

Positioning data from other types of navigation sensors may be integrated with the GNSS data provided other positioning data do not cause position errors exceeding the track-keeping accuracy requirements.

2.3.3. Functional requirements

2.3.3.1. The following system functions are the minimum required to conduct RNAV 5 operations:

- a) continuous indication of aircraft position relative to track to be displayed to the pilot flying the aircraft, on a navigation display situated in his/her primary field of view;
- b) where the minimum flight crew is two pilots, indication of the aircraft position relative to track to be displayed to the pilot not flying the aircraft, on a navigation display situated in his/her primary field of view;
- c) display of distance and bearing to the active (to) waypoint;

- d) display of ground-speed or time to the active (to) waypoint;
- e) storage of waypoints; minimum of 4; and
- f) appropriate failure indication of the RNAV system, including the sensors.

2.3.3.2. RNAV 5 navigation displays

Navigation data must be available for display either on a display forming part of the RNAV equipment or on a lateral deviation display (e.g. CDI, (E)HSI, or a navigation map display).

These must be used as primary flight instruments for the navigation of the aircraft, for manoeuvre anticipation and for failure/status/integrity indication. They should meet the following requirements:

- a) the displays must be visible to the pilot when looking forward along the flight path;
- b) the lateral deviation display scaling should be compatible with any alerting and annunciation limits, where implemented; and
- c) the lateral deviation display must have a scaling and full-scale deflection suitable for the RNAV 5 operation.

2.4. Operating procedures

2.4.1. General

Airworthiness certification alone does not authorize flights in airspace or along routes for which RNAV 5 approval is required. Operational approval is also required to confirm the adequacy of the operator's normal and contingency procedures for the particular equipment installation.

2.4.2. Pre-flight planning

2.4.2.1. Operators and pilots intending to conduct operations on RNAV 5 routes should file the appropriate flight plan suffixes indicating their approval for operation on the routes.

2.4.2.2. During the pre-flight planning phase, the availability of the NAVAID infrastructure,

required for the intended routes, including any non-RNAV contingencies, must be confirmed for the period of intended operations. The pilot must also confirm availability of the on-board navigation equipment necessary for the operation.

2.4.2.3. Where a navigation database is used, it should be current and appropriate for the region of intended operation and must include the NAVAIDs and waypoints required for the route.

2.4.2.4. The availability of the NAVAID infrastructure, required for the intended routes, including any non-RNAV contingencies, must be confirmed for the period of intended operations using all available information. Since GNSS integrity (RAIM or SBAS signal) is required by Annex 10, Volume I, the availability of these should also be determined as appropriate. For aircraft navigating with SBAS receivers (all TSO-C145/C146), operators should check appropriate GPS RAIM availability in areas where SBAS signal is unavailable.

2.4.3. ABAS availability

2.4.3.1. En-route RAIM levels are required for RNAV 5 and can be verified either through NOTAMs (where available) or through prediction services. The operating authority may provide specific guidance on how to comply with this requirement (e.g. if sufficient satellites are available, a prediction may not be necessary). Operators should be familiar with the prediction information available for the intended route.

2.4.3.2. RAIM availability prediction should take into account the latest GPS constellation NOTAMs and avionics model. The service may be provided by the ANSP, avionics manufacturer, other entities or through an airborne receiver RAIM prediction capability.

2.4.3.3. In the event of a predicted, continuous loss of appropriate level of fault detection of more than five minutes for any part of the RNAV 5 operation, the flight planning should be revised (i.e. delaying the departure or planning a different departure procedure).

2.4.3.4. RAIM availability prediction software is a tool used to assess the expected capability of meeting the navigation performance. Due to unplanned failure of some GNSS elements, pilots/ANSP must realize that RAIM or GPS navigation may be lost altogether while airborne,

which may require reversion to an alternative means of navigation. Therefore, pilots should assess their capability to navigate (potentially to an alternate destination) in case of failure of GPS navigation.

2.4.4. General operating procedures

2.4.4.1. Operators and pilots should not request or file RNAV 5 routes unless they satisfy all the criteria in the relevant documents. If an aircraft not meeting these criteria receives a clearance from ATC to conduct an RNAV procedure, the pilot must advise ATC that he/she is unable to accept the clearance and must request alternate instructions.

2.4.4.2. The pilot should comply with any instructions or procedures identified by the manufacturer as being necessary to comply with the performance requirements in this manual.

2.4.4.3. Pilots of RNAV 5 aircraft must adhere to any AFM limitations or operating procedures required to maintain the navigation accuracy specified for the procedure.

2.4.4.4. Where installed, pilots must confirm that the navigation database is up to date.

2.4.4.5. The pilots should cross-check the cleared flight plan by comparing charts or other applicable resources with the navigation system textual display and the aircraft map display, if applicable. If required, the exclusion of specific NAVAIDs should be confirmed.

2.4.4.6. During the flight, where feasible, the flight progress should be monitored for navigational reasonableness, by cross-checks with conventional NAVAIDs using the primary displays in conjunction with the RNAV control and display unit (CDU).

2.4.4.7. For RNAV 5, pilots should use a lateral deviation indicator, flight director or autopilot in lateral navigation mode. Pilots may use a navigation map display as described in 2.3.3.2, without a flight director or autopilot. Pilots of aircraft with a lateral deviation display must ensure that lateral deviation scaling is suitable for the navigation accuracy associated with the route/procedure (e.g. full-scale deflection: ± 5 NM).

2.4.4.8. All pilots are expected to maintain route centrelines, as depicted by on-board lateral deviation indicators and/or flight guidance, during all RNAV operations described in this manual, unless authorized to deviate by ATC or under emergency conditions. For normal operations, cross-track error/deviation (the difference between the RNAV system-computed path and the aircraft position relative to the path) should be limited to $\pm\frac{1}{2}$ the navigation accuracy associated with the procedure or route (i.e. 2.5 NM). Brief deviations from this standard (e.g. overshoots or undershoots) during and immediately after procedure/route turns, up to a maximum of one-times the navigation accuracy (i.e. 5 NM), are allowable.

Note: Some aircraft do not display or compute a path during turns; pilots of these aircraft may not be able to adhere to the $\pm\frac{1}{2}$ accuracy standard during route turns, but are still expected to satisfy the standard during intercepts of the final track following the turn and on straight segments.

2.4.4.9. If ATS issues a heading assignment taking the aircraft off a route, the pilot should not modify the flight plan in the RNAV system until a clearance is received to rejoin the route or the controller confirms a new clearance. When the aircraft is not on the published route, the specified accuracy requirement does not apply.

2.4.5. Contingency procedures

2.4.5.1. The pilot must notify ATC when the RNAV performance ceases to meet the requirements for RNAV 5. The communication to ATC must be in accordance with the authorized procedures (Doc 4444 or Doc 7030, as appropriate).

2.4.5.2. In the event of communications failure, the pilot should continue with the flight plan in accordance with the published "lost communication" procedure.

2.4.5.3. Where stand-alone GNSS equipment is used:

- a) In the event of that there is a loss of the RAIM detection function, the GNSS position may continue to be used for navigation. The pilot should attempt to cross-check the aircraft position, with other sources of position information, (e.g. VOR, DME and/or NDB

information) to confirm an acceptable level of navigation performance. Otherwise, the pilot should revert to an alternative means of navigation and advise ATC.

- b) In the event that the navigation display is flagged invalid due to a RAIM alert, the pilot should revert to an alternative means of navigation and advise ATC.

2.5. Pilot knowledge and training

The pilot training programme should address the following items:

- a) the capabilities and limitations of the RNAV system installed;
- b) the operations and airspace for which the RNAV system is approved to operate;
- c) the NAVAID limitations with respect to the RNAV system to be used for the RNAV 5 operation;
- d) contingency procedures for RNAV failures;
- e) the radio/telephony phraseology for the airspace, in accordance with Doc 4444 and Doc 7030, as appropriate;
- f) the flight planning requirements for the RNAV operation;
- g) RNAV requirements as determined from chart depiction and textual description;
- h) RNAV system-specific information, including:
 - i. levels of automation, mode annunciations, changes, alerts, interactions, reversions, and degradation;
 - ii. functional integration with other aircraft systems;
 - iii. monitoring procedures for each phase of the flight (e.g. monitor PROG or LEGS page);
 - iv. types of navigation sensors (e.g. DME, IRU, GNSS) utilized by the RNAV system and associated system prioritization/weighting/logic;
 - v. turn anticipation with consideration to speed and altitude effects;
 - vi. interpretation of electronic displays and symbols;
- i) RNAV equipment operating procedures, as applicable, including how to perform the following actions:
 - i. verify that the aircraft navigation data is current;
 - ii. verify the successful completion of RNAV system self-tests;
 - iii. initialize RNAV system position;

- iv. fly direct to a waypoint;
- v. intercept a course/track;
- vi. be vectored off and rejoin a procedure;
- vii. determine cross-track error/deviation;
- viii. remove and reselect navigation sensor input;
- ix. when required, confirm exclusion of a specific NAVAID or NAVAID type; and
- x. perform gross navigation error checks using conventional NAVAIDs.

2.6. Navigation database

Where a navigation database is carried and used, it must be current and appropriate for the region of intended operation and must include the NAVAIDs and waypoints required for the route.

Note: Navigation databases are expected to be current for the duration of the flight. If the AIRAC cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy of the navigation data, including the suitability of navigation facilities used to define the routes for the flight. Traditionally, this has been accomplished by verifying electronic data against paper products.

2.7. Oversight of operators

2.7.1. A process needs to be established whereby navigation error reports can be submitted and analysed in order to establish the need for remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment need to be followed up and action taken to remove the causal factor(s).

2.7.2. The nature of the error cause will determine the remedial action which could include the need for remedial training, restrictions in the application of the system, or requirements for software changes in the navigation system.

2.7.3. The nature and severity of the error may result in temporary cancellation of the approval for use of that equipment until the cause of the problem has been identified and rectified.

CHAPTER 3 IMPLEMENTING RNAV1 AND RNAV2

3.1. Background

3.1.1. This section identifies the aircraft requirements and operating procedures for RNAV 1 and RNAV 2 operations. Operational compliance with these requirements should be addressed through national operational regulations, and, in some cases, may require a specific operational approval. For example, JAR-OPS 1 requires operators to apply to the State of the Operator/Registry, as appropriate, for operational approval.

3.1.2. RNAV 1 and RNAV 2 specifications constitute harmonization between European Precision RNAV (P-RNAV) and United States RNAV (US-RNAV) criteria. Aircraft approved for RNAV 1 and RNAV 2 operations are automatically approved to operate within the United States or airspace of the Member States of the European Civil Aviation Conference (ECAC).

3.2. Approval process

This navigation specification does not in itself constitute regulatory guidance material against which either the aircraft or the operator will be assessed and approved. Aircraft are certified by their State of Manufacture. Operators are approved in accordance with their national operating rules. This navigation specification provides the technical and operational criteria, and does not necessarily imply a need for recertification.

Notes:

- 1. Detailed information on operational approvals is provided in Doc 9613 Volume I, Attachment C*
- 2. Where appropriate, States may refer to previous operational approvals in order to expedite this process for individual operators where performance and functionality is applicable to the current request for operational approval.*

3.2.1. Aircraft eligibility

The aircraft eligibility must be determined through demonstration of compliance against the relevant airworthiness criteria and the requirements of 3.3. The OEM or the holder of installation approval for the aircraft, e.g. STC holder, will demonstrate compliance to their national airworthiness authority (NAA) (e.g. EASA, FAA) and the approval can be documented in

manufacturer documentation (e.g. service letters). Aircraft flight manual (AFM) entries are not required provided the State accepts manufacturer documentation.

3.2.2. Operational Approval

3.2.2.1. Description of aircraft equipment

The operator must have a configuration list and, if necessary, a Minimum Equipment List (MEL) detailing the required aircraft equipment for RNAV 1 and/or RNAV 2 operations.

3.2.2.2. Training documentation

Commercial operators must have a training programme addressing the operational practices, procedures and training items related to RNAV 1 and/or RNAV 2 operations (e.g. initial, upgrade or recurrent training for pilots, dispatchers or maintenance personnel).

Note: Operators need not establish a separate training programme if they already integrate RNAV training as an element of their training programme. However, the operator should be able to identify the aspects of RNAV 1 and/or RNAV 2 covered within their training programme.

Private operators must be familiar with the practices and procedures in paragraph 3.5, “Pilot knowledge and training”.

3.2.2.3. Operations manuals and checklists

Operations manuals and checklists for commercial operators must address information/guidance on the standard operating procedures detailed in 3.4. The appropriate manuals should contain navigation operating instructions and contingency procedures, where specified. When required by the State of Operator/Registry, the operator must submit their manuals and checklists for review as part of the application process.

Private operators should operate using the practices and procedures in paragraph 3.5, “Pilot knowledge and training”.

3.2.2.4. Minimum Equipment List (MEL) considerations

Any Minimum Equipment List (MEL) revisions necessary to address RNAV 1 and/or RNAV 2

provisions must be approved. Operators must adjust the MEL, or equivalent, and specify the required dispatch conditions.

3.2.2.5. Continuing airworthiness

The operator must submit the continuing airworthiness instructions applicable to the aircraft configuration and the aircraft qualification for this navigation specification. Additionally, there is a requirement for the operator to submit their maintenance programme, including a reliability programme for monitoring the equipment.

Note: The operator should confirm with the OEM, or the holder of installation approval for the aircraft, that acceptance of subsequent changes in the aircraft configuration e.g. service bulletins, does not invalidate current operational approvals.

3.3. Aircraft requirements

RNAV 1 and RNAV 2 operations are based upon the use of RNAV equipment that automatically determines the aircraft position in the horizontal plane using input from the following types of position sensors (no specific priority):

- a) Global navigation satellite system (GNSS) in accordance with FAA TSO-C145(), TSO-C146(), or TSO-C129(). Positioning data from other types of navigation sensors may be integrated with the GNSS data provided other position data do not cause position errors exceeding the total system accuracy requirements. The use of GNSS equipment approved to TSO-C129 () is limited to those systems which include the minimum functions. As a minimum, integrity should be provided by an aircraft-based augmentation system. In addition, TSO-C129 equipment should include the following additional functions:
 - i. pseudo-range step detection;
 - ii. health word checking;
- b) DME/DME RNAV equipment complying with the criteria and
- c) DME/DME/IRU RNAV equipment complying with the criteria.

3.3.1. On-board performance monitoring and alerting

3.3.1.1. *Accuracy:* During operations in airspace or on routes designated as RNAV 1, the lateral total system error must be within ± 1 NM for at least 95 per cent of the total flight time.

The along-track error must also be within ± 1 NM for at least 95 per cent of the total flight time. During operations in airspace or on routes designated as RNAV 2, the lateral total system error must be within ± 2 NM for at least 95 per cent of the total flight time. The along-track error must also be within ± 2 NM for at least 95 per cent of the total flight time.

3.3.1.2. *Integrity*: Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness regulations (i.e. 10–5 per hour).

3.3.1.3. *Continuity*: Loss of function is classified as a minor failure condition if the operator can revert to a different navigation system and proceed to a suitable airport.

3.3.1.4. *Signal-in-space*: During operations in airspace or on routes designated as RNAV 1 if using GNSS, the aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 2 NM exceeds 10–7 per hour. During operations in airspace or on routes designated as RNAV 2 if using GNSS, the aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 4 NM exceeds 10–7 per hour.

3.4. Operating procedures

3.4.1. Airworthiness certification alone does not authorize flight in airspace or along routes for which RNAV 1 or RNAV 2 approval is required. Operational approval is also required to confirm the adequacy of the operator’s normal and contingency procedures for the particular equipment installation.

3.4.2. Pre-flight planning

3.4.2.1. Operators and pilots intending to conduct operations on RNAV 1 and RNAV 2 routes should file the appropriate flight plan suffixes.

3.4.2.2. The on-board navigation data must be current and appropriate for the region of intended operation and must include the NAVAIDs, waypoints, and relevant coded ATS routes for departure, arrival, and alternate airfields.

Note: Navigation databases are expected to be current for the duration of the flight. If the AIRAC cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy of the navigation data, including the suitability of navigation facilities used to define the routes and procedures for flight.

3.4.2.3. The availability of the NAVAID infrastructure, required for the intended routes, including any non-RNAV contingencies, must be confirmed for the period of intended operations using all available information. Since GNSS integrity (RAIM or SBAS signal) is required by Annex 10, Volume I, the availability of these should also be determined as appropriate. For aircraft navigating with the SBAS receivers (all TSO-C145/C146), operators should check appropriate GPS RAIM availability in areas where the SBAS signal is unavailable.

3.4.2.4. Aircraft-based augmentation system (ABAS) availability

RAIM levels required for RNAV 1 and RNAV 2 can be verified either through NOTAMs (where available) or through prediction services. The operating authority may provide specific guidance on how to comply with this requirement (e.g. if sufficient satellites are available, a prediction may not be necessary). Operators should be familiar with the prediction information available for the intended route.

RAIM availability prediction should take into account the latest GPS constellation NOTAMs and avionics model (when available). The service may be provided by the ANSP, avionics manufacturer, other entities or through an airborne receiver RAIM prediction capability.

In the event of a predicted, continuous loss of appropriate level of fault detection of more than five minutes for any part of the RNAV 1 or RNAV 2 operation, the flight plan should be revised (e.g. delaying the departure or planning a different departure procedure).

RAIM availability prediction software does not guarantee a service; such tools assess the RNAV system's ability to meet the navigation performance. Because of unplanned failure of some GNSS elements, pilots/ANSP must realize that RAIM or GPS navigation altogether may be lost while airborne which may require reversion to an alternative means of navigation. Therefore, pilots should assess their capability to navigate (potentially to an alternate destination) in case of failure of GPS navigation.

3.4.2.5. Distance measuring equipment (DME) availability

For navigation relying on DME, NOTAMs should be checked to verify the condition of critical DMEs. Pilots should assess their capability to navigate (potentially to an alternate destination) in case of failure of critical DME while airborne.

3.4.3. General operating procedures

3.4.3.1. The pilot should comply with any instructions or procedures identified by the manufacturer as necessary to comply with the performance requirements in this chapter.

3.4.3.2. Operators and pilots should not request or file RNAV 1 and RNAV 2 routes unless they satisfy all the criteria in the relevant State documents. If an aircraft not meeting these criteria receives a clearance from ATC to conduct an RNAV route, the pilot must advise ATC that he/she is unable to accept the clearance and must request alternate instructions.

3.4.3.3. At system initialization, pilots must confirm the navigation database is current and verify that the aircraft position has been entered correctly. Pilots must verify proper entry of their ATC assigned route upon initial clearance and any subsequent change of route. Pilots must ensure the waypoints sequence, depicted by their navigation system, matches the route depicted on the appropriate chart(s) and their assigned route.

3.4.3.4. Pilots must not fly an RNAV 1 or RNAV 2 SID or STAR unless it is retrievable by route name from the on-board navigation database and conforms to the charted route. However, the route may subsequently be modified through the insertion or deletion of specific waypoints in response to ATC clearances. The manual entry, or creation of new waypoints by manual entry, of latitude and longitude or rho/theta values is not permitted. Additionally, pilots must not change any RNAV SID or STAR database waypoint type from a fly-by to a flyover or vice versa.

3.4.3.5. Whenever possible, RNAV 1 and RNAV 2 routes in the en-route domain should be extracted from the database in their entirety, rather than loading individual waypoints from the database into the flight plan. However, it is permitted to select and insert individual, named fixes/waypoints from the navigation database, provided all fixes along the published route to be

flown are inserted. Moreover, the route may subsequently be modified through the insertion or deletion of specific waypoints in response to ATC clearances. The creation of new waypoints by manual entry of latitude and longitude or rho/theta values is not permitted.

3.4.3.6 Pilots should cross-check the cleared flight plan by comparing charts or other applicable resources with the navigation system textual display and the aircraft map display, if applicable. If required, the exclusion of specific NAVAIDs should be confirmed.

Note: Pilots may notice a slight difference between the navigation information portrayed on the chart and their primary navigation display. Differences of 3 degrees or less may result from the equipment manufacturer's application of magnetic variation and are operationally acceptable.

3.4.3.7 During the flight, where feasible, the pilot should use available data from ground-based NAVAIDs to confirm navigational reasonableness.

3.4.3.8 For RNAV 2 routes, pilots should use a lateral deviation indicator, flight director or autopilot in lateral navigation mode. Pilots may use a navigation map display with equivalent functionality as a lateral deviation indicator, as described in 3.3.3.3 a) (1-5), without a flight director or autopilot.

3.4.3.9 For RNAV 1 routes, pilots must use a lateral deviation indicator, flight director, or autopilot in lateral navigation mode.

3.4.3.10 Pilots of aircraft with a lateral deviation display must ensure that lateral deviation scaling is suitable for the navigation accuracy associated with the route/procedure (e.g. full-scale deflection: ± 1 NM for RNAV 1, ± 2 NM for RNAV 2, or ± 5 NM for TSO-C129() equipment on RNAV 2 routes).

3.4.3.11 All pilots are expected to maintain route centrelines, as depicted by on-board lateral deviation indicators and/or flight guidance during all RNAV operations described in this manual, unless authorized to deviate by ATC or under emergency conditions. For normal operations, cross-track error/deviation (the difference between the RNAV system computed path and the aircraft position relative to the path, i.e. FTE) should be limited to $\pm \frac{1}{2}$ the navigation accuracy associated with the procedure or route (i.e. 0.5 NM for RNAV 1, 1.0 NM for RNAV 2). Brief deviations from this standard (e.g. overshoots or undershoots) during and

immediately after procedure/route turns, up to a maximum of one-times the navigation accuracy (i.e. 1.0 NM for RNAV 1, 2.0 NM for RNAV), are allowable.

Note: Some aircraft do not display or compute a path during turns, therefore, pilots of these aircraft may not be able to adhere to the $\pm\frac{1}{2}$ lateral navigation accuracy during procedural/route turns, but are still expected to satisfy the standard during intercepts following turns and on straight segments.

3.4.3.12 If ATC issues a heading assignment taking the aircraft off a route, the pilot should not modify the flight plan in the RNAV system until a clearance is received to rejoin the route or the controller confirms a new route clearance. When the aircraft is not on the published route, the specified accuracy requirement does not apply.

3.4.3.13 Manually selecting aircraft bank limiting functions may reduce the aircraft's ability to maintain its desired track and are not recommended. Pilots should recognize that manually selectable aircraft bank-limiting functions might reduce their ability to satisfy ATC path expectations, especially when executing large angle turns. This should not be construed as a requirement to deviate from aeroplane flight manual procedures; rather, pilots should be encouraged to limit the selection of such functions within accepted procedures.

3.4.4. RNAV SID specific requirements

3.4.4.1. Prior to commencing take-off, the pilot must verify the aircraft's RNAV system is available, operating correctly, and the correct airport and runway data are loaded. Prior to flight, pilots must verify their aircraft navigation system is operating correctly and the correct runway and departure procedure (including any applicable en-route transition) are entered and properly depicted. Pilots who are assigned an RNAV departure procedure and subsequently receive a change of runway, procedure or transition must verify the appropriate changes are entered and available for navigation prior to take-off. A final check of proper runway entry and correct route depiction, shortly before take-off, is recommended.

3.4.4.2. RNAV engagement altitude. The pilot must be able to use RNAV equipment to follow flight guidance for lateral navigation e.g., LNAV no later than 153 m (500 ft) above the airport elevation. The altitude at which RNAV guidance begins on a given route may be higher (e.g. climb to 304 m (1 000 ft) then direct to ...).

3.4.4.3. Pilots must use an authorized method (lateral deviation indicator/navigation map display/flight director/autopilot) to achieve an appropriate level of performance for RNAV 1.

3.4.4.4. DME/DME aircraft. Pilots of aircraft without GPS, using DME/DME sensors without IRU input, cannot use their RNAV system until the aircraft has entered adequate DME coverage. The air navigation service provider (ANSP) will ensure adequate DME coverage is available on each RNAV (DME/DME) SID at an acceptable altitude. The initial legs of the SID may be defined based on heading.

3.4.4.5. DME/DME/IRU (D/D/I) aircraft. Pilots of aircraft without GPS, using DME/DME RNAV systems with an IRU (DME/DME/IRU), should ensure the aircraft navigation system position is confirmed, within 304 m (1 000 ft) (0.17 NM) of a known position, at the starting point of the take-off roll. This is usually achieved by the use of an automatic or manual runway update function. A navigation map may also be used to confirm aircraft position, if the pilot procedures and the display resolution allow for compliance with the 304 m (1 000 ft) tolerance requirement.

Note: Based on evaluated IRU performance, the growth in position error after reverting to IRU can be expected to be less than 2 NM per 15 minutes.

3.4.4.6. GNSS aircraft. When using GNSS, the signal must be acquired before the take-off roll commences. For aircraft using TSO-C129/C129A equipment, the departure airport must be loaded into the flight plan in order to achieve the appropriate navigation system monitoring and sensitivity. For aircraft using TSO-C145a/C146a avionics, if the departure begins at a runway waypoint, then the departure airport does not need to be in the flight plan to obtain appropriate monitoring and sensitivity.

3.4.5. RNAV STAR specific requirements

3.4.5.1. Prior to the arrival phase, the pilot should verify that the correct terminal route has been loaded. The active flight plan should be checked by comparing the charts with the map display (if applicable) and the MCDU. This includes confirmation of the waypoint sequence, reasonableness of track angles and distances, any altitude or speed constraints, and, where possible, which waypoints are fly-by and which are flyover. If required by a route, a check will need to be made to confirm that updating will exclude a particular NAVAID. A route must not be

used if doubt exists as to the validity of the route in the navigation database.

Note: As a minimum, the arrival checks could be a simple inspection of a suitable map display that achieves the objectives of this paragraph.

3.4.5.2. The creation of new waypoints by manual entry into the RNAV system by the pilot would invalidate the route and is not permitted.

3.4.5.3. Where the contingency procedure requires reversion to a conventional arrival route, necessary preparations must be completed before commencing the RNAV route.

3.4.5.4. Route modifications in the terminal area may take the form of radar headings or “direct to” clearances and the pilot must be capable of reacting in a timely fashion. This may include the insertion of tactical waypoints loaded from the database. Manual entry or modification by the pilot of the loaded route, using temporary waypoints or fixes not provided in the database, is not permitted.

3.4.5.5. Pilots must verify their aircraft navigation system is operating correctly and the correct arrival procedure and runway (including any applicable transition) are entered and properly depicted.

3.4.5.6. Although a particular method is not mandated, any published altitude and speed constraints must be observed.

3.4.6. Contingency procedures

3.4.6.1. The pilot must notify ATC of any loss of the RNAV capability, together with the proposed course of action. If unable to comply with the requirements of an RNAV route, pilots must advise ATS as soon as possible. The loss of RNAV capability includes any failure or event causing the aircraft to no longer satisfy the RNAV requirements of the route.

3.4.6.2. In the event of communications failure, the pilot should continue with the RNAV route in accordance with established lost communications procedures.

3.5. Pilot knowledge and training

The following items should be addressed in the pilot training programme (e.g. simulator, training device, or aircraft) for the aircraft's RNAV system:

- a) the information in this chapter;
- b) the meaning and proper use of aircraft equipment/navigation suffixes;
- c) procedure characteristics as determined from chart depiction and textual description;
- d) depiction of waypoint types (flyover and fly-by) and path terminators and any other types used by the operator, as well as associated aircraft flight paths;
- e) required navigation equipment for operation on RNAV routes/SIDs/STARs, e.g. DME/DME, DME/DME/IRU, and GNSS;
- f) RNAV system-specific information:
 - i. levels of automation, mode annunciators, changes, alerts, interactions, reversions, and degradation;
 - ii. functional integration with other aircraft systems;
 - iii. the meaning and appropriateness of route discontinuities as well as related flight crew procedures;
 - iv. pilot procedures consistent with the operation;
 - v. types of navigation sensors (e.g. DME, IRU, GNSS) utilized by the RNAV system and associated system prioritization/weighting/logic;
 - vi. turn anticipation with consideration to speed and altitude effects;
 - vii. interpretation of electronic displays and symbols;
 - viii. understanding of the aircraft configuration and operational conditions required to support RNAV operations, i.e. appropriate selection of CDI scaling (lateral deviation display scaling);
- g) RNAV equipment operating procedures, as applicable, including how to perform the following actions:
 - i. verify currency and integrity of the aircraft navigation data;
 - ii. verify the successful completion of RNAV system self-tests;
 - iii. initialize navigation system position;
 - iv. retrieve and fly a SID or a STAR with appropriate transition;
 - v. adhere to speed and/or altitude constraints associated with a SID or STAR;

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- vi. select the appropriate STAR or SID for the active runway in use and be familiar with procedures to deal with a runway change;
- vii. perform a manual or automatic update (with take-off point shift, if applicable);
- viii. verify waypoints and flight plan programming;
- ix. fly direct to a waypoint;
- x. fly a course/track to a waypoint;
- xi. intercept a course/track;
- xii. following vectors and rejoining an RNAV route from “heading” mode;
- xiii. determine cross-track error/deviation. More specifically, the maximum deviations allowed to support RNAV must be understood and respected;
- xiv. resolve route discontinuities;
- xv. remove and reselect navigation sensor input;
- xvi. when required, confirm exclusion of a specific NAVAID or NAVAID type;
- xvii. when required by the State aviation authority, perform gross navigation error checks using conventional NAVAIDs;
- xviii. change arrival airport and alternate airport;
- xix. perform parallel offset functions if capability exists. Pilots should know how offsets are applied, the functionality of their particular RNAV system and the need to advise ATC if this functionality is not available;
- xx. perform RNAV holding functions;
- h) operator-recommended levels of automation for phase of flight and workload, including methods to minimize cross-track error to maintain route centreline;
- i) R/T phraseology for RNAV applications; and
- j) contingency procedures for RNAV applications.

3.6. Navigation database

3.6.1. The navigation database should be obtained from a supplier that complies with RTCA DO 200A/EUROCAE document ED 76, Standards for Processing Aeronautical Data and should be compatible with the intended function of the equipment (Annex 6, Part 1, Chapter 7). A Letter of Acceptance (LOA), issued by the appropriate regulatory authority to each of the participants in the data chain, demonstrates compliance with this requirement (e.g. FAA LOA issued in accordance with FAA AC 20-153 or EASA LOA issued in accordance with EASA OPINION Nr. 01/2005).

3.6.2. Discrepancies that invalidate a route must be reported to the navigation database supplier and affected routes must be prohibited by an operator's notice to its pilots.

3.6.3. Aircraft operators should consider the need to conduct periodic checks of the operational navigation databases in order to meet existing quality system requirements. DME/DME RNAV systems must only use DME facilities identified in State AIPs. Systems must not use facilities indicated by the State as inappropriate for RNAV 1 and RNAV 2 operations in the AIP or facilities associated with an ILS or MLS that uses a range offset. This may be accomplished by excluding specific DME facilities, which are known to have a deleterious effect on the navigation solution, from the aircraft's navigation database, when the RNAV routes are within reception range of these DME facilities.

3.7. Oversight of operators

3.7.1. A regulatory authority may consider any navigation error reports in determining remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment may result in cancellation of the approval for use of that equipment.

3.7.2. Information that indicates the potential for repeated errors may require modification of an operator's training programme. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training or licence review.

CHAPTER 4 IMPLEMENTING RNP4

4.1. Background

4.1.1. This section identifies the airworthiness and operational requirements for RNP 4 operations. Operational compliance with these requirements must be addressed through national operational regulations, and may require a specific operational approval in some cases. For example, certain operational regulations require that operators to apply to their national authority (State of Registry) for operational approval.

4.1.2. This chapter addresses only the lateral part of the navigation system.

4.2. Approval process

This navigation specification does not in itself constitute regulatory guidance material against which either the aircraft or the operator will be assessed and approved. Aircraft are certified by their State of Manufacture. Operators are approved in accordance with their national operating rules. This navigation specification provides the technical and operational criteria, and does not necessarily imply a need for recertification.

Notes:

- 1. Detailed information on operational approvals is provided in Doc 9613 Volume I, Attachment C*
- 2. Where appropriate, States may refer to previous operational approvals in order to expedite this process for individual operators where performance and functionality is applicable to the current request for operational approval.*

4.2.1. Aircraft eligibility

4.2.1.1. The aircraft eligibility must be determined through demonstration of compliance against the relevant airworthiness criteria and the requirements of 4.3. The OEM or the holder of installation approval for the aircraft, e.g. STC holder, will demonstrate compliance to their national airworthiness authority (NAA) (e.g. EASA, FAA) and the approval can be documented in

manufacturer documentation (e.g. service letters). Aircraft flight manual (AFM) entries are not required provided the State accepts manufacturer documentation.

4.2.1.2. Aircraft eligibility groups:

a) Group 1: RNP certification:

Group 1 aircraft are those with formal certification and approval of RNP integration in the aircraft. RNP compliance is documented in the aircraft's flight manual.

The certification will not necessarily be limited to a specific RNP specification. The flight manual must address the RNP levels that have been demonstrated and any related provisions applicable to their use (e.g. NAVAID sensor requirements). Operational approval is based upon the performance stated in the flight manual.

This method also applies in cases where certification is received through an STC issued to cover retrofitting of equipment, such as GNSS receivers, to enable the aircraft to meet RNP 4 requirements in oceanic and remote area airspace.

b) Group 2: Prior navigation system certification:

Group 2 aircraft are those that can equate their certified level of performance, given under previous standards, to RNP 4 criteria. Those standards listed in i) to iii) can be used to qualify aircraft under Group 2:

- i. Global navigation satellite systems (GNSS). Aircraft fitted with GNSS only as an approved long-range navigation system for oceanic and remote airspace operations must meet the technical requirements specified in 4.3. The flight manual must indicate that dual GNSS equipment approved under an appropriate standard is required. Appropriate standards are FAA technical standard orders (TSO) c129a or c146(), and JAA joint technical standard orders (JTSO) c129a or c146(). In addition, an approved dispatch fault detection and exclusion (FDE) availability prediction programme must be used. The maximum allowable time for which FDE capability is projected to be unavailable on any one event is 25 minutes. This maximum outage time must be included as a condition of the RNP 4 operational approval. If predictions indicate that the maximum allowable FDE outage will be exceeded, the operation must be rescheduled to a time when FDE is available.

- ii. Multi-sensor systems integrating GNSS with integrity provided by receiver autonomous integrity monitoring (RAIM). Multi-sensor systems incorporating global positioning system (GPS) with RAIM and FDE that are approved under FAA AC20-130a, or other equivalent documents, meet the technical requirements specified in 4.3. Note that there is no requirement to use dispatch FDE availability prediction programmes when multi-sensor systems are fitted and used.
- iii. Aircraft autonomous integrity monitoring (AAIM). AAIM uses the redundancy of position estimates from multiple sensors, including GNSS, to provide integrity performance that is at least equivalent to RAIM. These airborne augmentations must be certified in accordance with TSO c-115b, JTSA c-115b or other equivalent documents. An example is the use of an inertial navigation system or other navigation sensors as an integrity check on GNSS data when RAIM is unavailable but GNSS positioning information continues to be valid.

c) Group 3: New technology:

This group has been provided to cover new navigation systems that meet the technical requirements for operations in airspace where RNP 4 is specified.

4.2.2. Operational Approval

4.2.2.1. Description of aircraft equipment

The operator must have a configuration list and, if necessary, a Minimum Equipment List (MEL) detailing the required aircraft equipment for RNP 4 operations.

4.2.2.2. Training documentation

Commercial operators must have a training programme addressing the operational practices, procedures and training items related to RNP 4 operations (e.g. initial, upgrade or recurrent training for pilots, dispatchers or maintenance personnel).

Note: Operators need not establish a separate training programme or regimen if they already integrate RNAV training as an element of their training programme. However, the operator should be able to identify the aspects of RNP 4 covered within their training programme.

Private operators must be familiar with the practices and procedures in paragraph 4.5, “Pilot knowledge and training”.

4.2.2.3. Operations manuals and checklists

Operations manuals and checklists for commercial operators must address information/guidance on the standard operating procedures detailed in 4.4. The appropriate manuals should contain navigation operating instructions and contingency procedures, where specified. When required by the State of Operator/Registry, the operator must submit their manuals and checklists for review as part of the application process.

Private operators should operate using the practices and procedures in paragraph 4.5, “Pilot knowledge and training”.

4.2.2.4. Minimum Equipment List (MEL) considerations

Any Minimum Equipment List (MEL) revisions necessary to address RNP 4 provisions must be approved. Operators must adjust the MEL, or equivalent, and specify the required dispatch conditions.

4.2.2.5. Continuing airworthiness

The operator must submit the continuing airworthiness instructions applicable to the aircraft’s configuration and the aircraft’s qualification for this navigation specification. Additionally, there is a requirement for the operator to submit their maintenance programme, including a reliability programme for monitoring the equipment.

Note: The operator should confirm with the OEM, or the holder of installation approval for the aircraft, that acceptance of subsequent changes in the aircraft configuration e.g. service bulletins, does not invalidate current operational approvals.

4.3. Aircraft requirements

For RNP 4 operations in oceanic or remote airspace, at least two fully serviceable independent long-range navigation systems (LRNSs), with integrity such that the navigation system does not provide misleading information, must be fitted to the aircraft and form part of the basis upon which RNP 4 operational approval is granted. GNSS must be used and can be used as either a

stand-alone navigation system or as one of the sensors in a multi-sensor system.

United States FAA Advisory Circular AC 20-138A, or equivalent documents, provides an acceptable means of complying with installation requirements for aircraft that use, but do not integrate, the GNSS output with that of other sensors. FAA AC 20-130A describes an acceptable means of compliance for multi-sensor navigation systems that incorporate GNSS.

The equipment configuration used to demonstrate the required accuracy must be identical to the configuration specified in the MEL or flight manual.

The design of the installation must comply with the design standards that are applicable to the aircraft being modified and changes must be reflected in the flight manual prior to commencing operations requiring an RNP 4 navigation approval.

4.3.1. On-Board Performance monitoring and alerting

4.3.1.1. *Accuracy:* During operations in airspace or on routes designated as RNP 4, the lateral total system error must be within ± 4 NM for at least 95 per cent of the total flight time. The along-track error must also be within ± 4 NM for at least 95 per cent of the total flight time.

4.3.1.2. *Integrity:* Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness regulations (i.e. 10–5 per hour).

4.3.1.3. *Continuity:* Loss of function is classified as a major failure condition for oceanic and remote navigation. The continuity requirement is satisfied by the carriage of dual independent long-range navigation systems (excluding signal-in-space).

4.3.1.4. *On-board performance monitoring and alerting:* The RNP system, or the RNP system and pilot in combination, shall provide an alert if the accuracy requirement is not met, or if the probability that the lateral TSE exceeds 8 NM is greater than 10–5.

4.3.1.5. *Signal-in-space:* If using GNSS, the aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 8 NM exceeds 10–7 per hour.

Note.— Compliance with the on-board performance monitoring and alerting requirement does not imply an automatic monitor of flight technical error. The on-board monitoring and alerting function should consist at least of a navigation system error (NSE) monitoring and alerting algorithm and a lateral deviation display enabling the crew to monitor the flight technical error (FTE). To the extent operational procedures are used to monitor FTE, the crew procedure, equipment characteristics, and installation are evaluated for their effectiveness and equivalence as described in the functional requirements and operating procedures. Path definition error (PDE) is considered negligible due to the quality assurance process (1.3.6) and crew procedures (1.3.4).

4.3.2. Functional requirements

The on-board navigation system must have the following functionalities:

- a) display of navigation data;
- b) track to fix (TF);
- c) direct to fix (DF);
- d) direct to function;
- e) course to fix (CF);
- f) parallel offset;
- g) fly-by transition criteria;
- h) user interface displays;
- i) flight planning path selection;
- j) flight planning fix sequencing;
- k) user defined course to fix;
- l) path steering;
- m) alerting requirements;
- n) navigation database access;
- o) WGS-84 geodetic reference system; and
- p) automatic radio position updating.

4.4. Operating procedures

4.4.1. Airworthiness certification alone does not authorize RNP 4 operations. Operational approval is also required to confirm the adequacy of the operator's normal and contingency procedures for the particular equipment installation.

4.4.2. Pre-flight planning

4.4.2.1. Operators should use the appropriate ICAO flight plan designation specified for the RNP route. The letter “R” should be placed in block 10 of the ICAO flight plan to indicate the pilot has reviewed the planned route of flight and determined the RNP requirements and the aircraft and operator approval for RNP routes. Additional information should be displayed in the remarks section indicating the accuracy capability, such as RNP 4 versus RNP 10. It is important to understand that additional requirements will have to be met for operational authorization in RNP 4 airspace or on RNP 4 routes. Controller-pilot data link communications (CPDLC) and automatic dependent surveillance — contract (ADS-C) systems will also be required when the separation standard is 30 NM lateral and/or longitudinal. The on-board navigation data must be current and include appropriate procedures.

Note.— Navigation databases are expected to be current for the duration of the flight. If the AIRAC cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy of navigation data, including suitability of navigation facilities used to define the routes and procedures for flight.

4.4.2.2. The pilot must:

- a) review maintenance logs and forms to ascertain the condition of the equipment required for flight in RNP 4 airspace or on routes requiring RNP 4 navigation capability;
- b) ensure that maintenance action has been taken to correct defects in the required equipment; and
- c) review the contingency procedures for operations in RNP 4 airspace or on routes requiring an RNP 4 navigation capability. These are no different than normal oceanic contingency procedures with one exception: crews must be able to recognize, and ATC must be advised, when the aircraft is no longer able to navigate to its RNP 4 navigational capability.

4.4.3. Availability of GNSS

At dispatch or during flight planning, the operator must ensure that adequate navigation capability is available en route to enable the aircraft to navigate to RNP 4 and to include the availability of FDE, if appropriate for the operation.

4.4.4. En route

4.4.4.1. At least two LRNSs, capable of navigating to RNP 4, and listed in the flight manual, must be operational at the entry point of the RNP airspace. If an item of equipment required for RNP 4 operations is unserviceable, then the pilot should consider an alternate route or diversion for repairs.

4.4.4.2. In flight operating procedures must include mandatory cross-checking procedures to identify navigation errors in sufficient time to prevent inadvertent deviation from ATC-cleared routes.

4.4.4.3. Crews must advise ATC of any deterioration or failure of the navigation equipment that cause navigation performance to fall below the required level, and/or any deviations required for a contingency procedure.

4.4.4.4. Pilots should use a lateral deviation indicator, flight director, or autopilot in lateral navigation mode on RNP 4 routes. Pilots may use a navigation map display with equivalent functionality to a lateral deviation indicator. Pilots of aircraft with a lateral deviation indicator must ensure that the lateral deviation indicator scaling (full-scale deflection) is suitable for the navigation accuracy associated with the route (i.e. ± 4 NM). All pilots are expected to maintain route centrelines, as depicted by on-board lateral deviation indicators and/or flight guidance during all RNP operations described in this manual unless authorized to deviate by ATC or under emergency conditions. For normal operations, cross-track error/deviation (the difference between the RNAV system computed path and the aircraft position relative to the path) should be limited to $\pm \frac{1}{2}$ the navigation accuracy associated with the route (i.e. 2 NM). Brief deviations from this standard (e.g. overshoots or undershoots) during and immediately after route turns, up to a maximum of one-times the navigation accuracy (i.e. 4 NM), are allowable.

4.5. Pilot knowledge and training

4.5.1. Operators/owners must ensure that pilots are trained and have appropriate knowledge of the topics contained in this guidance material, the limits of their RNP 4 navigation

capabilities, the effects of updating, and RNP 4 contingency procedures.

- 4.5.2. In determining whether training is adequate, an approving authority might:
- evaluate a training course before accepting a training centre certificate from a specific centre;
 - accept a statement by the operator/owner in the application for an RNP 4 approval that the operator/owner has ensured and will continue to ensure that pilots are familiar with the RNP 4 operating practices and procedures contained in this chapter; or
 - accept a statement by the operator that it has conducted or will conduct an RNP 4 training programme utilizing the guidance contained in this chapter.

4.6. Navigation database

4.6.1. The navigation database should be obtained from a supplier that complies with RTCA DO 200A/EUROCAE document ED 76, Standards for Processing Aeronautical Data. A Letter of Acceptance (LOA) issued by the appropriate regulatory authority demonstrates compliance with this requirement (e.g. FAA LOA issued in accordance with FAA AC 20-153 or EASA LOA issued in accordance with EASA OPINION Nr. 01/2005).

4.6.2. Discrepancies that invalidate the route must be reported to the navigation database supplier and the affected route must be prohibited by an operator's notice to its pilots.

4.6.3. Aircraft operators should consider the need to conduct periodic checks of the operational navigation databases in order to meet existing quality system requirements.

Note.— To minimize path definition error, the database should comply with DO-200A/ED-76, or an equivalent operational means must be in place to ensure database integrity for the RNP 4.

4.7. Oversight of operators

4.7.1. An aviation authority should consider any navigation error reports in determining remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment or operational procedure may result in cancellation of the operational



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approval pending replacement or modifications on the navigation equipment or changes in the operator's operational procedures.

4.7.2. Information that indicates the potential for repeated errors may require modification of an operator's training programme, maintenance programme or specific equipment certification. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training or crew licence review.

CHAPTER 5 IMPLEMENTING RNP2

5.1. Background

This section identifies the operational requirements for RNP 2 operations. Operational compliance with these requirements should be addressed through national operational regulations, and may require a specific operational approval from the State of Operator/Registry for commercial operations as applicable and non-commercial operations when required.

5.2. Approval process

This navigation specification does not in itself constitute regulatory guidance material against which either the aircraft or the operator will be assessed and approved. Aircraft are certified by their state of manufacture. Operators are approved in accordance with their national operating rules. This navigation specification provides the technical and operational criteria, and does not necessarily imply a need for recertification.

Notes:

- 1. Detailed information on operational approvals is provided in Doc 9613 Volume I, Attachment C*
- 2. Where appropriate, States may refer to previous operational approvals in order to expedite this process for individual operators where performance and functionality is applicable to the current request for operational approval.*

5.2.1. Aircraft eligibility

5.2.1.1. The aircraft eligibility must be determined through demonstration of compliance against the relevant airworthiness criteria and the requirements of 5.3. The OEM or the holder of installation approval for the aircraft, e.g. STC holder, will demonstrate compliance to their national airworthiness authority (NAA) (e.g. EASA, FAA) and the approval can be documented in manufacturer documentation (e.g. service letters). Aircraft flight manual (AFM) entries are not required provided the State accepts manufacturer documentation.

5.2.1.2. In this navigation specification, the continuity requirements for oceanic/remote and continental applications are different – see paragraph 5.3. Where an aircraft is eligible for continental applications only, such a limitation must be clearly identified to support operational approvals. Aircraft meeting the oceanic/remote continuity requirement also meet the continental continuity requirement.

5.2.1.3. Advanced RNP systems are considered as qualified for RNP 2 Continental applications without further examination, and for RNP 2 oceanic/remote applications provided the oceanic/remote continuity requirement has been met.

Note: Requests for approval to use optional functionality (e.g. RF Legs, Fixed Radius Transition) should address the aircraft and operational requirements as described in the appropriate functional annex to Volume II.

5.2.2. Operational Approval

5.2.2.1. Description of aircraft equipment

The operator must have a configuration list and, if necessary, a Minimum Equipment List (MEL) detailing the required aircraft equipment for RNP 2 operations.

5.2.2.2. Training documentation

Commercial operators must have a training programme addressing the operational practices, procedures and training items related to RNP 2 operations (e.g. initial, upgrade or recurrent training for pilots, dispatchers or maintenance personnel).

Note: Operators need not establish a separate training programme if they already integrate RNAV training as an element of their training programme. However, the operator should be able to identify the aspects of RNP 2 covered within their training programme.

Private operators must be familiar with the practices and procedures in paragraph 5.5, “Pilot knowledge and training”.

5.2.2.3. Operations manuals and checklists

Operations manuals and checklists for commercial operators must address information/guidance on the standard operating procedures detailed in 5.4. The appropriate manuals should contain navigation operating instructions and contingency procedures, where specified. When required by the State of Operator/Registry, the operator must submit their manuals and checklists for review as part of the application process.

Private operators should operate using the practices and procedures in paragraph 5.5, “Pilot knowledge and training”.

5.2.2.4. Minimum Equipment List (MEL) considerations

Any Minimum Equipment List (MEL) revisions necessary to address RNP 2 provisions must be approved. Operators must adjust the MEL, or equivalent, and specify the required dispatch conditions.

5.2.2.5. Continuing airworthiness

The operator must submit the continuing airworthiness instructions applicable to the aircraft’s configuration and the aircraft’s qualification for this navigation specification. Additionally, there is a requirement for the operator to submit their maintenance programme, including a reliability programme for monitoring the equipment.

Note: The operator should confirm with the OEM, or the holder of installation approval for the aircraft, that acceptance of subsequent changes in the aircraft configuration e.g. service bulletins, does not invalidate current operational approvals.

5.3. Aircraft requirements

On-board performance monitoring and alerting is required. This section provides the criteria for a total system error (TSE) form of performance monitoring and alerting (as described in *ICAO DOC 9613 Volume II, Part A, Chapter 2, paragraph 2.3.10*) that will ensure a consistent evaluation and assessment of compliance for RNP 2 applications.

The aircraft navigation system, or aircraft navigation system and pilot in combination, is required to monitor the TSE, and to provide an alert if the accuracy requirement is not met or if the probability that the lateral TSE exceeds two-times the accuracy value is larger than 1×10^{-6} .

5. To the extent operational procedures are used to satisfy this requirement, the crew procedure, equipment characteristics, and installation should be evaluated for their effectiveness and equivalence. Examples of information provided to the pilot for awareness of navigation system performance include “EPU”, “ACTUAL”, “ANP” and “EPE”. Examples of indications and alerts provided when the operational requirement is or can be determined as not being met include “UNABLE RNP”, “NAV ACCUR DOWNGRAD”, GNSS alert limit, loss of GNSS integrity, TSE monitoring (real time monitoring of NSE and FTE combined), etc. The navigation system is not required to provide both performance and sensor based alerts e.g. if a TSE based alert is provided, a GNSS alert may not be necessary.

The following systems meet the accuracy and integrity requirements of these criteria;

- a) aircraft with E/TSO-C129a sensor (Class B or C), E/TSO-C145() and the requirements of E/TSO-C115b FMS, installed for IFR use in accordance with FAA AC 20-130A;
- b) aircraft with E/TSO-C129a Class A1 or E/TSO-C146() equipment installed for IFR use in accordance with FAA AC 20-138A or AC 20-138B;

5.3.1. On-Board performance monitoring and alerting

5.3.1.1. *Accuracy:* During operations in airspace or on routes designated as RNP 2, the lateral total system error must be within ± 2 NM for at least 95 per cent (95%) of the total flight time. The along-track error must also be within ± 2 NM for at least 95 per cent (95%) of the total flight time. To satisfy the accuracy requirement, the 95 per cent (95%) FTE should not exceed 1 NM.

Note: The use of a deviation indicator with 2 NM full-scale deflection is an acceptable means of compliance.

5.3.1.2. *Integrity:* Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness guidance material (i.e. 10^{-5} per hour).

5.3.1.3. *Continuity:* For RNP 2 Oceanic / remote continental airspace applications, loss of function is a major failure condition. For RNP 2 continental applications, Loss of function is a minor failure condition if the operator can revert to a different navigation system and proceed to a suitable airport. If a single aircraft configuration is to support all potential applications of RNP 2, the more stringent continuity requirement applies. The AFM Limitations section must reflect

restrictions in capability to aid in Operational approvals.

5.3.1.4. *Signal-in-space*: The aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 4 NM exceeds 1×10^{-7} per hour.

5.3.2. Flight Technical Error

During the aircraft certification process, the manufacturer must demonstrate the ability of the pilot to operate the aircraft within the allowable FTE. The demonstration of FTE should account for the aircraft type, the operating envelope, aircraft displays, autopilot performance, and flight guidance characteristics. When this is done, the pilot may use the demonstrated value of FTE to monitor compliance to the RNP requirements. This value must be the cross-track distance to the defined path. For cross-track containment compliance, the demonstration should account for any inaccuracies in the cross-track error computation (e.g. resolution) in the total system error.

Path Definition Error (PDE) is considered negligible because a quality assurance process is applied at the navigation database level.

5.4. Operating procedures

5.4.1. Airworthiness certification and recognition of RNP 2 aircraft qualification alone do not authorize RNP 2 operations. Operational approval is also required to confirm the adequacy of the operator's normal and contingency procedures for the particular equipment installation.

5.4.2. Pre-flight planning

5.4.2.1. Operators and pilots intending to conduct operations on RNP 2 routes must file the appropriate flight plan suffixes.

The on-board navigation data must be current and include appropriate procedures. Navigation databases should be current for the duration of the flight. If the AIRAC cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy of the

navigation data, including the suitability of navigation facilities defining the routes and procedures for flight.

5.4.2.2. The operator must confirm the availability of the NAVAID infrastructure, required for the intended routes, including those for use in a non-GNSS contingency, for the period of intended operations using all available information. Since Annex 10 requires GNSS integrity (RAIM or SBAS signal), the procedures should determine the availability of these services and functions as appropriate. For aircraft navigating with SBAS capability (all TSO-C145()/C146()), operators should check appropriate GNSS RAIM availability in areas where the SBAS signal is unavailable.

5.4.3. ABAS availability

5.4.3.1. Operators can verify the availability of RAIM to support RNP 2 operations via NOTAMs (where available) or through GNSS prediction services. The operating authority may provide specific guidance on how to comply with this requirement. Operators should be familiar with the prediction information available for the intended route.

5.4.3.2. RAIM availability prediction should take into account the latest GNSS constellation NOTAMs and avionics model (when available). The ANSP, avionics manufacturer, or the RNP system may provide this service.

5.4.3.3. In the event of a predicted, continuous loss of appropriate level of fault detection of more than five (5) minutes for any part of the RNP 2 operation, the operator should revise the flight plan (e.g. delay the departure or plan a different route).

5.4.3.4. RAIM availability prediction software does not guarantee the service. Rather, RAIM prediction tools assess the expected capability to meet the required navigation performance. Because of unplanned failure of some GNSS elements, pilots and ANSPs must realize that RAIM or GNSS navigation may be lost while airborne, and this may require reversion to an alternative means of navigation. Therefore, pilots should prepare to assess their capability to navigate (potentially to an alternate destination) in case of failure of GNSS navigation.

5.4.4. General operating procedures

5.4.4.1. The pilot should comply with any instructions or procedures the manufacturer of the aircraft or avionics identifies as necessary to comply with the RNP 2 performance requirements. Pilots must adhere to any AFM limitations or operating procedures the manufacturer requires to maintain RNP 2 performance.

5.4.4.2. Operators and pilots should not request or file for RNP 2 routes unless they satisfy all the criteria in the relevant State documents. If an aircraft does not meet these criteria and receives a clearance from ATC to operate on an RNP 2 route, the pilot must advise ATC they are unable to accept the clearance and must request an alternate clearance.

5.4.4.3. At system initialization, pilots must confirm the navigation database is current and verify proper aircraft position. Pilots must also verify proper entry of their ATC assigned route upon initial clearance and any subsequent change of route. Pilots must then ensure the waypoint sequence depicted by their navigation system matches the route depicted on the appropriate chart(s) and their assigned route.

Note: Pilots may notice a slight difference between the navigation information portrayed on the chart and their primary navigation display. Differences of 3° or less may result from the equipment manufacturer's application of magnetic variation and are operationally acceptable.

5.4.4.4. Pilots must not fly a published RNP 2 route unless they can retrieve the route by name from the on-board navigation database and confirm it matches the charted route. However, pilots may subsequently modify the route through the insertion or deletion of specific waypoints in response to ATC requests and clearances. Pilots must not make manual entries or create new waypoints by manual entry of latitude and longitude or rho/theta values for fixed, published routes. Additionally, pilots must not change any route database waypoint type from a fly-by to a flyover or vice versa.

For flexible route structures, entry of latitude and longitude may also be permitted provided the potential for entry error by pilots is accounted for during associated safety analyses.

Note: When the waypoints that make up an RNP 2 route are available by name in the aircraft's on-board navigation database, the operational authority may permit pilots to make

manual entry of the waypoints to define a published RNP 2 route in their navigation system.

5.4.4.5. The pilot need not cross-check the LNAV guidance with conventional NAVAIDs, as the absence of an integrity alert is sufficient to meet the integrity requirements.

5.4.4.6. For RNP 2 routes, pilots must use a lateral deviation indicator, flight director, or autopilot in lateral navigation mode. Pilots of aircraft with a lateral deviation display must ensure the lateral deviation scaling is suitable for the navigation accuracy associated with the route (e.g. full-scale deflection: ± 2 NM for RNP 2 or ± 5 NM in the case of some TSO-C129a equipment) and know their allowable lateral deviation limits.

Note; An appropriately scaled map display, as provided for in 5.3.2., may also be used.

5.4.4.7. All pilots must maintain centreline, as depicted by on-board lateral deviation indicators and/or flight guidance during all RNP 2 operations described in this manual, unless authorized to deviate by ATC or under emergency conditions. For normal operations, cross-track error/deviation (the difference between the system computed path and the aircraft position relative to the path, i.e. FTE) should be limited to $\pm\frac{1}{2}$ the navigation accuracy associated with the route (i.e. 1 NM for RNP 2). Brief deviations from this standard (e.g. overshoots or undershoots) during and immediately after turns, up to a maximum of 1 times the navigation accuracy (i.e. 2 NM for RNP 2) are allowable. Some aircraft do not display or compute a path during turns, therefore, pilots of these aircraft may not be able to confirm adherence to the $\pm\frac{1}{2}$ lateral navigation accuracy during turns, but must satisfy the standard during intercepts following turns and on straight segments.

5.4.4.8. Manually selecting or use of default aircraft bank limiting functions may reduce the aircraft's ability to maintain desired track and the pilot should not use these functions. Pilots should understand manually selecting aircraft bank-limiting functions may reduce their ability to satisfy ATC path expectations, especially when executing large angle turns. However, pilots should not deviate from aircraft flight manual procedures and should limit the use of such functions within accepted procedures that meet the requirements for operation on an RNP 2 route.

5.4.4.9. If ATC issues a heading assignment that takes an aircraft off of a route, the pilot

should not modify the flight plan in the RNP system until they receive a clearance to rejoin the route or the controller confirms a new route clearance. When the aircraft is not on the RNP 2 route, the RNP 2 performance requirements do not apply.

5.4.4.10. Pilots of aircraft with RNP input selection capability should select a navigation accuracy value of 2NM, or lower. The selection of the navigation accuracy value should ensure the RNP system offers appropriate lateral deviation scaling permitting the pilot to monitor lateral deviation and meet the requirements of the RNP 2 operation.

5.4.5. Contingency Procedures

The pilot must notify ATC of any loss of the RNP 2 capability (integrity alerts or loss of navigation). If unable to comply with the requirements of an RNP 2 route for any reason, pilots must advise ATC as soon as possible. The loss of RNP 2 capability includes any failure or event causing the aircraft to no longer satisfy the RNP 2 requirements.

5.5. Pilot knowledge and training

The training programme should provide sufficient training (e.g. simulator, training device, or aircraft) on the aircraft's RNP system to the extent that the pilots are familiar with the following:

- a) the information in this chapter;
- b) the meaning and proper use of aircraft equipment/navigation suffixes;
- c) route and airspace characteristics as determined from chart depiction and textual description;
- d) required navigation equipment on RNP 2 operations;
- e) RNP system-specific information:
 - i. levels of automation, mode annunciations, changes, alerts, interactions, reversions, and degradation;
 - ii. functional integration with other aircraft systems;
 - iii. the meaning and appropriateness of route discontinuities as well as related flight crew procedures;
 - iv. pilot procedures consistent with the operation;
 - v. types of navigation sensors utilized by the RNP system and associated system prioritization/ weighting/logic/limitations;

- vi. turn anticipation with consideration to speed and altitude effects;
- vii. interpretation of electronic displays and symbols used to conduct an RNP 2 operation;
- viii. understanding of the aircraft configuration and operational condition required to support RNP 2 operations, e.g. appropriate selection of CDI scaling (lateral deviation display scaling);
- f) RNP system-specific information: RNP system operating procedures, as applicable, including how to perform the following actions:
 - i. verify currency and integrity of the aircraft navigation data;
 - ii. verify the successful completion of RNP system self-tests;
 - iii. initialize navigation system position;
 - iv. retrieve / manually enter and fly an RNP 2 route;
 - v. adhere to speed and/or altitude constraints associated with an RNP 2 route;
 - vi. verify waypoints and flight plan programming;
 - vii. fly direct to a waypoint;
 - viii. fly a course/track to a waypoint;
 - ix. intercept a course/track (flying assigned vectors and rejoining an RNP 2 route from “heading” mode);
 - x. x) determine cross-track error/deviation. More specifically, the maximum deviations allowed to support RNP 2 must be understood and respected;
 - xi. resolve route discontinuities;
 - xii. remove and reselect navigation sensor input;
 - xiii. perform parallel offset function during RNP 2 operations if capability exists. Pilots should know how offsets are applied, the functionality of their particular RNP system and the need to advise ATC if this functionality is not available;
- g) operator-recommended levels of automation for phase of flight and workload, including methods to minimize cross-track error to maintain route centerline;
- h) R/T phraseology for RNP applications; and
- i) contingency procedures for RNP failures.

5.6. Navigation database

5.6.1. Navigation data management is addressed in ICAO Annex 6, Part 1, Chapter 7. In support of this, the operator must obtain the navigation database from a supplier complying

with RTCA DO 200A/EUROCAE document ED 76, Standards for Processing Aeronautical Data, and the database must be compatible with the intended function of the equipment. Regulatory authorities recognize compliance to the referenced standard using a Letter of Acceptance or other equivalent document.

5.6.2. The operator must report any discrepancies invalidating an ATS route to the navigation database supplier, and the operator must take actions to prohibit their pilots from flying the affected ATS route.

5.6.3. Aircraft operators should consider the need to conduct periodic checks of the operational navigation databases in order to meet existing quality system requirements.

5.7. Oversight of operators

5.7.1. A regulatory authority should consider any navigation error reports in determining remedial action for an operator. Repeated navigation error occurrences attributed to specific navigation equipment should result in cancellation of the operational approval permitting use of that equipment during RNP 2 operations.

5.7.2. Information indicating the potential for repeated errors may require modification of an operator's training programme. Information attributing multiple errors to a particular pilot may necessitate remedial training or licence review.

CHAPTER 6 IMPLEMENTING RNP1

6.1. Background

This chapter identifies the operational requirements for RNP 1 operations. Operational compliance with these requirements should be addressed through national operational regulations, and may require a specific operational approval in some cases. For example, EU OPS requires operators to apply to the State of the Operator/Registry, as appropriate, for operational approval.

6.2. Approval process

This navigation specification does not in itself constitute regulatory guidance material against which either the aircraft or the operator will be assessed and approved. Aircraft are certified by their State of Manufacture. Operators are approved in accordance with their national operating rules. This navigation specification provides the technical and operational criteria, and does not necessarily imply a need for recertification.

Notes:

- 1. Detailed information on operational approvals is provided in Doc 9613 Volume I, Attachment C*
- 2. Where appropriate, States may refer to previous operational approvals in order to expedite this process for individual operators where performance and functionality is applicable to the current request for operational approval.*

6.2.1. Aircraft eligibility

The aircraft eligibility must be determined through demonstration of compliance against the relevant airworthiness criteria and the requirements of 6.3. The OEM or the holder of installation approval for the aircraft, e.g. STC holder, will demonstrate compliance to their national airworthiness authority (NAA) (e.g. EASA, FAA) and the approval can be documented in manufacturer documentation (e.g. service letters). Aircraft flight manual (AFM) entries are not required provided the State accepts manufacturer documentation.

Note: Requests for approval to use optional functionality (e.g. RF Legs,) should address the aircraft and operational requirements as described in the appropriate functional annex to Volume II.

6.2.2. Operational Approval

6.2.2.1. Description of aircraft equipment

The operator must have a configuration list and, if necessary, a Minimum Equipment List (MEL) detailing the required aircraft equipment for RNP 1 operations.

6.2.2.2. Training documentation

Commercial operators must have a training programme addressing the operational practices, procedures and training items related to RNP 1 operations (e.g. initial, upgrade or recurrent training for pilots, dispatchers or maintenance personnel).

Note: Operators need not establish a separate training programme if they already integrate RNAV training as an element of their training programme. However, the operator should be able to identify the aspects of RNP 1 covered within their training programme.

Private operators must be familiar with the practices and procedures in paragraph 6.5, “Pilot knowledge and training”.

6.2.2.3. Operations manuals and checklists

Operations manuals and checklists for commercial operators must address information/guidance on the standard operating procedures detailed in 6.4. The appropriate manuals should contain navigation operating instructions and contingency procedures, where specified. When required by the State of Operator/Registry, the operator must submit their manuals and checklists for review as part of the application process.

Private operators should operate using the practices and procedures in paragraph 6.5, “Pilot knowledge and training”.

6.2.2.4. Minimum Equipment List (MEL) considerations

Any Minimum Equipment List (MEL) revisions necessary to address RNP 1 provisions must be approved. Operators must adjust the MEL, or equivalent, and specify the required dispatch conditions.

6.2.2.5. Continuing airworthiness

The operator must submit the continuing airworthiness instructions applicable to the aircraft’s configuration and the aircraft’s qualification for this navigation specification. Additionally, there

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is a requirement for the operator to submit their maintenance programme, including a reliability programme for monitoring the equipment.

Note: The operator should confirm with the OEM, or the holder of installation approval for the aircraft, that acceptance of subsequent changes in the aircraft configuration e.g. service bulletins, does not invalidate current operational approvals.

6.3. Aircraft requirements

The following systems meet the accuracy, integrity and continuity requirements of these criteria.

- a) aircraft with E/TSO-C129a sensor (Class B or C), E/TSO-C145() and the requirements of E/TSO-C115b FMS, installed for IFR use in accordance with FAA AC 20-130A;
- b) aircraft with E/TSO-C129a Class A1 or E/TSO-C146() equipment installed for IFR use in accordance with FAA AC 20-138 or AC 20-138A;
- c) aircraft with RNP capability certified or approved to equivalent standards.

Note: For RNP procedures, the RNP system may only use DME updating when authorized by the State. The manufacturer should identify any operating constraints (e.g., manual inhibit of DME) in order for a given aircraft to comply with this requirement.

This is in recognition of States where a DME infrastructure and capable equipped aircraft are available, those States may establish a basis for aircraft qualification and operational approval to enable use of DME. It is not intended to imply a requirement for implementation of DME infrastructure or the addition of RNP capability using DME for RNP operations.

This requirement does not imply an equipment capability must exist providing a direct means of inhibiting DME updating. A procedural means for the pilots to inhibit DME updating or executing a missed approach if reverting to DME updating may meet this requirement.

6.3.1. On-board performance monitoring and alerting

6.3.1.1. *Accuracy:* During operations in airspace or on routes designated as RNP 1, the lateral total system error must be within ± 1 NM for at least 95 per cent of the total flight time. The along-track error must also be within ± 1 NM for at least 95 per cent of the total flight time. To satisfy the accuracy requirement, the 95 per cent FTE should not exceed 0.5 NM.

Note: The use of a deviation indicator with 1 NM full-scale deflection has been found to be an acceptable means of compliance. The use of an autopilot or flight director has been found to be an acceptable means of compliance (roll stabilization systems do not qualify).

6.3.1.2. *Integrity:* Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness regulations (i.e. 1×10^{-5} per hour).

6.3.1.3. *Continuity:* Loss of function is classified as a minor failure condition if the operator can revert to a different navigation system and proceed to a suitable airport.

6.3.1.4. *On-board performance monitoring and alerting:* The RNP system, or the RNP system and pilot in combination, shall provide an alert if the accuracy requirement is not met, or if the probability that the lateral TSE exceeds 1 NM is greater than 1×10^{-5} .

6.3.1.5. *Signal-in-space:* If using GNSS, the aircraft navigation equipment shall provide an alert if the probability of signal-in-space errors causing a lateral position error greater than 2 NM exceeds 1×10^{-7} per hour.

Note: Compliance with the on-board performance monitoring and alerting requirements does not imply automatic monitoring of flight technical errors. The on-board monitoring and alerting function should consist at least of a navigation system error (NSE) monitoring and alerting algorithm and a lateral deviation display enabling the crew to monitor the flight technical error (FTE). To the extent operational procedures are used to monitor FTE, the crew procedure, equipment characteristics, and installation are evaluated for their effectiveness and equivalence, as described in the functional requirements and operating procedures. Path definition error (PDE) is considered negligible due to the quality assurance process (3.3.6) and crew procedures (3.3.4).

6.3.2. Criteria for specific navigation systems

RNP 1 is based on GNSS positioning. Positioning data from other types of navigation sensors

may be integrated with the GNSS data provided the other positioning data do not cause position errors exceeding the total system error (TSE) budget. Otherwise, means should be provided to deselect the other navigation sensor types.

Note: For RNP procedures, the RNP system may only use DME updating when authorized by the State. The manufacturer should identify any operating constraints (e.g., manual inhibit of DME) in order for a given aircraft to comply with this requirement. This is in recognition of States where a DME infrastructure and capable equipped aircraft are available. Those States may establish a basis for aircraft qualification and operational approval to enable use of DME. It is not intended to imply a requirement for implementation of DME infrastructure or the addition of RNP capability using DME for RNP operations. This requirement does not imply an equipment capability must exist providing a direct means of inhibiting DME updating. A procedural means for the pilot to inhibit DME updating or executing a missed approach if reverting to DME updating may meet this requirement.

6.4. Operating procedures

6.4.1. Airworthiness certification alone does not authorize RNP 1 operations. Operational approval is also required to confirm the adequacy of the operator's normal and contingency procedures for the particular equipment installation.

6.4.2. Pre-flight planning

6.4.2.1. Operators and pilots intending to conduct operations on RNP 1 SIDs and STARs should file the appropriate flight plan suffixes.

6.4.2.2. The on-board navigation data must be current and include appropriate procedures.

Note: Navigation databases are expected to be current for the duration of the flight. If the AIRAC cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy of the navigation data, including the suitability of navigation facilities used to define the routes and procedures for flight.

6.4.2.3. The availability of the NAVAID infrastructure, required for the intended routes, including any non-RNAV contingencies, must be confirmed for the period of intended operations

using all available information. Since GNSS integrity (RAIM or SBAS signal) is required by Annex 10, the availability of these should also be determined as appropriate. For aircraft navigating with SBAS receivers (all TSO-C145()/C146()), operators should check appropriate GPS RAIM availability in areas where the SBAS signal is unavailable.

6.4.3. ABAS availability

6.4.3.1. RAIM levels required for RNP 1 can be verified either through NOTAMs (where available) or through prediction services. The operating authority may provide specific guidance on how to comply with this requirement (e.g. if sufficient satellites are available, a prediction may not be necessary). Operators should be familiar with the prediction information available for the intended route.

6.4.3.2. RAIM availability prediction should take into account the latest GPS constellation NOTAMs and avionics model (when available). The service may be provided by the ANSP, avionics manufacturer, other entities or through an airborne receiver RAIM prediction capability.

6.4.3.3. In the event of a predicted, continuous loss of appropriate level of fault detection of more than five minutes for any part of the RNP 1 operation, the flight planning should be revised (e.g. delaying the departure or planning a different departure procedure).

6.4.3.4. RAIM availability prediction software does not guarantee the service, rather, they are tools to assess the expected capability to meet the required navigation performance. Because of unplanned failure of some GNSS elements, pilots/ANSP must realize that RAIM or GPS navigation altogether may be lost while airborne which may require reversion to an alternative means of navigation. Therefore, pilots should assess their capability to navigate (potentially to an alternate destination) in case of failure of GPS navigation.

6.4.4. General operating procedures

6.4.4.1. The pilot should comply with any instructions or procedures identified by the manufacturer as necessary to comply with the performance requirements in this navigation specification.

6.4.4.2. Operators and pilots should not request or file RNP 1 procedures unless they satisfy all the criteria in the relevant State documents. If an aircraft not meeting these criteria receives a clearance from ATC to conduct a RNP 1 procedure, the pilot must advise ATC that he/she is unable to accept the clearance and must request alternate instructions.

6.4.4.3. At system initialization, pilots must confirm that the aircraft position has been entered correctly. Pilots must verify proper entry of their ATC assigned route upon initial clearance and any subsequent change of route. Pilots must ensure that the waypoint sequence depicted by their navigation system matches the route depicted on the appropriate chart(s) and their assigned route.

6.4.4.4. Pilots must not fly a RNP 1 SID or STAR unless it is retrievable by procedure name from the on-board navigation database and conforms to the charted procedure. However, the procedure may subsequently be modified through the insertion or deletion of specific waypoints in response to ATC clearances. The manual entry, or creation of new waypoints, by manual entry of latitude and longitude or rho/theta values is not permitted. Additionally, pilots must not change any SID or STAR database waypoint type from a fly-by to a flyover or vice versa.

6.4.4.5. Pilots should cross-check the cleared flight plan by comparing charts or other applicable resources with the navigation system textual display and the aircraft map display, if applicable. If required, the exclusion of specific NAVAIDs should be confirmed.

Note: Pilots may notice a slight difference between the navigation information portrayed on the chart and their primary navigation display. Differences of 3 degrees or less may result from the equipment manufacturer's application of magnetic variation and are operationally acceptable.

6.4.4.6. Cross-checking with conventional NAVAIDs is not required, as the absence of integrity alert is considered sufficient to meet the integrity requirements. However, monitoring of navigation reasonableness is suggested, and any loss of RNP capability shall be reported to ATC.

6.4.4.7. For RNP 1 routes, pilots must use a lateral deviation indicator, flight director, or autopilot in lateral navigation mode. Pilots of aircraft with a lateral deviation display must ensure

that lateral deviation scaling is suitable for the navigation accuracy associated with the route/procedure (e.g. full-scale deflection: ± 1 NM for RNP 1).

6.4.4.8. All pilots are expected to maintain centrelines, as depicted by on-board lateral deviation indicators and/or flight guidance during all RNP 1 operations described in this manual, unless authorized to deviate by ATC or under emergency conditions. For normal operations, cross-track error/deviation (the difference between the system computed path and the aircraft position relative to the path, i.e. FTE) should be limited to $\pm \frac{1}{2}$ the navigation accuracy associated with the procedure (i.e. 0.5 NM for RNP 1). Brief deviations from this standard (e.g. overshoots or undershoots) during and immediately after turns, up to a maximum of one-times the navigation accuracy (i.e. 1.0 NM for RNP 1) are allowable.

Note: Some aircraft do not display or compute a path during turns, but are still expected to satisfy the above standard during intercepts following turns and on straight segments.

6.4.4.9. If ATC issues a heading assignment that takes an aircraft off of a route, the pilot should not modify the flight plan in the RNP system until a clearance is received to rejoin the route or the controller confirms a new route clearance. When the aircraft is not on the published RNP 1 route, the specified accuracy requirement does not apply.

6.4.4.10. Manually selecting aircraft bank limiting functions may reduce the aircraft's ability to maintain its desired track and are not recommended. Pilots should recognize that manually selectable aircraft bank-limiting functions might reduce their ability to satisfy ATC path expectations, especially when executing large angle turns. This should not be construed as a requirement to deviate from aeroplane flight manual procedures; pilots should be encouraged to limit the selection of such functions within accepted procedures.

6.4.5. Aircraft with RNP selection capability

Pilots of aircraft with RNP input selection capability should select RNP 1 or lower, for RNP 1 SIDs and STARs.

6.4.6. RNP 1 SID specific requirements

6.4.6.1. Prior to commencing take-off, the pilot must verify the aircraft's RNP 1 system is available, operating correctly, and the correct airport and runway data are loaded. Prior to flight, pilots must verify their aircraft navigation system is operating correctly and the correct runway and departure procedure (including any applicable en-route transition) are entered and properly depicted. Pilots who are assigned a RNP 1 departure procedure and subsequently receive a change of runway, procedure or transition must verify the appropriate changes are entered and available for navigation prior to take-off. A final check of proper runway entry and correct route depiction, shortly before take-off, is recommended.

6.4.6.2. *Engagement altitude.* The pilot must be able to use RNP 1 equipment to follow flight guidance for lateral navigation e.g., LNAV no later than 153 m (500 ft) above airport elevation.

6.4.6.3. Pilots must use an authorized method (lateral deviation indicator/navigation map display/flight director/autopilot) to achieve an appropriate level of performance for RNP 1.

6.4.6.4. GNSS aircraft. When using GNSS, the signal must be acquired before the take-off roll commences. For aircraft using TSO-C129a avionics, the departure airport must be loaded into the flight plan in order to achieve the appropriate navigation system monitoring and sensitivity. For aircraft using TSO-C145()/C146() avionics, if the departure begins at a runway waypoint, then the departure airport does not need to be in the flight plan to obtain appropriate monitoring and sensitivity. If the RNP 1 SID extends beyond 30 NM from the ARP and a lateral deviation indicator is used, its full-scale sensitivity must be selected to not greater than 1 NM between 30 NM from the ARP and the termination of the RNP 1 SID.

6.4.6.5. For aircraft using a lateral deviation display (i.e. navigation map display), the scale must be set for the RNP 1 SID, and the flight director or autopilot should be used.

6.4.7. RNP 1 STAR specific requirements

6.4.7.1. Prior to the arrival phase, the pilot should verify that the correct terminal route has been loaded. The active flight plan should be checked by comparing the charts with the map display (if applicable) and the MCDU. This includes confirmation of the waypoint sequence,

reasonableness of track angles and distances, any altitude or speed constraints, and, where possible, which waypoints are fly-by and which are flyover. If required by a route, a check will need to be made to confirm that updating will exclude a particular NAVAID. A route must not be used if doubt exists as to the validity of the route in the navigation database.

Note: As a minimum, the arrival checks could be a simple inspection of a suitable map display that achieves the objectives of this paragraph.

6.4.7.2. The creation of new waypoints by manual entry into the RNP 1 system by the pilot would invalidate the route and is not permitted.

6.4.7.3. Where the contingency procedure requires reversion to a conventional arrival route, necessary preparations must be completed before commencing the RNP 1 procedure.

6.4.7.4. Procedure modifications in the terminal area may take the form of radar headings or “direct to” clearances and the pilot must be capable of reacting in a timely fashion. This may include the insertion of tactical waypoints loaded from the database. Manual entry or modification by the pilot of the loaded route, using temporary waypoints or fixes not provided in the database, is not permitted.

6.4.7.5 Pilots must verify their aircraft navigation system is operating correctly and the correct arrival procedure and runway (including any applicable transition) are entered and properly depicted.

6.4.7.5. Although a particular method is not mandated, any published altitude and speed constraints must be observed.

6.4.7.6. Aircraft with TSO-C129a GNSS RNP systems: If the RNP 1 STAR begins beyond 30 NM from the ARP and a lateral deviation indicator is used, then full scale sensitivity should be manually selected to not greater than 1 NM prior to commencing the STAR. For aircraft using a lateral deviation display (i.e. navigation map display), the scale must be set for the RNP 1 STAR, and the flight director or autopilot should be used.

6.4.8. Contingency Procedures

6.4.8.1. The pilot must notify ATC of any loss of the RNP capability (integrity alerts or loss of navigation), together with the proposed course of action. If unable to comply with the requirements of a RNP 1 SID or STAR for any reason, pilots must advise ATS as soon as possible. The loss of RNP capability includes any failure or event causing the aircraft to no longer satisfy the RNP 1 requirements of the route.

6.4.8.2. In the event of communications failure, the pilot should continue with the published lost communications procedure.

6.5. Pilot knowledge and training

The training programme should provide sufficient training (e.g. simulator, training device, or aircraft) on the aircraft's RNP system to the extent that the pilots are familiar with the following:

- a) the information in this chapter;
- b) the meaning and proper use of aircraft equipment/navigation suffixes;
- c) procedure characteristics as determined from chart depiction and textual description;
- d) depiction of waypoint types (flyover and fly-by) and path terminators (provided in 3.3.3.3 AIRINC 424 path terminators) and any other types used by the operator), as well as associated aircraft flight paths;
- e) required navigation equipment for operation on RNP 1 SIDs, and STARs;
- f) RNP system-specific information:
 - i. levels of automation, mode annunciations, changes, alerts, interactions, reversions, and degradation;
 - ii. functional integration with other aircraft systems;
 - iii. the meaning and appropriateness of route discontinuities as well as related pilot procedures;
 - iv. pilot procedures consistent with the operation;
 - v. types of navigation sensors utilized by the RNP system and associated system prioritization/ weighting/logic;
 - vi. turn anticipation with consideration to speed and altitude effects;
 - vii. interpretation of electronic displays and symbols;
 - viii. understanding of the aircraft configuration and operational conditions required to support RNP 1 operations, i.e. appropriate selection of CDI scaling (lateral deviation display scaling);

- g) RNP system operating procedures, as applicable, including how to perform the following actions:
 - i. verify currency and integrity of the aircraft navigation data;
 - ii. verify the successful completion of RNP system self-tests;
 - iii. initialize navigation system position;
 - iv. retrieve and fly a RNP 1 SID or a STAR with appropriate transition;
 - v. adhere to speed and/or altitude constraints associated with a RNP 1 SID or STAR;
 - vi. select the appropriate RNP 1 SID or STAR for the active runway in use and be familiar with procedures to deal with a runway change;
 - vii. verify waypoints and flight plan programming;
 - viii. fly direct to a waypoint;
 - ix. fly a course/track to a waypoint;
 - x. intercept a course/track;
 - xi. following vectors and rejoining a RNP 1 route from “heading” mode;
 - xii. determine cross-track error/deviation. More specifically, the maximum deviations allowed to support RNP 1 must be understood and respected;
 - xiii. resolve route discontinuities;
 - xiv. remove and reselect navigation sensor input;
 - xv. when required, confirm exclusion of a specific NAVAID or NAVAID type;
 - xvi. change arrival airport and alternate airport;
 - xvii. perform parallel offset function if capability exists. Pilots should know how offsets are applied, the functionality of their particular RNP system and the need to advise ATC if this functionality is not available;
 - xviii. perform RNAV holding function;
- h) operator-recommended levels of automation for phase of flight and workload, including methods to minimize cross-track error to maintain route centerline;
- i) R/T phraseology for RNAV/RNP applications; and
- j) contingency procedures for RNAV/RNP failures.

6.6. Navigation database

6.6.1. The navigation database must be obtained from a supplier that complies with RTCA DO 200A/EUROCAE document ED 76, Standards for Processing Aeronautical Data. A Letter of

Acceptance (LOA), issued by the appropriate regulatory authority to each of the participants in the data chain demonstrates compliance with this requirement (e.g. FAA LOA issued in accordance with FAA AC 20-153 or EASA LOA issued in accordance with EASA OPINION Nr. 01/2005).

6.6.2. Discrepancies that invalidate a SID or STAR must be reported to the navigation database supplier and the affected SID or STAR must be prohibited by an operator's notice to its pilots.

6.6.3. Aircraft operators should consider the need to conduct periodic checks of the operational navigation databases in order to meet existing quality system requirements.

Note: To minimize path definition error, the database should comply with DO 200A, or an equivalent operational means must be in place to ensure database integrity for the RNP 1 SIDs or STARS.

6.7. Oversight of operators

6.7.1. A regulatory authority should consider any navigation error reports in determining remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment may result in cancellation of the approval for use of that equipment.

6.7.2. Information that indicates the potential for repeated errors may require modification of an operator's training programme. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training or licence review.

CHAPTER 7 IMPLEMENTING RNP APPROACH

7.1. Background

This section identifies the airworthiness and operational requirements for RNP APCH operation down to LP or LPV minima using augmented GNSS. Operational compliance with these requirements must be addressed through national operational regulations, and may require a specific operational approval in some cases. For example, certain operational regulations require operators to apply to their national Authority (State of Registry) for operational approval.

This chapter addresses the lateral and vertical part of the navigation system.

7.2. Approval process

This navigation specification does not in itself constitute regulatory guidance material against which either the aircraft or the operator will be assessed and approved. Aircraft are certified by their State of Manufacture. Operators are approved in accordance with their national operating rules. This navigation specification provides the technical and operational criteria, and does not necessarily imply a need for recertification.

Notes:

- 1. Detailed information on operational approvals is provided in Doc 9613 Volume I, Attachment C*
- 2. Where appropriate, States may refer to previous operational approvals in order to expedite this process for individual operators where performance and functionality is applicable to the current request for operational approval.*

7.2.1. Aircraft Eligibility

The aircraft eligibility must be determined through demonstration of compliance against the relevant airworthiness criteria and the requirements of 7.3. The OEM or the holder of installation approval for the aircraft, e.g. STC holder, will demonstrate compliance to their national airworthiness authority (NAA) (e.g. EASA, FAA) and the approval can be documented in manufacturer documentation (e.g. service letters). Aircraft flight manual (AFM) entries are not

required provided the State accepts manufacturer documentation.

Note. Requests for approval to use optional functionality (e.g. RF Legs) should address the aircraft and operational requirements as described in the appropriate functional annex to Volume II.

7.2.2. Operational Approval

7.2.2.1. Description of aircraft equipment

The operator must have a configuration list and, if necessary, a Minimum Equipment List (MEL) detailing the required aircraft equipment for RNP APCH operations to LP or LPV minima.

7.2.2.2. Training documentation

Commercial operators must have a training programme addressing the operational practices, procedures and training items related to RNP APCH operations to LP or LPV minima (e.g. initial, upgrade or recurrent training for pilots, dispatchers or maintenance personnel).

Note. Operators need not establish a separate training programme or regimen if they already integrate RNAV training as an element of their training programme. However, the operator should be able to identify the aspects of RNP APCH operations to LP or LPV minima covered within their training programme.

Private operators must be familiar with the practices and procedures in paragraph 7.5, “Pilot knowledge and training”.

7.2.2.3. Operations manuals and checklists

Operations manuals and checklists for commercial operators must address information/guidance on the standard operating procedures detailed in 7.4. The appropriate manuals should contain navigation operating instructions and contingency procedures, where specified. When required by the State of Operator/Registry, the operator must submit their manuals and checklists for review as part of the application process.

Private operators should operate using the practices and procedures in paragraph 7.5, “Pilot knowledge and training”.

7.2.2.4. Minimum Equipment List (MEL) considerations

Any Minimum Equipment List (MEL) revisions necessary to address provisions for RNP APCH operations to LP or LPV minima must be approved. Operators must adjust the MEL, or equivalent, and specify the required dispatch conditions.

7.2.2.5. Continuing airworthiness

The operator must submit the continuing airworthiness instructions applicable to the aircraft's configuration and the aircraft's qualification for this navigation specification. Additionally, there is a requirement for the operator to submit their maintenance programme, including a reliability programme for monitoring the equipment.

Note: The operator should confirm with the OEM, or the holder of installation approval for the aircraft, that acceptance of subsequent changes in the aircraft configuration e.g. service bulletins, does not invalidate current operational approvals.

7.3. Aircraft requirements

7.3.1. On-Board Performance monitoring and alerting

7.3.1.1. *Accuracy:* Along the final approach segment and the straight continuation of the final approach in the missed approach, the lateral and vertical Total System Error is dependent on the Navigation System Error (NSE), Path Definition Error (PDE) and Flight Technical Error (FTE).

- a) NSE: the accuracy itself (the error bound with 95 per cent probability) changes due to different satellite geometries. Assessment based on measurements within a sliding time window is not suitable for GNSS. Therefore, GNSS accuracy is specified as a probability for each and every sample NSE requirements are fulfilled without any demonstration if the equipment computes three dimensional position using linearized, weighted least square solution in accordance with RTCA DO 229C (or subsequent version) Appendix J.
- b) FTE: FTE performance is considered acceptable if the lateral and vertical display full scale deflection is compliant with the non-numeric lateral cross-track and vertical deviation requirements of RTCA DO 229 C (or subsequent version) and if the crew maintain the aircraft within 1/3 the full scale deflection for the lateral deviation and within 1/2 the full scale deflection for the vertical deviation

- c) PDE: PDE is considered negligible based upon the process of path specification to data specification and associated quality assurance that is included in the FAS data-block generation process which is a standardized process. The responsibilities for FAS data block generation lies with the Air Navigation Service Provider.

Note: FTE performance is considered acceptable if the approach mode of the Flight Guidance System is used during such approach.

7.3.1.2. Integrity: Simultaneously presenting misleading lateral and vertical guidance with misleading distance data during an RNP APCH operation down to LPV minima is considered a hazardous failure condition (extremely remote). Simultaneously presenting misleading lateral guidance with misleading distance data during an RNP APCH operation down to LP minima is considered a hazardous failure condition (extremely remote).

7.3.1.3. Continuity: Loss of approach capability is considered a minor failure condition if the operator can revert to a different navigation system and proceed to a suitable airport. For RNP APCH operation down to LP or LPV minima at least one system is required.

7.3.1.4. On-board performance monitoring and alerting: Operations on the final approach segment of an RNP APCH operation down to LP and LPV minima, the on-board performance monitoring and alerting function is fulfilled by:

- a) NSE monitoring and alerting (see *Signal-in-space* section).
- b) FTE monitoring and alerting: LPV approach guidance must be displayed on a lateral and vertical deviation display (HSI, EHSI, CDI/VDI) including a failure indicator. The deviation display must have a suitable full-scale deflection based on the required track keeping accuracy. The lateral and vertical full scale deflection are angular and associated to the lateral and vertical definitions of the final approach segment contained in the FAS data block.
- c) Navigation database: Once the FAS data block has been decoded, the equipment shall apply the CRC to the data block to determine if the data is valid. If the FAS data block does not pass the CRC test, the equipment shall not allow activation of the LP or LPV approach operation.

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7.3.1.5. Signal-in-space: between 2NM from the FAP and the FAP, the aircraft navigation equipment shall provide an alert within 10 seconds if the signal-in-space errors causing a lateral position error is greater than 0.6 NM, with a probability of $1-10^{-7}$ per hour.

After sequencing the FAP and during operations on the final approach segment of an RNP APCH operation down to LP or LPV minima:

- a) the aircraft navigation equipment shall provide an alert within 6 seconds if the signal-in-space errors causing a lateral position error is greater than 40 m, with a probability of $1-2.10^{-7}$ in any approach (Annex 10, Volume I, Table 3.7.2.4-1); and
- b) the aircraft navigation equipment shall provide an alert within 6 seconds if the signal-in-space errors causing a vertical position error is greater than 50m (or 35 m for LPV minima down to 200 ft), with a probability of $1-2.10^{-7}$ in any approach (Annex 10, Volume I, Table 3.7.2.4-1).

Notes

1. *There are no RNP APCH requirements for the missed approach if it is based on conventional means (VOR, DME, NDB) or on dead reckoning. The requirements for the straight continuation of the final approach, in the missed approach, are in accordance with RTCA DO 229C (or subsequent version).*

2. *Compliance with the performance monitoring and alerting requirement does not imply an automatic monitor of flight technical error. The on-board monitoring and alerting function should consist at least of a navigation system error (NSE) monitoring and alerting algorithm and a lateral and vertical deviation display enabling the crew to monitor the flight technical error (FTE). To the extent operational procedures are used to monitor FTE, the crew procedure, equipment characteristics, and installation are evaluated for their effectiveness and equivalence as described in the functional requirements and operating procedures. Path definition error (PDE) is considered negligible due to the quality assurance process (paragraph B.5.3.6) and crew procedures (paragraph B.5.3.4).*

3. *The following systems meet the accuracy, integrity and continuity requirements of these criteria:*

- a) *GNSS SBAS stand-alone equipment approved in accordance with E/TSO C146a (or*

subsequent version). Application of this standard guarantees that the equipment is at least compliant with RTCA DO 229C. The equipment should be a Class Gamma, operational class 3; b) for integrated navigation system (e.g. FMS) incorporating a GNSS SBAS sensor, E/TSO C115b and AC 20-130A provide an acceptable means of compliance for the approval of this navigation system when augmented by the following guidelines:

- i) the performance requirements of E/TSO-C146a (or subsequent version) that apply to the functional class gamma, operational class 3 or delta 4 is demonstrated; and*
- ii) The GNSS SBAS sensor is approved in accordance with E/TSO C145a class Beta, operational class 3;*
- c) approach system incorporating a class Delta GNSS SBAS equipment approved in accordance with E/TSO C146a (or subsequent version). This standard guarantees that the equipment is at least compliant with RTCA DO 229C. The equipment should be a Class Delta 4; and*
- d) future augmented GNSS systems are also expected to meet these requirements.*

7.3.2. Criteria for specific navigation systems

RNP APCH operations down to LP or LPV minima is based on augmented GNSS positioning. Positioning data from other types of navigation sensors may be integrated with the GNSS data provided it does not cause position errors exceeding the total system error (TSE) budget, or if means are provided to deselect the other navigation sensor types.

7.4. Operating procedures

7.4.1. Airworthiness certification alone does not authorize operator to conduct RNP APCH operation down to LP or LPV minima. Operational approval is also required to confirm the adequacy of the operator's normal and contingency procedures for the particular equipment installation.

7.4.2. Pre-flight planning

7.4.2.1. Operators and pilots intending to conduct RNP APCH operation down to LP or LPV minima must file the appropriate ATC flight plan suffixes. The on board navigation data must be current

and must include the appropriate procedures.

Note: Navigation databases are expected to be current for the duration of the flight. If the AIRAC cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy of navigation data, including suitability of navigation facilities used to define the routes and procedures for flight.

7.4.2.2. In addition to the normal pre-flight planning the following checks must be carried out:

- a) The pilot must ensure that approach procedures which may be used for the intended flight (including alternates aerodromes) are selectable from a valid navigation data base (current AIRAC cycle), have been verified by the appropriate process and are not prohibited by a company instruction or NOTAM.
- b) Subject to State's regulations, during the pre-flight phase, the pilot should ensure sufficient means are available to navigate and land at the destination or at an alternate aerodrome in the case of loss of LP or LPV airborne capability.
- c) Operators and flight-crews must take account of any NOTAMs (including SBAS NOTAMs) or operator briefing material that could adversely affect the aircraft system operation, or the availability or suitability of the procedures at the airport of landing, or any alternate airport.

- d) If the missed approach procedure is based on conventional means (e.g. VOR, NDB) the appropriate airborne equipment required to fly this procedure must be installed in the aircraft and must be operational. The associated ground-based NAVAIDs must also be operational. If the missed approach procedure is based on RNAV (no conventional or dead reckoning missed approach available) the appropriate airborne equipment required to fly this procedure must be installed in the aircraft and must be operational.

7.4.2.3. The availability of the NAVAID infrastructure, required for the intended routes, including any non-RNAV contingencies, must be confirmed for the period of intended operations using all available information. Since GNSS integrity is required by Annex 10, the availability of these should also be determined as appropriate.

7.4.3. Augmented GNSS availability

7.4.3.1. Service levels required for RNP APCH operations down to LP or LPV minima can be verified either through NOTAMs (where available) or through prediction services. The operating authority may provide specific guidance on how to comply with this requirement. Operators should be familiar with the prediction information available for the intended route.

7.4.3.2. LP or LPV service availability prediction should take into account the latest GPS constellation and SBAS system status NOTAMs and avionics model (when available). The service may be provided by the ANSP, avionics manufacturer, other entities or through an airborne receiver LP or LPV service prediction capability.

7.4.3.3. In the event of a predicted, continuous loss of appropriate level of fault detection of more than five minutes for any part of the RNP APCH operation, the flight planning should be revised (e.g. delaying the departure or planning a different departure procedure).

7.4.3.4. Service availability prediction software does not guarantee the service, they are tools to assess the expected capability to meet the required navigation performances. Because of unplanned failure of some GNSS or SBAS elements, pilots/ANSP should realize that GPS or SBAS navigation altogether may be lost while airborne which may require reversion to an alternative means of navigation. Therefore, pilots should assess their capability to navigate (potentially to an alternate destination) in case of failure of GPS plus SBAS navigation.

7.4.3.5. These availability prediction services are expected to be developed also for future GNSS systems with performances equivalent to SBAS.

7.4.4. Prior to commencing the procedure

7.4.4.1. In addition to the normal procedure prior to commencing the approach (before the IAF and in compatibility with crew workload), the flight crew must verify the correct procedure was loaded by comparison with the approach charts. This check must include:

- a) the waypoint sequence; and
- b) reasonableness of the tracks and distances of the approach legs, and the accuracy of the inbound course and length of the final approach segment.

Note.— As a minimum, this check could be a simple inspection of a suitable map display that achieves the objectives of this paragraph.

7.4.4.2 The crew must also check using the published charts, the map display or control display unit (CDU), which waypoints are fly-by and which are flyover.

7.4.4.3 For multi-sensor systems, the crew must verify, during the approach, that the GNSS sensor is used for position computation.

7.4.4.4 For an RNP system with ABAS requiring barometric corrected altitude, the current airport barometric altimeter setting should be input at the appropriate time and location, consistent with the performance of the flight operation.

7.4.4.5 When the operation is predicated on the availability of ABAS, the flight crew should perform a new RAIM availability check if ETA is more than 15 minutes different from the ETA used during the preflight planning. This check is also processed automatically 2 NM before the FAF for an E/TSO-C129a Class A1 receiver.

7.4.4.6 ATC tactical interventions in the terminal area may include radar headings, “direct to” clearances which bypass the initial legs of an approach, interception of an initial or intermediate segment of an approach, or the insertion of waypoints loaded from the database. In complying with ATC instructions, the flight crew should be aware of the implications for the RNP system:

- a) the manual entry of coordinates into the RNAV system by the flight crew for operation within the terminal area is not permitted; and
- b) “direct to” clearances may be accepted to the intermediate fix (IF) provided that the resulting track change at the IF does not exceed 45 degrees.

Note.— “Direct to” clearance to FAF is not acceptable.

7.4.4.7 The lateral definition of the flight path between the FAF and the missed approach point (MAPt) must not be revised by the flight crew under any circumstances.

7.4.5 During the procedure

7.4.5.1 The aircraft must be established on the final approach course no later than the FAF before starting the descent (to ensure terrain and obstacle clearance).

7.4.5.2 The crew must check the approach mode annunciator (or equivalent) is properly indicating approach mode integrity within 2 NM before the FAF.

Note.— This will not apply for certain RNP systems (e.g. aircraft already approved with demonstrated RNP capability). For such systems, other means are available including electronic map displays, flight guidance mode indications, etc., which clearly indicate to the crew that the approach mode is activated.

7.4.5.3 The appropriate displays must be selected so that the following information can be monitored:

- a) the RNAV-computed desired path (DTK); and
- b) the aircraft position relative to the path (cross-track deviation) for FTE monitoring.

7.4.5.4 The procedure must be discontinued:

- a) if the navigation display is flagged invalid; or
- b) in case of loss of integrity alerting function; or
- c) if integrity alerting function is annunciated not available before passing the FAF; or

Note.— Discontinuing the procedure may not be necessary for a multi-sensor RNP system that includes demonstrated RNP capability without GNSS. Manufacturer documentation should be examined to determine the extent the system may be used in such configuration.

- d) if FTE is excessive.

7.4.5.5 The missed approach must be flown in accordance with the published procedure. Use of the RNAV system during the missed approach is acceptable, provided:

a) the RNAV system is operational (e.g no loss of function, no NSE alert, no failure indication); and

b) the whole procedure (including the missed approach) is loaded from the navigation database.

7.4.5.6 During the RNP APCH procedure, pilots must use a lateral deviation indicator, flight director and/or autopilot in lateral navigation mode. Pilots of aircraft with a lateral deviation indicator (e.g. CDI) must ensure that lateral deviation indicator scaling (full-scale deflection) is suitable for the navigation accuracy associated with the various segments of the procedure (i.e. ± 1.0 NM for the initial and intermediate segments, ± 0.3 NM for the final approach segment, and ± 1.0 NM for the missed approach segment). All pilots are expected to maintain procedure centrelines, as depicted by on-board lateral deviation indicators and/or flight guidance during the whole approach procedure, unless authorized to deviate by ATC or under emergency conditions. For normal operations, cross-track error/deviation (the difference between the RNAV system computed path and the aircraft position relative to the path) should be limited to $\pm \frac{1}{2}$ the navigation accuracy associated with the procedure (i.e. 0.5 NM for the initial and intermediate segments, 0.15 NM for the final approach segment, and 0.5 NM for the missed approach segment). Brief deviations from this standard (e.g. overshoots or undershoots) during and immediately after turns, up to a maximum of one-times the navigation accuracy (i.e. 1.0 NM for the initial and intermediate segments), are allowable.

7.4.5.7 When Barometric VNAV is used for vertical path guidance during the final approach segment, deviations above and below the Barometric VNAV path must not exceed +30 m/–15 m (+100 ft/–50 ft), respectively.

7.4.5.8 Pilots must execute a missed approach if the lateral deviations or vertical deviations, if provided, exceed the criteria above, unless the pilot has in sight the visual references required to continue the approach.

7.4.6 General operating procedures

7.4.6.1 Operators and pilots must not request an RNP APCH operation down to LP or LPV minima unless they satisfy all the criteria in the relevant State documents. If an aircraft not

meeting these criteria receives a clearance from ATC to conduct such an approach procedure, the pilot must advise ATC that he/she is unable to accept the clearance and must request alternate instructions.

7.4.6.2 The pilot must comply with any instructions or procedures identified by the manufacturer as necessary to comply with the performance requirements in this chapter.

B.5.3.4.6.3 If the missed approach procedure is based on conventional means (e.g. NDB, VOR, DME), related navigation equipment must be installed and be serviceable.

7.4.6.4 Pilots are encouraged to use flight director and/or autopilot in lateral navigation mode, if available.

7.4.4.2. In addition to normal procedure prior to commencing the approach (before the IAF and in compatibility with crew workload), the pilot must verify the correctness of the loaded procedure by comparison with the appropriate approach charts. This check must include:

- a) the waypoint sequence;
- b) reasonableness of the tracks and distances of the approach legs, and the accuracy of the inbound course and mileage of the final approach segment; and

Note: As a minimum, this check could be a simple inspection of a suitable map display.

- c) the vertical path angle.

7.4.4.3. ATC tactical interventions in the terminal area may include radar headings, 'direct to' clearances which by-pass the initial legs of an approach, interception of an initial or intermediate segment of an approach or the insertion of waypoints loaded from the database. In complying with ATC instructions, the pilot should be aware of the implications for the navigation system.

- a) The manual entry of coordinates into the navigation system by the pilot for operation within the terminal area is not permitted.
- b) 'Direct to' clearances may be accepted to the intermediate fix (IF) provided that the resulting track change at the IF does not exceed 45°.

Note: Direct to clearance to FAP is not acceptable.

7.4.4.4. The approach system provides the capability for the pilot to intercept the final approach track well before the FAP (vector to final (VTF) function or equivalent). This function should be

used to respect a given ATC clearance.

7.4.5. During the procedure

7.4.5.1. The approach mode will be activated automatically by the RNP system. When a direct transition to the approach procedure is conducted (e.g. when the aircraft is vectored by the ATC to the extended final approach segment and crew selects the VTF function or an equivalent function), the LP or LPV approach mode is also immediately activated.

7.4.5.2. The system provides lateral and/or vertical guidance relative to the LP or LPV final approach segment or to the extended final approach segment (for the direct transition).

7.4.5.3. The crew must check that the GNSS approach mode indicates LP or LPV (or an equivalent annunciation) 2 NM before the FAP.

7.4.5.4. The final approach segment should be intercepted no later than the FAP in order for the aircraft to be correctly established on the final approach course before starting the descent (to ensure terrain and obstacle clearance).

7.4.5.5. The appropriate displays should be selected so that the following information can be monitored:

- a) aircraft position relative to the lateral path;
- b) aircraft position relative to the vertical path; and
- c) absence of LOI (loss of integrity) alert.

7.4.5.6. The crew should respect all published altitude and speed constraints.

7.4.5.7. Prior to sequencing the FAP, the crew should abort the approach procedure if there is:

- a) loss of navigation indicated by a warning flag (e.g. absence of power, equipment

- failure,...);
- b) loss of integrity monitoring (LOI), annunciated locally, or equivalent; and
- c) low altitude alert (if applicable).

7.4.5.8. After sequencing the FAP, unless the pilot has the visual references required to continue the approach in sight, the procedure must be discontinued if:

- a) loss of navigation is indicated by a warning flag (e.g. lateral flag, vertical flag or both flags);

Note: Loss of integrity monitoring (LOI) after sequencing the FAP leads to a loss of navigation (warning flag).

- b) loss of vertical guidance is indicated (even if lateral guidance is already displayed); and
- c) FTE is excessive and cannot be corrected in a timely manner.

7.4.5.9. Pilots must execute a missed approach if excessive lateral and/or vertical deviations are encountered and cannot be timely corrected, unless the pilot has in sight the visual references required to continue the approach. The missed approach must be flown in accordance with the published procedure (e.g. conventional or RNAV).

7.4.6. General operating procedures

7.4.6.1. Operators and pilots must not request an RNP APCH operation down to LP or LPV minima unless they satisfy all the criteria in the relevant State documents. If an aircraft not meeting these criteria receives a clearance from ATC to conduct such an approach procedure, the pilot must advise ATC that he/she is unable to accept the clearance and must request alternate instructions.

7.4.6.2. The pilot must comply with any instructions or procedures identified by the manufacturer as necessary to comply with the performance requirements in this chapter. B.5.3.4.6.3 If the missed approach procedure is based on conventional means (e.g. NDB, VOR, DME), related navigation equipment must be installed and be serviceable.

7.4.6.3. Pilots are encouraged to use flight director and/or autopilot in lateral navigation mode, if available.

7.4.7. Contingency procedures

7.4.7.1. The operator should develop contingency procedure in order to react safely following the loss of the approach capability during the approach.

7.4.7.2. The pilot must notify ATC of any loss of the RNP APCH capability, together with the proposed course of action. If unable to comply with the requirements of an RNP APCH procedure, pilots must advise Air Traffic Service as soon as possible. The loss of RNP APCH capability includes any failure or event causing the aircraft to no longer satisfy the RNP APCH requirements of the procedure.

7.4.7.3. In the event of communications failure, the pilot should continue with the procedure in accordance with published lost communication procedures.

7.5. Pilot knowledge and training

The pilot training programme should be structured to provide sufficient theoretical and practical training, using a simulator, training device, or line training in an aircraft, on the use of the aircraft's approach system to ensure that pilots are not just task oriented. The following syllabus should be considered as a minimum amendment to the training programme to support these operations:

- a) RNP approach concept containing LP or LPV minima:
 - i. theory of approach operations;
 - ii. approach charting;
 - iii. use of the approach system including:
 - 1) selection of the LP or LPV approach procedure;
 - 2) ILS look alike principle;
 - iv. use of lateral navigation mode(s) and associated lateral control techniques;
 - v. use of vertical navigation mode(s) and associated vertical control techniques;
 - vi. R/T phraseology for LP or LPV approach operations;
 - vii. the implication for LP or LPV approach operations of systems malfunctions which

are not related to the approach system (e.g. hydraulic failure); and

- b) RNP approach operation containing LP or LPV minima:
 - i. definition of LP or LPV approach operations and its direct relationship with RNAV(GNSS) procedures;
 - ii. regulatory requirements for LP or LPV approach operations;
 - iii. required navigation equipment for LP or LPV approach operations:
 - 1) GPS concepts and characteristics;
 - 2) augmented GNSS characteristics; and
 - 3) MEL; and
 - iv. procedure characteristics:
 - 1) chart depiction;
 - 2) aircraft display depiction;
 - 3) minima; and
 - v. retrieving a LP or LPV approach procedure from the database (e.g. using its name or the SBAS channel number);
 - vi. Change arrival airport and alternate airport;
 - vii. Flying the procedure:
 - 1) use of autopilot, autothrottle and flight director;
 - 2) flight Guidance(FG) mode behaviour;
 - 3) Lateral and vertical path management;
 - 4) adherence to speed and/or altitude constraints;
 - 5) fly interception of an initial or intermediate segment of an approach following ATC notification;
 - 6) fly interception of the extended final approach segment (e.g. using the VTF function);
 - 7) consideration of the GNSS approach mode indication (LP, LPV, LNAV/VNAV, LNAV,...); and
 - 8) the use of other aircraft equipment to support track monitoring, weather and obstacle avoidance; and
 - viii. ATC procedures;
 - ix. abnormal procedures; and
 - x. contingency procedures.

7.6. Navigation database

7.6.1. The operator should not use a navigation database for these approach operations unless the navigation database supplier holds a Type 2 Letter of Acceptance (LoA) or equivalent.

7.6.2. An EASA Type 2 LoA is issued by EASA in accordance with EASA OPINION Nr. 01/2005 on “The Acceptance of Navigation Database Suppliers” dated 14 January 2005. The FAA issues a Type 2 LoA in accordance with AC 20-153, while Transport Canada (TCCA) issues an Acknowledgement Letter of an Aeronautical Data Process using the same basis.

7.6.3. EUROCAE/RTCA document ED-76/DO-200A Standards for Processing Aeronautical Data contains guidance relating to the processes that the supplier may follow. The LoA demonstrates compliance with this standard.

7.6.4. The operator should continue to monitor both the process and the products in accordance with the quality system required by the applicable operational regulations.

7.6.5. The operator should implement procedures that ensure timely distribution and insertion of current and unaltered electronic navigation data to all aircraft that require it.

7.7. Oversight of operators

7.7.1. A regulatory authority may consider any navigation error reports in determining remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment may result in cancellation of the approval for use of that equipment.

7.7.2. Information that indicates the potential for repeated errors may require modification of an operator’s training program. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training or license review.

CHAPTER 8 IMPLEMENTING RNP AR

8.1. Background

This section identifies the operational requirements for RNP AR APCH operations. Operational compliance with these requirements shall be addressed through national operational regulations.

8.2. Approval process

This navigation specification does not in itself constitute regulatory guidance material against which either the aircraft or the operator will be assessed and approved. Aircraft are certified by their State of Manufacture. Operators are approved in accordance with their national operating rules. This navigation specification provides the technical and operational criteria, and does not necessarily imply a need for recertification.

Notes:

- 1. Detailed information on operational approvals is provided in Doc 9613 Volume I, Attachment C*
- 2. Where appropriate, States may refer to previous operational approvals in order to expedite this process for individual operators where performance and functionality is applicable to the current request for operational approval.*

Any operator with an appropriate operational approval may conduct RNP AR APCH instrument approach procedures, in a similar manner that operators with the proper authorization may conduct CAT II and CAT III ILS operations. This authorization may be in the form of a single approval for all RNP AR APCH procedures within a State, separate approvals for each RNP AR APCH procedure, or a combination of these methods (for example, State-wide approval for all procedures except those in highly challenging operational environments).

Due to the unique requirements of RNP AR APCH operations and the demand for crew procedures that are specific to each particular aircraft and navigation system, RNP AR APCH operational support documentation is required from the manufacturer. The documentation should describe the navigation capabilities of the applicant's aircraft in the context of the RNP AR APCH operations for which approval is being sought, and provide all the assumptions,

limitations and supporting information necessary for the safe conduct of RNP AR APCH operations. Such documentation is intended to support the operational approval requirements of the appropriate regulatory authorities.

In preparation for an operational approval to conduct RNP AR APCH procedures, operators should refer to aircraft and avionics manufacturer’s recommendations and guidance. Installation of equipment or recognition of aircraft eligibility is not sufficient by itself to obtain operational approval for RNP AR APCH operations from the national authority.

8.2.1. Aircraft eligibility

The aircraft eligibility must be determined through demonstration of compliance against the relevant airworthiness criteria and the requirements of 8.3. The OEM or the holder of installation approval for the aircraft, e.g. STC holder, will demonstrate compliance to their national airworthiness authority (NAA) (e.g. EASA, FAA) and the approval can be documented in manufacturer documentation (e.g. service letters). Aircraft flight manual (AFM) entries are not required provided the State accepts manufacturer documentation.

8.2.2. Operational Approval

8.2.2.1. Description of aircraft equipment

The operator must have a configuration list and, if necessary, a Minimum Equipment List (MEL) detailing the required aircraft equipment for RNP AR APCH operations.

8.2.2.2. Training documentation

Commercial operators must have a training programme addressing the operational practices, procedures and training items related to RNP AR APCH operations (e.g. initial, upgrade or recurrent training for pilots, dispatchers or maintenance personnel).

Note: Operators need not establish a separate training programme if they already integrate RNAV training as an element of their training programme. However, the operator should be able to identify the aspects of RNP AR APCH operations covered within their training programme.

Private operators must be familiar with the practices and procedures in paragraph 8.5, “Pilot

knowledge and training”.

8.2.2.3. Operations manuals and checklists

Operations manuals and checklists for commercial operators must address information/guidance on the standard operating procedures detailed in 8.4. The appropriate manuals should contain navigation operating instructions and contingency procedures, where specified. When required by the State of Operator/Registry, the operator must submit their manuals and checklists for review as part of the application process.

Private operators should operate using the practices and procedures in paragraph 8.5, “Pilot knowledge and training”.

8.2.2.4. Minimum Equipment List (MEL) considerations

Any Minimum Equipment List (MEL) revisions necessary to address provisions for RNP AR APCH operations must be approved. Operators must adjust the MEL, or equivalent, and specify the required dispatch conditions.

8.2.2.5. Continuing airworthiness

The operator must submit the continuing airworthiness instructions applicable to the aircraft’s configuration and the aircraft’s qualification for this navigation specification. Additionally, there is a requirement for the operator to submit their maintenance programme, including a reliability programme for monitoring the equipment.

Note: The operator should confirm with the OEM, or the holder of installation approval for the aircraft, that acceptance of subsequent changes in the aircraft configuration e.g. service bulletins, does not invalidate current operational approvals.

8.2.2.6. Approval submittal

8.2.2.6.1. Following the successful completion of the above steps, the above material must be accepted by the State regulatory authority; operational approval (subject to any conditions or limitations) should be obtained in accordance with national operating rules.

8.2.2.6.2. The applicable safety assessment items listed in 6.4 should be considered prior to implementation.

8.2.2.6.3. An RNP AR APCH operational approval (letter of authorization, appropriate operations specifications (Ops Spec), or amendment to the operations manual), should then be issued by the State annotating RNP AR APCH as appropriate.

8.2.2.6.4. Once approval is received from the State of Registry, operators should also be able to perform RNP AR APCH operations in other States.

8.2.2.6.5. The approval should identify the type of procedures for which the operator is approved i.e. the most demanding level of performance permitted, RNP 0.3, RNP 0.15, etc or additional requirements such as RF turns. Equipment configurations, selected modes and crew procedures must be defined for RNP AR APCH procedures.

8.3. Aircraft requirements

This section describes the aircraft performance and functional criteria for aircraft to qualify for RNP AR APCH. In addition to the specific guidance in this chapter, the aircraft must comply with FAA AC 20-129 and either FAA AC 20-130 or AC 20-138, or equivalent.

8.3.1. On Board Performance Monitoring and alerting

8.3.1.1. This section defines the general performance requirements for aircraft qualification. The requirements for RNP AR APCH are unique due to the reduced obstacle clearance and advanced functionality, therefore the requirements in this section do not use the same structure as for other navigation specifications e.g. RNP 4, RNP 1 and RNP APCH.

8.3.1.2. *Path definition.* Aircraft performance is evaluated around the path defined by the published procedure and RTCA/DO-236B Section 3.2; EUROCAE ED-75B. All vertical paths used in conjunction with the final approach segment will be defined by a flight path angle (RTCA/DO 236B Section 3.2.8.4.3) as a straight line emanating to a fix and altitude.

8.3.1.3. *Lateral accuracy.* All aircraft operating on RNP AR APCH procedures must have a cross-

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track navigation error no greater than the applicable accuracy value (0.1 NM to 0.3 NM) for 95 per cent of the flight time. This includes positioning error, flight technical error (FTE), path definition error (PDE) and display error. Also, the aircraft along-track positioning error must be no greater than the applicable accuracy value for 95 per cent of the flight time.

8.3.1.4. *Vertical accuracy.* The vertical system error includes altimetry error (assuming the temperature and lapse rates of the International Standard Atmosphere), the effect of along-track error, system computation error, data resolution error, and flight technical error. The 99.7 per cent of system error in the vertical direction must be less than the following (in feet):

$$\sqrt{((6076.115)(1.225)RNP \cdot \tan \theta)^2 + (60 \tan \theta)^2 + 75^2 + ((-8.8 \cdot 10^{-8})(h + \Delta h))^2 + (6.5 \cdot 10^{-3})(h + \Delta h) + 50}$$

where θ is the vertical navigation (VNAV) path angle, h is the height of the local altimetry reporting station and Δh is the height of the aircraft above the reporting station.

Note: Vertical navigation systems compliant with the performance specification for RNP APCH operations down to LPV minima (reference Chapter 5, part B) meet or exceed this vertical accuracy performance criteria.

8.3.1.5. *System monitoring.* A critical component of RNP is the ability of the aircraft navigation system to monitor its achieved navigation performance, and to identify, for the pilot, whether the operational requirement is or is not being met during an operation (e.g. “UNABLE RNP”, “NAV ACCUR DOWNGRAD”). It should be noted that the monitoring system may not provide warnings of FTE. The management of FTE must be addressed as a pilot procedure.

8.3.1.6. *GNSS Updating.* A crew alert is required when GNSS updating is lost unless the navigation system provides an alert when the selected RNP no longer meets the requirements for continued navigation.

8.3.1.7. *Airspace containment:*

- a) RNP and Barometric VNAV aircraft. This chapter provides a detailed acceptable means of compliance for aircraft that use an RNP system based primarily on GNSS, and a VNAV system based on barometric altimetry. Aircraft and operations complying with this

navigation specification provide the requisite airspace protection through a variety of monitoring and alerting systems and pilot procedures.

- b) Aircraft and operations complying with this navigation specification provide the requisite performance and assurance to satisfy the airspace requirements and safety margins through a variety of monitoring and alerting (e.g. “Unable RNP”, GNSS alert limit, and path deviation monitoring).
- c) Other systems or alternate means of compliance. For other systems or alternate means of compliance to a), the probability of the aircraft exiting the lateral and vertical extent of the obstacle clearance volume of the procedure must not exceed 10⁻⁷ per approach (including the missed approach). This requirement may be satisfied by an operational safety assessment applying:
 - i. appropriate quantitative numerical methods;
 - ii. qualitative operational and procedural considerations and mitigations; or
 - iii. an appropriate combination of both quantitative and qualitative methods.

Notes:

1. This requirement applies to the total probability of excursion outside the obstacle clearance volume, including events caused by latent conditions (integrity) and by detected conditions (continuity) if the aircraft does not remain within the obstacle clearance volume after the failure is annunciated (considering the aircraft wingspan). The monitor limit of the alert, the latency of the alert, the crew reaction time, and the aircraft response should all be considered when ensuring that the aircraft does not exit the obstacle clearance volume. The requirement applies to a single approach, considering the exposure time of the operation and the NAVAID geometry and navigation performance available for each published approach.

2. This containment requirement is derived from the operational requirement which is notably different than the containment requirement specified in RTCA/DO 236B (EUROCAE ED-75B). The requirement in RTCA/DO-236B (EUROCAE ED-75B) was developed to facilitate airspace design and does not directly equate to obstacle clearance.

8.3.2. Criteria for specific navigation services

8.3.2.1. This section identifies unique issues for the navigation sensors within the context of RNP

AR APCH operations.

8.3.2.2.ABAS and other GNSS augmentations based on GPS:

- a) The sensor must comply with the guidelines in AC 20-138() or AC 20-130 A. For systems that comply with AC 20-138(), the following sensor accuracies can be used in the total system accuracy analysis without additional substantiation: GPS (ABAS) sensor lateral accuracy is better than 36 m (119 ft) (95 per cent), and augmented GPS (GBAS or SBAS) sensor lateral accuracy is better than 2 m (7 ft) (95 per cent).
- b) In the event of a latent GPS satellite failure and marginal GPS satellite geometry (e.g. horizontal integrity limit (HIL) equal to the horizontal alert limit), the probability that the aircraft remains within the obstacle clearance volume used to evaluate the procedure must be greater than 95 per cent (both laterally and vertically).

Notes:

1. *Other GNSS systems meeting or exceeding the accuracy of GPS can use the criteria in paragraph a) and b) above.*
2. *GNSS-based sensors output a HIL, also known as a horizontal protection level (HPL) (see AC 20-138A, Appendix 1 and RTCA/DO-229C for an explanation of these terms). The HIL is a measure of the position estimation error assuming a latent failure is present. In lieu of a detailed analysis of the effects of latent failures on the total system error, an acceptable means of compliance for GNSS-based systems is to ensure the HIL remains less than twice the navigation accuracy, minus the 95 per cent of FTE, during the RNP AR APCH operation.*

8.3.2.3. Inertial reference system (IRS). An inertial reference system must satisfy the criteria of US 14 CFR part 121, Appendix G, or equivalent. While Appendix G defines the requirement for a 2 NM per hour drift rate (95 per cent) for flights up to 10 hours, this rate may not apply to an RNP system after loss of position updating. Systems that have demonstrated compliance with Part 121, Appendix G, can be assumed to have an initial drift rate of 8 NM/hour for the first 30 minutes (95 per cent) without further substantiation.

Aircraft manufacturers and applicants can demonstrate improved inertial performance in accordance with the methods described in Appendix 1 or 2 of FAA Order 8400.12A.

Note: Integrated GPS/INS position solutions reduce the rate of degradation after loss of position updating. For “tightly coupled” GPS/IRUs, RTCA/DO-229C, Appendix R, provides additional guidance.

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8.3.2.4. *Distance measuring equipment (DME).* GNSS-updating is the basis for initiating all RNP AR APCH procedures. When authorized by the State, the aircraft may use DME/DME-updating as a reversionary navigation mode during an approach or during the missed approach when the navigation system continues to comply with the required navigation accuracy. The aircraft manufacturer should identify any requirements for the DME infrastructure or any necessary operational procedures and limitations when conducting a procedure through use of DME/DME-updating of the aircraft's position.

8.3.2.5. *VHF omnidirectional range (VOR) station.* The aircraft's RNP system may not use VOR-updating when conducting RNP AR APCH procedures. The aircraft manufacturer should identify any pilot procedures or techniques for an aircraft to comply with this requirement.

Note: This does not imply a requirement for a direct means of inhibiting VOR updating. An operational procedure requiring the pilot to inhibit VOR updating or a procedure requiring the pilot to execute a missed approach when the navigation system reverts to VOR-updating, may satisfy this requirement.

8.3.2.6. For multi-sensor systems, there must be automatic reversion to an alternate area navigation sensor if the primary AREA NAVIGATION sensor fails. Automatic reversion from one multi-sensor system to another multi-sensor system is not required.

8.3.2.7. The 99.7 per cent aircraft altimetry system error for each aircraft (assuming the temperature and lapse rates of the International Standard Atmosphere) must be less than or equal to the following with the aircraft in the approach configuration:

$$ASE = -8.8 \cdot 10^{-8} \cdot H^2 + 6.5 \cdot 10^{-3} \cdot H + 50 \text{ (ft)}$$

Where **H** is the true altitude of the aircraft.

8.3.2.8. *Temperature compensation systems.* Systems that provide temperature-based corrections to the barometric VNAV guidance must comply with RTCA/DO-236B, Appendix H.2. This applies to the final approach segment. Manufacturers should document compliance to this standard to allow the operator to conduct RNP approaches when the actual temperature is below or above the published procedure design limit. Appendix H also provides guidance on operational issues associated with temperature compensated systems, such as intercepting the compensated path

from uncompensated procedure altitudes.

8.4. Operating procedures

8.4.1. Pre-flight considerations

8.4.1.1. *Minimum Equipment List (MEL)*. The operator's MEL should be developed/revised to address the equipment requirements for RNP AR instrument procedures. Guidance for these equipment requirements is available from the aircraft manufacturer. The required equipment may depend on the intended navigation accuracy and whether the missed approach requires an RNP less than 1.0. For example, GNSS and autopilot are typically required for high navigation accuracy. Dual equipment is typically required for approaches when using a line of minima less than RNP 0.3 and/or where the missed approach has an RNP less than 1.0. An operable Class A terrain awareness warning system (TAWS) is required for all RNP AR APCH procedures. It is recommended that the TAWS use an altitude that compensates for local pressure and temperature effects (e.g. corrected barometric and GNSS altitude), and includes significant terrain and obstacle data. The TAWS must not utilise the Captain's altimeter sub-scale setting as the sole reference to help militate against a dual QNH setting error by the pilot. The pilot must be cognizant of the required equipment.

8.4.1.2. *Autopilot and flight director*. RNP AR APCH procedures with a lateral navigation accuracy of less than RNP 0.3 or with RF legs require the use of an autopilot or flight director driven by the RNP system in all cases. Thus, the autopilot/flight director must operable and able to track the lateral and vertical paths defined by the procedure. When the dispatch of a flight is predicated on flying an RNP AR APCH procedure requiring the autopilot at the destination and/or alternate, the dispatcher must determine that the autopilot is operational.

8.4.1.3. *Dispatch RNP availability prediction*. The operator must have a predictive performance capability which can forecast whether or not the specified RNP will be available at the time and location of a desired RNP AR APCH procedure. This capability can be a ground service and need not be resident in the aircraft's avionics equipment. The operator must establish procedures requiring use of this capability as both a pre-flight dispatch tool and as a flight-following tool in the event of reported failures. The RNP assessment must consider the specific combination of the

aircraft capability (sensors and integration).

- a) RNP assessment when GNSS updating. This predictive capability must account for known and predicted outages of GNSS satellites or other impacts on the navigation system's sensors. The prediction programme should not use a mask angle below 5 degrees, as operational experience indicates that satellite signals at low elevations are not reliable. The prediction must use the actual GNSS constellation with the integrity monitoring algorithm (RAIM, AAIM etc) identical to that used in the actual equipment. For RNP AR APCH operations with
- b) high terrain, use a mask angle appropriate to the terrain.
- c) RNP AR APCH operations must have GNSS updating available prior to the commencement of the procedure.

8.4.1.4. *NAVAID exclusion.* The operator must establish procedures to exclude NAVAID facilities in accordance with NOTAMs (e.g. DMEs, VORs, localizers).

8.4.1.5. *Navigation database currency.* During system initialization, pilots of aircraft equipped with an RNP capable system, must confirm that the navigation database is current. Navigation databases are expected to be current for the duration of the flight. If the AIRAC cycle changes during flight, operators and pilots must establish procedures to ensure the accuracy of the navigation data, including the suitability of the navigation facilities used to define the routes and procedures for the flight. An outdated database must not be used to conduct the RNP AR APCH operation unless it has been established that any amendments to the database has no material impact on the procedure. If an amended chart is published for the procedure, the database must not be used to conduct the operation.

8.4.2. In-flight considerations

8.4.2.1. *Modification of the flight plan.* Pilots are not authorized to fly a published RNP AR APCH procedure unless it is retrievable by the procedure name from the aircraft navigation database and conforms to the charted procedure. The lateral path must not be modified, with the exception of

- a) Accepting a clearance to go direct to a fix in the approach procedure that is before

the FAF and that does not immediately precede an RF leg.

- b) Changing the altitude and/or airspeed waypoint constraints on the initial, intermediate, or missed approach segments of an approach (e.g. to apply cold temperature corrections or comply with an ATC clearance/instruction).

8.4.2.2. *Required list of equipment.* The pilot must have a required list of equipment for conducting RNP AR APCH operations or alternate methods to address in-flight equipment failures prohibiting RNP AR APCH procedures (e.g. a quick reference handbook).

8.4.2.3. *RNP management.* The pilot's operating procedures must ensure the navigation system uses the appropriate navigation accuracy throughout the approach. If multiple lines of minima associated with a different navigation accuracy are shown on the approach chart, the crew must confirm that the desired navigation accuracy is entered in the RNP system. If the navigation system does not extract and set the navigation accuracy from the on-board navigation database for each leg of the procedure, then the pilot's operating procedures must ensure that the smallest navigation accuracy required to complete the approach or missed approach is selected before initiating the procedure (e.g. before the initial approach fix (IAF) and before take off roll). Different segments may have a different navigation accuracy, which are annotated on the approach chart.

8.4.2.4. *GNSS updating.* All RNP AR instrument procedures require GNSS updating of the navigation position solution. The pilot must verify that GNSS updating is available prior to commencing the RNP AR procedure. During an approach, if at any time GNSS updating is lost and the navigation system does not have the performance to continue the approach, the pilot must abandon the RNP AR APCH unless the pilot has in sight the visual references required to continue the approach.

8.4.2.5. *Radio updating.* Initiation of all RNP AR APCH procedures is based on the availability of GNSS updating. Except where specifically designated on a procedure as "Not Authorized", DME/DME updating can be used as a reversionary mode during the approach or missed approach when the system complies with the navigation accuracy. VOR updating is not authorized at this time. The pilot must comply with the operator's procedures for inhibiting specific facilities.

8.4.2.6. *Procedure confirmation.* The pilot must confirm that the correct procedure has been

selected. This process includes confirmation of the waypoint sequence, reasonableness of track angles and distances, and any other parameters that can be altered by the pilot, such as altitude or speed constraints. A procedure must not be used if the validity of the navigation database is in doubt. A navigation system textual display or navigation map display must be used.

8.4.2.7. *Track deviation monitoring.* Pilots must use a lateral deviation indicator and/or flight director in lateral navigation mode on RNP AR APCH procedures. Pilots of aircraft with a lateral deviation indicator must ensure that lateral deviation indicator scaling (full-scale deflection) is suitable for the navigation accuracy associated with the various segments of the RNP AR APCH procedure. All pilots are expected to maintain procedure centrelines, as depicted by on-board lateral deviation indicators and/or flight guidance during all RNP operations described in this manual, unless authorized to deviate by ATC or under emergency conditions. For normal operations, cross-track error/deviation (the difference between the RNP system computed path and the aircraft position relative to the path) should be limited to $\pm\frac{1}{2}$ the navigation accuracy associated with the procedure segment. Brief lateral deviations from this standard (e.g. overshoots or undershoots) during and immediately after turns, up to a maximum of one-times the navigation accuracy of the procedure segment are tolerable.

8.4.2.8. The vertical deviation must be within 22 m (75 ft) during the final approach segment noting that transients in excess of 75' above the vertical path are acceptable (e.g. configuration changes or energy management actions). Vertical deviation should be monitored above and below the vertical path; while being above the vertical path provides margin against obstacles on the final approach continued intentional flight above the vertical path can result in a go-around decision closer to the runway and reduce the margin against obstacles in the missed approach.

8.4.2.9. Pilots must execute a missed approach if the lateral deviation exceeds $1 \times$ RNP or the vertical deviation exceeds - 22 m (- 75 ft), unless the pilot has in sight the visual references required to continue the approach.

- a) Some aircraft navigation displays do not incorporate lateral and vertical deviations scaled for each RNP AR APCH operation in the primary optimum field of view. Where a moving map, low-resolution vertical deviation indicator (VDI), or numeric display of deviations are to be used, pilot training and procedures must ensure the effectiveness

of these displays. Typically, this involves the demonstration of the procedure with a number of trained crews and inclusion of this monitoring procedure in the recurrent RNP AR APCH training programme.

- b) For installations that use a CDI for lateral path tracking, the aircraft flight manual (AFM) or aircraft qualification guidance should state which navigation accuracy and operations the aircraft supports and the operational effects on the CDI scale. The pilot must know the CDI full-scale deflection value. The avionics may automatically set the CDI scale (dependent on the phase of flight) or the pilot may manually set the scale. If the pilot manually selects the CDI scale, the operator must have procedures and training in place to assure the selected CDI scale is appropriate for the intended RNP operation. The deviation limit must be readily apparent given the scale (e.g. full-scale deflection).

8.4.2.10. System cross-check. For approaches with a navigation accuracy less than RNP 0.3, the pilot must monitor the lateral and vertical guidance provided by the navigation system by ensuring it is consistent with other available data and displays that are provided by an independent means.

Note: This cross-check may not be necessary if the lateral and vertical guidance systems have been developed consistent with a hazardous (severe-major) failure condition for misleading information and if the normal system performance supports airspace containment.

8.4.2.11. *Procedures with RF legs.* An RNP AR APCH procedure may require the ability to execute an RF leg to avoid terrain or obstacles. This requirement will be noted on the chart. As not all aircraft have this capability, pilots must be aware of whether or not they can conduct these procedures. When flying an RF leg pilots must not exceed the maximum airspeeds shown in Table II-C-6-1 throughout the RF leg segment. For example, a Category C A320 must slow to 160 KIAS at the FAF or may fly as fast as 185 KIAS if using Category D minima. A missed approach prior to decision altitude (DA) may require the segment speed for that segment be maintained.



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Indicated airspeed (knots)						
Segment	Indicated airspeed by aircraft category					
	Cat H	Cat A	Cat B	Cat C	Cat D	Cat E
Initial and intermediate (IAF to FAF)	120	150	180	240	250	250
Final (FAF to DA)	90	100	130	160	185	As specified
Missed approach (DA to MAHF)	90	110	150	240	265	As specified
Airspeed restriction*	As specified					

* RNP AR APCH procedure design may use airspeed restrictions to reduce the RF turn radius regardless of aircraft category. Operators therefore need to ensure they comply with the limiting speed for planned RNP AR APCH operations under all operating configurations and conditions..

8.4.2.12. *Temperature compensation.* For aircraft with temperature compensation capabilities, approved operating procedure may allow pilots to disregard the temperature limits on RNP AR APCH procedures if the operator provides pilot training on the use of the temperature compensation function. Temperature compensation by the system is applicable to the Barometric VNAV guidance and is not a substitute for the pilot compensating for the cold temperature effects on minimum altitudes or the decision altitude. Pilots should be familiar with the effects of the temperature compensation on intercepting the compensated path described in EUROCAE ED-75B/ RTCA DO-236B Appendix H.

Note: When using GNSS vertical guidance on RNP AR operations (e.g. SBAS or GBAS), the temperature limits for the procedure do not apply. However, the pilot may still need to compensate for the cold temperature effects on minimum altitudes or the decisions altitude.

8.4.2.13. *Altimeter setting.* RNP AR APCH instrument approach procedures use barometric data to derive vertical guidance. The pilot must ensure that the current local QNH is set prior to the final approach fix (FAF). Remote altimeter settings are not permitted.

8.4.2.14. *Altimeter cross-check.* The pilot must complete an altimetry cross-check ensuring both pilots' altimeters agree within 30 m (± 100 ft) prior to the FAF but no earlier than the IAF on approach. If the altimetry cross-check fails then the procedure must not be continued. If the avionics systems provide a comparator warning system for the pilots' altimeters, the pilot procedures should address actions to take if a comparator warning for the pilots' altimeters occurs while conducting an RNP AR APCH procedure.

Notes:

1. This operational cross-check is not necessary if the aircraft automatically compares the altitudes to within 30 m (100 ft) (see also 6.3.3.3.1.3, Displays, (n) Display of barometric altitude).

2. This operational check is not necessary when the aircraft uses GNSS vertical guidance (e.g. SBAS or GBAS).

8.4.2.15. *VNAV altitude transitions.* The aircraft barometric VNAV system provides fly-by vertical guidance, and may result in a path that starts to intercept the vertical path of the procedure prior to the FAF. The small vertical displacement which may occur at a vertical constraint (e.g. the FAF is considered operationally acceptable, providing a smooth transition to the next flight path vertical segment. This momentary deviation below the published minimum procedure altitude is acceptable provided the deviation is limited to no more than 30 m (100 ft) and is a result of a normal VNAV capture. This applies to both “level off” or “altitude acquire” segments following a climb or descent, or vertical climb or descent segment initiation, or joining of climb or descent paths with different gradients.

8.4.2.16. *Non-standard climb gradient.* When an approach procedure specifies a non-standard climb gradient, the operator must ensure the aircraft is capable of complying with the published climb gradient at the aircraft landing weight under ambient atmospheric conditions.

8.4.2.17. *Go-around or missed approach.* Where possible, the missed approach will require a navigation accuracy of RNP 1.0. The missed approach portion of these procedures is similar to a missed approach of an RNP APCH approach. Where necessary, navigation accuracy less than RNP 1.0 will be used in the missed approach. Approval to conduct these approaches, equipage and procedures must meet criteria in “Requirements for approaches with missed approach less than RNP 1.0”.

8.4.2.18. In some aircraft, activating take-off/go-around (TOGA) during the initiation of a go-around or missed approach may cause a change in lateral navigation mode or functionality, (i.e. TOGA disengages the autopilot and flight director from LNAV guidance) and track guidance may revert to track-hold derived from the inertial system. In such cases, LNAV guidance to the autopilot and flight director should be re-engaged as quickly as possible.

8.4.2.19. The pilot procedures and training must address the impact on navigation capability and flight guidance if the pilot initiates a go-around while the aircraft is in a turn. When initiating an early go-around, the pilot must ensure adherence to the published track unless ATC has issued a different clearance. The pilot should also be aware that RF legs are designed for a maximum ground speed. Initiating an early go-around at speeds higher than those considered in the design, may cause the aircraft to diverge throughout the turn and require pilot intervention to maintain the path.

8.4.2.20. *Contingency procedures — failure while en route.* The aircraft RNP capability is dependent on operational aircraft equipment and GNSS. The pilot must be able to assess the impact of equipment failure on the anticipated RNP AR APCH procedure and take appropriate action. As described in 8.4.1.3 “Dispatch RNP assessment”, the pilot also must be able to assess the impact of changes in the GNSS constellation and take appropriate action.

8.4.2.21. *Contingency procedures—failure on approach.* The operator’s contingency procedures need to address the following conditions: Failure of the RNP system components, including those affecting lateral and vertical deviation performance (e.g. failures of a GPS sensor, the flight director or automatic pilot); and loss of navigation signal-in-space (loss or degradation of external signal).

8.5. Pilot/dispatch/operator knowledge and training

8.5.1. The operator must provide training for key personnel (e.g. pilots and dispatchers) in the use and application of RNP AR APCH procedures. A thorough understanding of the operational procedures and best practices is critical to the safe operation of aircraft during RNP AR APCH operations. This programme must provide sufficient detail on the aircraft’s navigation and flight control systems to enable the pilots to identify failures affecting the aircraft’s RNP capability and the appropriate abnormal/emergency procedures. Training must include both knowledge and skill assessments of the crew members’ and dispatchers’ duties.

8.5.2. Operator responsibilities

- a) Each operator is responsible for the training of pilots for the specific RNP AR APCH operations exercised by the operator. The operator must include training on the

different types of RNP AR APCH procedures and required equipment. Training must include discussion of RNP AR APCH regulatory requirements. The operator must include these requirements and procedures in their flight operations and training manuals (as applicable). This material must cover all aspects of the operator's RNP AR APCH operations including the applicable operational authorization. An individual must have completed the appropriate ground and or flight training segment before engaging in RNP AR APCH operations.

- b) Flight training segments must include training and checking modules representative of the type of RNP AR APCH procedures the operator conducts during line-oriented flying activities. Many operators may train for RNP AR APCH procedures under the established training standards and provisions for advanced qualification programmes (AQP). They may conduct evaluations in line-oriented flight training (LOFT) scenarios, selected event training (SET) scenarios or in a combination of both. The operator may conduct required flight training modules in flight training devices, aircraft simulators, and other enhanced training devices as long as these training devices accurately replicate the operator's equipment and RNP AR APCH operations.
- c) Operators must address initial RNP AR APCH training and qualifications during initial, transition, upgrade, recurrent, differences, or stand-alone training and qualification programmes in the respective qualification category. The qualification standards assess each pilot's ability to properly understand and use RNP AR procedures (RNP AR APCH initial evaluation). The operator must also develop recurrent qualification standards to ensure their pilots maintain appropriate RNP AR APCH operations knowledge and skills (RNP AR APCH recurrent qualification).
- d) Operators may address RNP AR APCH operation topics separately or integrate them with other curriculum elements. For example, an RNP AR APCH pilot qualification may focus on a specific aircraft during transition, upgrade, or differences courses. General training may also address RNP AR APCH qualification, e.g. during recurrent training or checking events such as recurrent proficiency check/proficiency training, line-oriented evaluation or special purpose operational training. A separate, independent RNP AR APCH operations qualification programme may also address RNP AR APCH training, e.g. by completion of an applicable RNP AR APCH curriculum at an operator's training centre

or at designated crew bases.

- e) Operators intending to receive credit for RNP training, when their proposed programme relies on previous training (e.g. Special RNP IAPs), must receive specific authorization from their principal operations inspector/flight operations inspector. In addition to the current RNP training programme, the air carrier will need to provide differences training between existing training programme and the RNP AR APCH training requirements.
- f) Training for flight dispatchers must include: the explanation of the different types of RNP AR APCH procedures, the importance of specific navigation equipment and other equipment during RNP AR APCH operations and the RNP AR APCH regulatory requirements and procedures. Dispatcher procedure and training manuals must include these requirements (as applicable). This material must cover all aspects of the operator's RNP AR operations including the applicable authorizations (e.g. Ops Specs, operations manual, MSpecs or LOA). An individual must have completed the appropriate training course before engaging in RNP AR APCH operations. Additionally, the dispatchers' training must address how to determine: RNP AR APCH availability (considering aircraft equipment capabilities), MEL requirements, aircraft performance, and navigation signal availability (e.g. GPS RAIM/predictive RNP capability tool) for destination and alternate airports.

8.5.3. Ground training segments content

8.5.3.1. Ground training segments must address the following subjects, as training modules, in an approved RNP AR APCH training programme during the initial introduction of a crew member to RNP AR APCH systems and operations. For recurrent programmes, the curriculum need only review initial curriculum requirements and address new, revised, or emphasized items.

8.5.3.2. General concepts of RNP AR APCH operation. RNP AR APCH training must cover RNP AR APCH systems theory to the extent appropriate to ensure proper operational use. The pilot must understand basic concepts of RNP AR APCH systems operation, classifications, and limitations. The training must include general knowledge and operational application of RNP AR procedures. This training module must address the following specific elements:

- a) definition of RNP AR APCH;

- b) the differences between RNAV and RNP;
- c) the types of RNP AR APCH procedures and familiarity with the charting of these procedures;
- d) the programming and displaying of RNP and aircraft specific displays (e.g. actual navigation performance (ANP display));
- e) how to enable and disable the navigation updating modes related to RNP;
- f) the navigation accuracy appropriate for different phases of flight and RNP AR APCH procedures and how to select the navigation accuracy, if required;
- g) the use of GPS RAIM (or equivalent) forecasts and the effects of RAIM availability on RNP AR APCH procedures (pilot and dispatchers);
- h) when and how to terminate RNP navigation and transfer to traditional navigation due to loss of RNP and/or required equipment;
- i) how to determine database currency and whether it contains the navigational data required for use of GNSS waypoints;
- j) explanation of the different components that contribute to the total system error and their characteristics (e.g. effect of temperature on baro-VNAV and drift characteristics when using IRU with no radio updating).
- k) temperature compensation — pilots operating avionics systems with compensation for altimetry errors introduced by deviations from ISA may disregard the temperature limits on RNP AR APCH procedures, if pilot training on the use of the temperature compensation function is provided by the operator and the compensation function is utilized by the crew. However, the training must also recognize the temperature compensation by the system is applicable to the VNAV guidance and is not a substitute for the pilot compensating for the cold temperature effects on minimum altitudes or the decision altitude.

8.5.3.3. *ATC communication and coordination for use of RNP AR APCH.* Ground training must instruct the pilots on proper flight plan classifications and any air traffic control (ATC) procedures applicable to RNP AR APCH operations. The pilots must receive instructions on the need to advise ATC immediately when the performance of the aircraft's navigation system is no longer suitable to support continuation of an RNP AR APCH procedure. Pilots must also know what navigation sensors form the basis for their RNP AR APCH compliance, and they must be able to assess the impact of a failure of any avionics or a known loss of ground systems on the remainder of the

flight plan.

8.5.3.4. *RNP AR APCH equipment components, controls, displays, and alerts.* Academic training must include a discussion of RNP terminology, symbology, operation, optional controls, and display features including any items unique to an operator's implementation or systems. The training must address applicable failure alerts and equipment limitations. The pilots and dispatchers should achieve a thorough understanding of the equipment used in RNP operations and any limitations on the use of the equipment during those operations.

8.5.3.5. *AFM information and operating procedures.* The AFM or other aircraft eligibility evidence must address normal and abnormal flight crew operating procedures, responses to failure alerts, and any equipment limitations, including related information on RNP modes of operation. Training must also address contingency procedures for loss or degradation of RNP capability. The flight operations manuals approved for use by the pilots (e.g. flight operations manual (FOM) or pilot operating handbook (POH)) should contain this information.

8.5.3.6. *MEL operating provisions.* Pilots must have a thorough understanding of the MEL requirements supporting RNP AR APCH operations.

8.5.4. Flight training segments — content

8.5.4.1. Training programmes must cover the proper execution of RNP AR APCH procedures in concert with the OEM's documentation. The operational training must include: RNP AR APCH procedures and limitations; standardization of the set-up of the cockpit's electronic displays during an RNP AR APCH procedure; recognition of the aural advisories, alerts and other annunciations that can impact compliance with an RNP AR APCH procedure; and the timely and correct responses to loss of RNP AR APCH capability in a variety of scenarios, embracing the scope of the RNP AR APCH procedures which the operator plans to complete. Such training may also use approved flight training devices or simulators. This training must address the following specific elements:

- a) Procedures for verifying that each pilot's altimeter has the current setting before beginning the final approach of an RNP AR APCH procedure, including any operational

- limitations associated with the source(s) for the altimeter setting and the latency of checking and setting the altimeters approaching the FAF.
- b) The use of aircraft radar, TAWS, GPWS, or other avionics systems to support the pilot's track monitoring and weather and obstacle avoidance.
 - c) The effect of wind on aircraft performance during RNP AR APCH procedures and the need to remain within RNP containment area, including any operational wind limitation and aircraft configuration essential to safely complete an RNP AR procedure.
 - d) The effect of ground speed on compliance with RNP AR APCH procedures and bank angle restrictions impacting the ability to remain on the course centreline. For RNP AR APCH procedures, aircraft are expected to maintain the standard speeds associated with the applicable category.
 - e) The relationship between RNP and the appropriate approach minima line on an approved published RNP AR APCH procedure and any operational limitations noted on the chart e.g. temperature limits, RF leg requirements or loss of GNSS updating on approach, etc.
 - f) Concise and complete pilot briefings for all RNP AR APCH procedures and the important role cockpit resource management (CRM) plays in successfully completing an RNP AR APCH procedure.
 - g) Alerts from the loading and use of improper navigation accuracy data for a desired segment of an RNP AR procedure.
 - h) The performance requirement to couple the autopilot/flight director to the navigation system's lateral and vertical guidance on RNP AR APCH procedures requiring an RNP of less than RNP 0.3.
 - i) The importance of aircraft configuration to ensure the aircraft maintains any required speeds during RNP AR procedures.
 - j) The events triggering a missed approach when using the aircraft's RNP capability.
 - k) Any bank angle restrictions or limitations on RNP AR APCH procedures.

 - l) The potentially detrimental effect on the ability to comply with an RNP AR APCH procedure when reducing the flap setting, reducing the bank angle or increasing airspeed.
 - m) Pilot knowledge and skills necessary to properly conduct RNP AR APCH operations.
 - n) Programming and operating the FMC, autopilot, auto throttles, radar, GPS, INS, EFIS (including the moving map), and TAWS in support of RNP AR APCH procedures.

- o) The effect of activating TOGA while in a turn.
- p) FTE monitoring and impact on go-around decision and operation.
- q) Loss of GNSS during a procedure.
- r) Performance issues associated with reversion to radio updating and limitations on the use of DME and VOR updating.
- s) Flight crew contingency procedures for a loss of RNP capability during a missed approach. Due to the lack of navigation guidance, the training should emphasize the flight crew contingency actions that achieve separation from terrain and obstacles. The operator should tailor these contingency procedures to their specific RNP AR APCH procedures.

8.5.5. Evaluation module

8.5.5.1. *Initial evaluation of RNP AR APCH operations knowledge and procedures.* The operator must evaluate each individual pilot's knowledge of RNP AR APCH procedures prior to employing RNP AR APCH procedures as appropriate. As a minimum, the review must include a thorough evaluation of pilot procedures and specific aircraft performance requirements for RNP AR APCH operations. An acceptable means for this initial assessment includes one of the following:

- a) an evaluation by an authorized instructor/evaluator or check-airman using an approved simulator or training device;
- b) an evaluation by an authorized instructor/evaluator or check-airman during line operations, training flights, proficiency checks, practical tests events, operating experience, route checks, and/or line checks; or
- c) line-oriented flight training (LOFT)/line-oriented evaluation (LOE) programmes using an approved simulator that incorporates RNP operations that employ the unique RNP AR APCH characteristics (i.e. RF legs, RNP missed approach) of the operator's approved procedures.

8.5.5.2. *Evaluation content.* Specific elements that must be addressed in this evaluation module are:

- a) demonstrate the use of any RNP limits that may impact various RNP AR APCH procedures;
- b) demonstrate the application of radio-updating procedures, such as enabling and

- disabling ground-based radio updating of the FMC (i.e. DME/DME and VOR/DME updating) and knowledge of when to use this feature. If the aircraft's avionics do not include the capability to disable radio updating, then the training must ensure the pilot is able to accomplish the operational actions that mitigate the lack of this feature;
- c) demonstrate the ability to monitor the actual lateral and vertical flight paths relative to the programmed flight path and complete the appropriate flight crew procedures when exceeding a lateral or vertical FTE limit;
 - d) demonstrate the ability to read and adapt to a RAIM (or equivalent) forecast, including forecasts predicting a lack of RAIM availability;
 - e) demonstrate the proper set-up of the FMC, the weather radar, TAWS, and moving map for the various RNP AR APCH operations and scenarios the operator plans to implement;
 - f) demonstrate the use of pilot briefings and checklists for RNP AR APCH operations as appropriate with emphasis on CRM;
 - g) demonstrate knowledge of and ability to perform an RNP AR APCH missed approach procedure in a variety of operational scenarios (e.g. loss of navigation or failure to acquire visual conditions)
 - h) demonstrate speed control during segments requiring speed restrictions to ensure compliance with an RNP AR APCH procedures;
 - i) demonstrate competent use of RNP AR APCH procedure plates, briefing cards, and checklists;
 - j) demonstrate the ability to complete a stable RNP AR APCH operation including bank angle, speed control, and remain on the procedure's centreline; and
 - k) knowledge of the operational limit for deviation below the desired flight path on an RNP AR APCH procedure and how to accurately monitor the aircraft's position relative to the vertical flight path.

8.5.6. Recurrent training

8.5.6.1. The operator should incorporate recurrent RNP training that employs the unique AR characteristics of the operator's approved procedures as part of the overall programme.

8.5.6.2. A minimum of two RNP AR APCHs, as applicable, must be flown by each pilot for each duty position (pilot flying and pilot monitoring), with one culminating in a landing and one culminating in a missed approach, and may be substituted for any required "precision-like" approach.

Note: Equivalent RNP approaches may be credited toward this requirement.

8.6. Navigation database

8.6.1. The procedure stored in the navigation database defines the lateral and vertical path. Navigation database updates occur every 28 days, and the navigation data in every update are critical to the integrity of every RNP AR APCH procedure. Given the reduced obstacle clearance associated with these procedures, validation of navigation data warrants special consideration. This section provides guidance for the operator's procedures for validating the navigation data associated with RNP AR APCH procedures.

8.6.2. Data process

8.6.2.1. The operator must identify the responsible manager for the data updating process within their procedures.

8.6.2.2. The operator must document a process for accepting, verifying and loading navigation data into the aircraft.

8.6.2.3. The operator must place their documented data process under configuration control.

8.6.2.4. *Initial data validation.* The operator must validate every RNP AR procedure before flying the procedure in instrument meteorological conditions (IMC) to ensure compatibility with their aircraft and to ensure the resulting path matches the published procedure. As a minimum, the operator must:

- a) compare the navigation data for the procedure(s) to be loaded into the flight management system with the published procedure;
- b) validate the loaded navigation data for the procedure, either in a simulator or in the actual aircraft in visual meteorological conditions (VMC). The depicted procedure on the map display must be compared to the published procedure. The entire procedure must be flown to ensure the path does not have any apparent lateral or vertical path disconnects, and is consistent with the published procedure; and
- c) once the procedure is validated, retain and maintain a copy of the validated navigation data for comparison to subsequent data updates.

8.6.2.5. *Data updates.* Upon receipt of each navigation data update, and before using the navigation data in the aircraft, the operator must compare the update to the validated procedure. This comparison must identify and resolve any discrepancies in the navigation data. If there are significant changes (any change affecting the approach path or performance) to any portion of a procedure and source data verifies the changes, the operator must validate the amended procedure in accordance with initial data validation.

8.6.2.6. *Data suppliers.* Data suppliers must have a Letter of Acceptance (LOA) for processing navigation data (e.g. FAA AC 20 153, EASA Conditions for the issuance of Letters of Acceptance for navigation database Suppliers by the Agency, or equivalent). An LOA recognizes the data supplier as one whose data quality, integrity and quality management practices are consistent with the criteria of DO-200A/ED-76. The operator's supplier (e.g. the FMS company) must have a Type 2 LOA, and their respective suppliers must have a Type 1 or 2 LOA.

8.6.2.7. *Aircraft modifications.* If an aircraft system required for RNP AR APCH operations is modified (e.g. software change), the operator is responsible for validating of RNP AR APCH procedures using the navigation database and the modified system. This may be accomplished without any direct evaluation if the manufacturer verifies that the modification has no effect on the navigation database or path computation. If no such assurance from the manufacturer is available, the operator must conduct an initial data validation using the modified system noting that flight control computers, FMS OPS and display software changes are particularly critical.

8.7. Oversight of operators

8.7.1. A regulatory authority may consider any anomaly reports in determining remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment may result in the cancellation of the approval for use of that equipment.

8.7.2. Information that indicates the potential for repeated errors may require modification of an operator's training programme. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training or licence review.

8.7.3. Operators must have an RNP monitoring programme to ensure continued compliance with the guidance of this chapter and to identify any negative trends in performance. At a minimum, this programme must address the following information. During the interim approval, operators must submit the following information every 30 days to the authority granting their authorization. Thereafter, operators must continue to collect and periodically review these data to identify potential safety concerns, as well as maintain summaries of these data:

- a) total number of RNP AR APCH procedures conducted;
- b) number of satisfactory approaches by aircraft/system (satisfactory if completed as planned without any navigation or guidance system anomalies);
- c) reasons for unsatisfactory approaches, such as:
 - i. UNABLE REQ NAV PERF, NAV ACCUR DOWNGRAD, or other RNP messages during approaches;
 - ii. excessive lateral or vertical deviation;
 - iii. TAWS warning;
 - iv. autopilot system disconnect;
 - v. navigation data errors; and
 - vi. pilot report of any anomaly;
- d) crew comments.

CHAPTER 9 PROCEDURES RELATED TO COMMUNICATION FAILURE AND CONTINGENCIES

9.1 SPECIAL PROCEDURES FOR IN-FLIGHT CONTINGENCIES IN OCEANIC AIRSPACE

9.1.1 Introduction

9.1.1.1 Although all possible contingencies cannot be covered, the procedures in 9.2.2 and 9.2.3 provide for the more frequent cases such as:

- a) inability to comply with assigned clearance due to meteorological conditions, aircraft performance or pressurization failure;
- b) en-route diversion across the prevailing traffic flow; and
- c) loss of, or significant reduction in, the required navigation capability when operating in an airspace where the navigation performance accuracy is a prerequisite to the safe conduct of flight operations.

9.1.1.2 With regard to 9.1.1.1 a) and b), the procedures are applicable primarily when descent and/or turnback or diversion is required. The pilot shall take action as necessary to ensure the safety of the aircraft, and the pilot’s judgement shall determine the sequence of actions to be taken, having regard to the prevailing circumstances. Air traffic control shall render all possible assistance.

9.2.2 General procedures

9.2.2.1 If an aircraft is unable to continue the flight in accordance with its ATC clearance, and/or an aircraft is unable to maintain the navigation performance accuracy specified for the airspace, a revised clearance shall be obtained, whenever possible, prior to initiating any action.

9.2.2.2 The radiotelephony distress signal (MAYDAY) or urgency signal (PAN PAN) preferably spoken three times shall be used as appropriate. Subsequent ATC action with respect to that aircraft shall be based on the intentions of the pilot and the overall air traffic situation.

9.2.2.3 If prior clearance cannot be obtained, until a revised clearance is received the following contingency procedures should be employed and the pilot shall advise air traffic control as soon as practicable, reminding them of the type of aircraft involved and the nature of the problem. In general terms, the aircraft should be flown at a flight level and on an offset track where other aircraft are least likely to be encountered. Specifically, the pilot shall:

a) leave the assigned route or track by initially turning at least 45 degrees to the right or to the left, in order to acquire a same or opposite direction track offset 15 NM (28 km) from the assigned track centreline. When possible, the direction of the turn should be determined by the position of the aircraft relative to any organized route or track system. Other factors which may affect the direction of the turn are:

- 1) the direction to an alternate airport;
- 2) terrain clearance;
- 3) any strategic lateral offset being flown; and
- 4) the flight levels allocated on adjacent routes or tracks;

b) having initiated the turn:

- 1) if unable to maintain the assigned flight level, initially minimize the rate of descent to the extent that is operationally feasible (pilots should take into account the possibility that aircraft below on the same track may be flying a 1 or 2 NM strategic lateral offset procedure (SLOP)) and select a final altitude which differs from those normally used by 150 m (500 ft) if at or below FL 410, or by 300 m (1 000 ft) if above FL 410; or

- 2) if able to maintain the assigned flight level, once the aircraft has deviated 19 km (10 NM) from the assigned track centreline, climb or descend to select a flight level which differs from those normally used by 150 m (500 ft), if at or below FL 410, or by 300 m (1 000 ft) if above FL 410;

- c) establish communications with and alert nearby aircraft by broadcasting, at suitable intervals on 121.5 MHz (or, as a backup, on the inter-pilot air-to-air frequency 123.45 MHz) and where appropriate on the frequency in use: aircraft identification, flight level, position (including the ATS route designator or the track code, as appropriate) and intentions;
- d) maintain a watch for conflicting traffic both visually and by reference to ACAS (if equipped);
- e) turn on all aircraft exterior lights (commensurate with appropriate operating limitations); and
- f) keep the SSR transponder on at all times.

9.2.2.4 When leaving the assigned track:

- a) if the intention is to acquire a same direction offset track, the pilot should consider limiting the turn to a 45 degree heading change, in order not to overshoot the offset contingency track; or
- b) if the intention is to acquire and maintain an opposite direction offset track, then:
 - 1) operational limitations on bank angles at cruising altitudes will normally result in overshooting the track to be acquired. In such cases a continuous turn should be extended beyond 180 degrees heading change, in order to re-intercept the offset contingency track as soon as operationally feasible; and
 - 2) furthermore, if executing such a turnback in a 56 km (30 NM) lateral separation route structure, extreme caution pertaining to opposite direction traffic on adjacent routes must be exercised and any climb or descent, as specified in 9.2.2.3 b) 2), should be completed preferably before approaching within 19 km (10 NM) of any adjacent ATS route.

9.2.2.5 Extended Range Operations by Aeroplanes with Two-Turbine Power-Units (ETOPS)

If the contingency procedures are employed by a twin-engine aircraft as a result of an engine shutdown or failure of an ETOPS critical system, the pilot should advise ATC as soon as practicable of the situation, reminding ATC of the type of aircraft involved, and request expeditious handling.

9.2.3 Weather deviation procedures

The following procedures are intended for deviations around adverse meteorological conditions.

When the pilot initiates communications with ATC, a rapid response may be obtained by stating “WEATHER DEVIATION REQUIRED” to indicate that priority is desired on the frequency and for ATC response. When necessary, the pilot should initiate the communications using the urgency call “PAN PAN” (preferably spoken three times).

The pilot shall inform ATC when weather deviation is no longer required, or when a weather deviation has been completed and the aircraft has returned to its cleared route.

9.2.3.1 Actions to be Taken When Controller-Pilot Communications Are Established

The pilot should notify ATC and request clearance to deviate from track, advising, when possible, the extent of the deviation expected.

ATC should take one of the following actions:

- a) when appropriate separation can be applied, issue clearance to deviate from track;
- or
- b) if there is conflicting traffic and ATC is unable to establish appropriate separation, ATC shall:
 - 1) advise the pilot of inability to issue clearance for the requested deviation;
 - 2) advise the pilot of conflicting traffic; and
 - 3) request the pilot’s intentions.

The pilot should take the following actions:

- a) comply with the ATC clearance issued; or

b) advise ATC of intentions and execute the procedures detailed in 9.2.3.2

9.2.3.2 ACTIONS TO BE TAKEN IF A REVISED ATC CLEARANCE CANNOT BE OBTAINED

Note.— The provisions of this section apply to situations where a pilot needs to exercise the authority of a pilot-in-command under the provisions of Annex 2, 2.3.1.

If the aircraft is required to deviate from track to avoid adverse meteorological conditions and prior clearance cannot be obtained, an ATC clearance shall be obtained at the earliest possible time. Until an ATC clearance is received, the pilot shall take the following actions:

a) if possible, deviate away from an organized track or route system;

b) establish communications with and alert nearby aircraft by broadcasting, at suitable intervals: aircraft identification, flight level, position (including ATS route designator or the track code) and intentions, on the frequency in use and on 121.5 MHz (or, as a backup, on the inter-pilot air-to-air frequency 123.45 MHz);

c) watch for conflicting traffic both visually and by reference to ACAS (if equipped);

Note.— If, as a result of actions taken under the provisions of 15.2.3.3.1 b) and c), the pilot determines that there is another aircraft at or near the same flight level with which a conflict may occur, then the pilot is expected to adjust the path of the aircraft, as necessary, to avoid conflict.

d) turn on all aircraft exterior lights (commensurate with appropriate operating limitations);

e) for deviations of less than 19 km (10 NM) remain at a level assigned by ATC;

f) for deviations greater than 19 km (10 NM), when the aircraft is approximately 19 km (10 NM) from track, initiate a level change in accordance with Table 9-1;

g) when returning to track, be at its assigned flight level when the aircraft is within approximately 19 km (10 NM) of the centre line; and

h) if contact was not established prior to deviating, continue to attempt to contact ATC to obtain a clearance. If contact was established, continue to keep ATC advised of intentions and obtain essential traffic information.

Table 9-1

<i>Route centre line track</i>	<i>Deviations > 19 km (10 NM)</i>	<i>Level change</i>
EAST 000° – 179° magnetic	LEFT RIGHT	DESCEND 90 m (300 ft) CLIMB 90 m (300 ft)
WEST 180° – 359° magnetic	LEFT RIGHT	CLIMB 90 m (300 ft) DESCEND 90 m (300 ft)

9.3 AIR-GROUND COMMUNICATIONS FAILURE

Note 1.— Procedures to be applied in relation to an aircraft experiencing air-ground communication failure when providing ATS surveillance services are contained in ICAO Doc4444, Chapter 8, Section 8.8.3.

Note 2.— An aircraft equipped with an SSR transponder is expected to operate the transponder on Mode A Code 7600 to indicate that it has experienced air-ground communication failure. An aircraft equipped with other surveillance system transmitters, including ADS-B and ADS-C, might indicate the loss of air-ground communication by all of the available means.

Note 3.— Some aircraft equipped with first generation ADS-B avionics have the capability to transmit a general emergency alert only, regardless of the code selected by the pilot.

Note 4.— See also ICAO Doc4444, Chapter 6, 6.3.2.5, concerning departure clearances containing no geographical or time limit for an initial level and procedures to be applied in relation to an aircraft experiencing air-ground communication failure under such circumstances.

Note 5.— See also ICAO Doc4444, Chapter 5, 5.4.2.6.3.2, for additional requirements applying to communication failure during the application of the 50 NM longitudinal RNAV/RNP 10 separation minimum.

9.3.1 Action by air traffic control units when unable to maintain two-way communication with an aircraft operating in a control area or control zone shall be as outlined in the paragraphs which follow.

9.3.2 As soon as it is known that two-way communication has failed, action shall be taken to ascertain whether the aircraft is able to receive transmissions from the air traffic control unit by requesting it to execute a specified manoeuvre which can be observed by an ATS surveillance system or to transmit, if possible, a specified signal in order to indicate acknowledgement.

Note.— Some aircraft equipped with first generation ADS-B avionics do not have the capability of squawking IDENT while the emergency and/or urgency mode is selected.

9.3.3 If the aircraft fails to indicate that it is able to receive and acknowledge transmissions, separation shall be maintained between the aircraft having the communication failure and other aircraft, based on the assumption that the aircraft will:

a) if in visual meteorological conditions:

1) continue to fly in visual meteorological conditions;

2) land at the nearest suitable aerodrome; and

3) report its arrival by the most expeditious means to the appropriate air traffic control unit; or

b) if in instrument meteorological conditions or when conditions are such that it does not appear likely that the pilot will complete the flight in accordance with a):

1) unless otherwise prescribed on the basis of a regional air navigation agreement, in airspace where procedural separation is being applied, maintain the last assigned speed and level, or minimum flight altitude if higher, for a period of 20 minutes following the aircraft's failure to report its position over a compulsory reporting point and thereafter adjust level and speed in accordance with the filed flight plan; or

2) in airspace where an ATS surveillance system is used in the provision of air

traffic control, maintain the last assigned speed and level, or minimum flight altitude if higher, for a period of 7 minutes following:

i) the time the last assigned level or minimum flight altitude is reached; or
ii) the time the transponder is set to Code 7600 or the ADS-B transmitter is set to indicate the loss of air-ground communications; or

iii) the aircraft's failure to report its position over a compulsory reporting point; whichever is later and thereafter adjust level and speed in accordance with the filed flight plan;

3) when being vectored or having been directed by ATC to proceed offset using RNAV without a specified limit, proceed in the most direct manner possible to rejoin the current flight plan route no later than the next significant point, taking into consideration the applicable minimum flight altitude;

4) proceed according to the current flight plan route to the appropriate designated navigation aid or fix serving destination aerodrome and, when required to ensure compliance with 5), hold over this aid or fix until commencement of descent;

5) commence descent from the navigation aid or fix specified in 4) at, or as close as possible to, the expected approach time last received and acknowledged; or, if no expected approach time has been received and acknowledged, at, or as close as possible to, the estimated time of arrival resulting from the current flight plan;

6) complete a normal instrument approach procedure as specified for the designated navigation aid or fix; and

7) land, if possible, within 30 minutes after the estimated time of arrival specified in 5) or the last acknowledged expected approach time, whichever is later.

Note 1.— Provisions related to minimum levels are contained in Annex 2, 5.1.2.

Note 2.— As evidenced by the meteorological conditions prescribed therein, 9.3.3 a) relates to all controlled flights, whereas 9.3.3 b) relates only to IFR flights.

9.3.4 Action taken to ensure suitable separation shall cease to be based on the assumption stated in 9.3.3 when:

- a) it is determined that the aircraft is following a procedure differing from that in 9.3.3; or
- b) through the use of electronic or other aids, air traffic control units determine that action differing from that required by 9.3.3 may be taken without impairing safety; or
- c) positive information is received that the aircraft has landed.

9.3.5 As soon as it is known that two-way communication has failed, appropriate information describing the action taken by the air traffic control unit, or instructions justified by any emergency situation, shall be transmitted blind for the attention of the aircraft concerned, on the frequencies available on which the aircraft is believed to be listening, including the voice frequencies of available radio navigation or approach aids. Information shall also be given concerning:

- a) meteorological conditions favourable to a cloud-breaking procedure in areas where congested traffic may be avoided; and
- b) meteorological conditions at suitable aerodromes.

9.3.6 Pertinent information shall be given to other aircraft in the vicinity of the presumed position of the aircraft experiencing the failure.

9.3.7 As soon as it is known that an aircraft which is operating in its area of responsibility is experiencing an apparent radiocommunication failure, an air traffic services unit shall forward information concerning the radiocommunication failure to all air traffic services units

concerned along the route of flight. The ACC in whose area the destination aerodrome is located shall take steps to obtain information on the alternate aerodrome(s) and other relevant information specified in the filed flight plan, if such information is not available.

9.3.8 If circumstances indicate that a controlled flight experiencing a communication failure might proceed to (one of) the alternate aerodrome(s) specified in the filed flight plan, the air traffic control unit(s) serving the alternate aerodrome(s) and any other air traffic control units that might be affected by a possible diversion shall be informed of the circumstances of the failure and requested to attempt to establish communication with the aircraft at a time when the aircraft could possibly be within communication range. This shall apply particularly when, by agreement with the operator or a designated representative, a clearance has been transmitted blind to the aircraft concerned to proceed to an alternate aerodrome, or when meteorological conditions at the aerodrome of intended landing are such that a diversion to an alternate is considered likely.

9.3.9 When an air traffic control unit receives information that an aircraft, after experiencing a communication failure has re-established communication or has landed, that unit shall inform the air traffic services unit in whose area the aircraft was operating at the time the failure occurred, and other air traffic services units concerned along the route of flight, giving necessary information for the continuation of control if the aircraft is continuing in flight.

9.3.10 If the aircraft has not reported within thirty minutes after:

- a) the estimated time of arrival furnished by the pilot;
- b) the estimated time of arrival calculated by the ACC; or
- c) the last acknowledged expected approach time, whichever is latest, pertinent information concerning the aircraft shall be forwarded to aircraft operators, or their designated representatives, and pilots-in-command of any aircraft concerned and normal control resumed if they so desire. It is the responsibility of the aircraft operators, or their designated representatives, and pilots-in-command of aircraft to determine whether they will resume normal operations or take other action.

APPENDIX A: AREA NAVIGATION SYSTEMS

1. GENERAL

1.1 An area navigation system automatically accepts inputs from various positioning sources. These can be ground-based NAVAIDS, satellite or airborne systems, e.g. VOR, DME, INS or GNSS. The quality of the available NAVAID infrastructure has a direct impact on the accuracy of the navigation solution. The area navigation system computes aircraft position, velocity, track angle, vertical flight path angle, drift angle, magnetic variation, barometric-corrected altitude, estimated time of arrival and wind direction and magnitude. It may also perform automatic radio NAVAID tuning as well as support manual tuning. While navigation can be based upon a single navigation signal source (e.g. GNSS), most systems are multi-sensor area navigation systems. Such systems use a variety of navigation sensors including GNSS, DME, VOR and IRS, or AHRS, to compute the position and velocity of the aircraft. While the implementation may vary, the system will typically base its calculations on the most accurate positioning sensor available.

1.2 The area navigation system will confirm the validity of the individual sensor data and, in most systems, will also confirm the consistency of the computed data before they are used. GNSS data are subjected to rigorous integrity and accuracy checks prior to being accepted for navigation position and velocity computation. DME and VOR data are typically subjected to a series of reasonableness checks prior to being accepted for radio updating. This difference in rigour is due to the capabilities and features designed into the navigation sensor technology and equipment. For multi-sensor area navigation systems, if GNSS is not available for calculating position/velocity, then the system may automatically select a lower priority update mode such as DME/DME or VOR/DME. If these radio update modes are not available or have been deselected, then the system may automatically revert to inertial coasting (i.e. navigation with reference to INS information or AHRS DR). For single-sensor systems, sensor failure may lead to a dead reckoning mode of operation. If the area navigation system is using ground NAVAIDS, it uses its current estimate of the aircraft's position and its internal database to automatically tune the ground stations in order to obtain the most accurate radio position.

Area navigation enables the aircraft to fly a path, or "leg", between points, called "waypoints", which are not necessarily co-located with ground-based navigation aids. If a navigation database is included in the area navigation system then the data in the database are specific to

an operator's requirements. These data are taken from the States' aeronautical information publications (AIPs) in the form of route structures, instrument flight procedures, runways and NAVAIDS. The intended flight path is programmed into the area navigation system by selection or input of a series of waypoints, or by loading a complete route or procedure description from the navigation database. If there is no database the pilot must insert all waypoint data.

1.3 The intended flight path is displayed to the pilot. Lateral and, where available, vertical guidance are provided to the pilot on displays in the primary field of view. Area navigation systems are generally coupled, or capable of being coupled, directly to the auto-flight system (autopilot).

1.4 More advanced area navigation systems include a capability for performance management where aerodynamic and propulsion models are used to compute vertical flight profiles matched to the aircraft and able to satisfy the constraints imposed by the procedure. A performance management function can be complex, utilizing fuel flow, total fuel, flap position, engine data and limits, altitude, airspeed, Mach, temperature, vertical speed, progress along the flight plan and pilot inputs to determine the optimum path. Area navigation systems routinely provide flight progress information for the waypoints en-route, for terminal and approach procedures, and the origin and destination. The information includes estimated time of arrival and distance-to-go, which are both useful in tactical and planning coordination with ATC.

2. GUIDANCE AND CONTROL

2.1 An area navigation system provides lateral guidance and, in many cases, vertical guidance. The lateral guidance function compares the aircraft's position generated by the navigation function with the desired lateral flight path and then generates steering commands to fly the aircraft along the desired path. Geodesic or great circle paths join the flight plan waypoints and circular transition arcs between these legs are calculated by the area navigation system. The flight path error is computed by comparing the aircraft's present position and direction with the reference path. Roll steering commands to track the reference path are based upon the path error. These steering commands are output to a flight guidance system, which either controls the aircraft directly or generates commands for the flight director. The vertical guidance function, where included, is used to control the aircraft along the vertical profile within constraints imposed by the flight plan. The outputs of the vertical guidance function are

typically pitch commands to a display and/or flight guidance system, and thrust or speed commands to displays and/or an auto-thrust function.

2.2 Display and system controls provide the means for system initialization, flight planning, computation of path deviations, progress monitoring, active guidance control and presentation of navigation data for flight crew situational awareness.

3. NAVIGATION DATABASE

3.1 Operators purchase the navigation data from third-party companies, known as data houses, that compile the navigation information from each State to support the operator's requirement. These data houses produce the datasets which are packaged and shipped in ARINC 424 format to the original equipment (area navigation system) manufacturers (OEMs). The OEMs, known as "data packers", code the datasets for the appropriate (target) area navigation systems. The databases are updated and validated in accordance with the ICAO AIRAC. Each area navigation system uses its own proprietary binary database format. Furthermore, each operator has a specific requirement for navigation data.

3.2 If the data in the dataset are incorrect, the data in the database will be incorrect and the pilot may not be aware of this. Each navigation specification includes requirements to ensure that the navigation database integrity is maintained and to ensure that only valid databases are used. The flight path extracted from the database should also be checked for accuracy and consistency against the chart information before and during every area navigation operation.

3.3 When using an area navigation system with a database, the pilot will select the route/procedure or the waypoints defining the flight planned route from the database to create a route in the area navigation system. For area navigation systems without a database, the pilot will manually insert the waypoints (key in the coordinates of each waypoint required) to define the route.

4. RNAV WAYPOINTS

A significant point is defined as a specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation. There are three categories of significant points: ground-based navigation aid, intersection and waypoint. An intersection is a significant point expressed as radials, bearings and/or distances from ground-based navigation aids. Area navigation systems use only significant points that are defined by geographic coordinates in WGS-84 and data houses convert fixes into “computer navigation fixes” with associated coordinates. Fixes are associated only with conventional navigation and are not used in PBN. All significant points are treated as “waypoints” within the area navigation system. Significant points are identified as follows:

- a) by a five-letter unique name code, e.g. BARN A;
- b) by the three-letter ICAO identifier for the NAVAID, e.g. OTR;
- c) by an alphanumeric name code if used in terminal airspace only, e.g. DF410.

4.2 Area navigation routes/procedures can specify a path laterally, longitudinally and vertically. The waypoints are used to indicate a change in direction (track), speed and/or height. In SIDs and missed approaches, turns may be predicated on altitude rather than waypoint location. The area navigation system will fly routes and procedures in a consistent manner but the actual track will depend upon the waypoint transition and, in terminal procedures, on the leg types used to define the procedure. Waypoint transition may be:

- a) flyover;
- b) fly-by;
- c) fixed radius.

4.3 A flyover waypoint requires that the turn is initiated when the aircraft passes overhead the waypoint. All area navigation systems are capable of a flyover turn followed by a manoeuvre to recapture the next leg. A fly-by waypoint requires the area navigation system to calculate a turn anticipation before the aircraft reaches the waypoint to allow interception of the next segment without the aircraft passing overhead the waypoint. The turn anticipation distance depends on aircraft ground speed and the angle of bank applied in the turn. Turn anticipation does not provide track guidance during the turn, and cross-track error cannot be

monitored until the aircraft is established on the subsequent leg. The effectiveness of the turn anticipation algorithm is limited by variation in ground speed during the turn (e.g. headwind to tailwind) and the achieved bank angle. Undershooting or overshooting of the turn can occur and crew intervention may be required. Fly-by functionality is called up in many navigation specifications but is not always available on older and less capable area navigation systems.

4.4 A fixed radius turn is defined differently in en-route and on terminal procedures. In the former, which is known as a fixed radius transition (FRT), a fixed radius value is associated with a waypoint, and the area navigation system is required to fly by that waypoint using the same turn radius regardless of the aircraft ground speed. In the latter case, the ground track is defined in the database with a waypoint at the start and end of the turn and the leg type specified as a radius to fix (RF) leg. In both cases the turn is a fixed circular track over the ground with tangential inbound and outbound legs. The area navigation system monitors cross-track error during the turn and provides guidance to maintain the circular track. RF and FRT functionality are not available on many older RNAV systems.

5. RNAV PERFORMANCE

PBN requirements are specified in terms of lateral, vertical and 4-D accuracy; integrity; continuity; availability and functionality. (Only one navigation specification to date addresses “time of arrival” (4-D) requirements.)

5.1 Accuracy

5.1.1 The accuracy achieved by an area navigation system depends on the position and timing sources, the RNAV system, the flight guidance and the navigation database. The total system error (TSE) is usually computed as a root sum square of the navigation system error (NSE), the flight technical error (FTE) and the position definition error (PDE).

5.1.2 The lateral track accuracy is based upon the path that has been defined by the area navigation system, the navigation sensor used to estimate the position, and the ability of the pilot and aircraft guidance system to fly the defined path. Each navigation specification identifies the 95 per cent accuracy requirement and may place additional constraints on certain of the error sources. For example, the FTE requirement is usually set at one-half full-scale

deflection (FSD), where:

$$TSE = \sqrt{NTE^2 + FTE^2 + PDE^2}$$

FSD = the 95 per cent accuracy requirement. Positioning sources may be limited, for example to DME/DME and GNSS only. Additional data integrity checks may be required to limit the potential for path definition error.

5.1.3 Position estimation accuracy is related to the type of navigation sensor used and the associated NSE. The NSE depends upon the signal-in-space and the dilution of precision (DOP) resulting from the relative angle that the signals subtend at the antenna.

5.1.4 Some sensors are better suited to PBN operations than others:

- a) NDB is not suitable for any area navigation systems.
- b) VOR accuracy deteriorates with range and is appropriate only for RNAV 5 applications.
- c) DME/DME requires there to be sufficient stations with appropriate geometry in order to support some PBN applications in continental en-route and terminal airspace. A position estimation accuracy sufficient for ± 1 NM accuracy requires that the signals from a pair of DME stations subtend more than 30 degrees but less than 150 degrees at the aircraft antenna.
- d) GNSS is the most accurate PBN positioning source and can be used in all PBN applications.

5.1.5 Vertical profile accuracy is, similarly, based upon the vertical path defined by the area navigation system, the sensor used to estimate the altitude, the vertical component of any along-track error and the ability of the pilot and aircraft guidance system to fly the defined profile. At present there are two vertical sensor sources for area navigation systems: barometric altimetry and SBAS.

5.2 Integrity

5.2.1 Integrity is the degree of confidence that can be placed in the guidance provided by the area navigation system. Any malfunction of the area navigation system or associated equipment (e.g. sensors) must not occur more than once in 100 000 flight hours. The pilot must be alerted if the system malfunctions.

5.2.2 In RNP systems, the pilot must also be alerted if the probability that the total system error (TSE) is greater than the 95 per cent accuracy requirement exceeds 10–5. In GNSS-equipped area navigation systems this is usually achieved using the receiver autonomous integrity monitoring (RAIM) function or the aircraft autonomous integrity monitoring (AAIM) function. SBAS also provides an integrity monitoring function.

5.2.3 The RAIM function in the GNSS receiver compares a series of position estimations using the available satellite signals and generates an alert if one of the position estimations exceeds a pre-set threshold value (horizontal alert limit (HAL)). This is known as fault detection (FD) and requires a minimum of five satellites in view, although a barometric input may be used instead of one satellite. More recent RAIM versions detect the fault and exclude the faulty satellite from the positioning solution without necessarily generating any alert. This is known as fault detection and exclusion (FDE) and requires a minimum of six satellites in view. RAIM availability is determined by calculating the radius of a circle, as a function of the RAIM threshold and the satellite geometry at the time of the measurements, which is centred on the GPS position solution and is guaranteed to contain the true position. If this radius is less than HAL, RAIM is available. The AAIM function compares the GNSS position estimation with the on-board inertial navigation position and generates an alert if the pre-set threshold values are breached. SBAS detects GPS satellite signal errors and broadcasts corrections to all users.

5.3 Availability and continuity

In order to perform a specific navigation application, both the signals-in-space and the aircraft systems must meet the required accuracy and integrity for that operation. Availability is a measure of the probability that this will be the case when the operation is to be performed. Continuity is a measure of the probability that it will continue to be the case for the duration of the operation. The service provider is responsible for ensuring that the signal is available and continues to be available. However, the navigation specifications do not specify a measure of availability, and operators are required to check the availability prior to departure and again

prior to commencing an operation. The navigation specifications all require that the airborne systems meet a continuity of 10⁻⁴ per flight hour. This is often achieved through redundancy (additional capability to handle failures), or by the carriage of additional systems (e.g. IRS/IRU). The probability of failure and therefore being unable to complete an operation must be acceptably low.

5.4 On-board performance monitoring and alerting

RNP systems do not necessarily provide the pilot with a warning when the lateral accuracy limits have been exceeded. Most RNP specifications require that the area navigation system, or the area navigation system and pilot in combination, provide an alert if the accuracy requirement is not met or if the probability that the lateral TSE exceeds a specified value is greater than 10⁻⁵. RNP systems typically have an NSE monitoring and alerting algorithm, which generates an alert, and displays FTE via a lateral deviation indicator, which is monitored by the crew.

5.5 Functionality

5.5.1 The following system functions are the minimum required to conduct area navigation operations:

- a) continuous indication of aircraft position relative to track to be displayed to the pilot flying (and the pilot monitoring) on a navigation display situated in the primary field of view;
- b) display of distance and bearing to the active (To) waypoint;
- c) display of ground speed or time to the active (To) waypoint;
- d) navigation data storage (usually a navigation database);
- e) appropriate failure indication of the area navigation system, including failed sensors or degraded mode of performance.

5.5.2 Each navigation specification identifies additional functionalities which may include:

- a) non-numeric lateral and vertical deviation displays in the primary field of view, automatically saved to the area navigation computed path and with full-scale deflection based upon the required TSE;
- b) map displays with appropriate scales;
- c) the means to retrieve and display data, including entire area navigation routes/procedures, from a navigation database;
- d) display active sensor type;
- e) execute “direct to” function;
- f) automatically sequence legs and display the sequencing (fly-by, flyover, turn at altitude);
- g) execute leg transitions and maintain tracks consistent with ARINC 424 path terminators (CA, CF, DF, FA, FM, HA, HF, HM, IF, RF, VA, VI and VM);
- h) define a vertical path by altitude constraints at two waypoints or by vertical path angle at a waypoint;
- i) provide guidance to a vertically constrained waypoint;
- j) display altitude restrictions and vertical path angles;
- k) execute fixed-radius transitions;
- l) automatic reversion to alternate sensor when primary sensor fails;
- m) execute parallel offset;
- n) maintain continuous track guidance upon initiation of missed approach/go-around;
- o) ensure that lower navigation accuracy is achieved by the waypoint which marks the start of the leg with the lower accuracy requirement;
- p) appropriate alert when the NSE limit cannot be assured.

5.6 Deviation display

There are a number of different ways in which lateral deviation can be displayed: the course deviation indicator (CDI) and the horizontal situation indicator (HSI) are both avionic instruments that display deviation from track by means of pointers; navigation performance scales (NPS) and also L/DEV and V/DEV provide a graphical representation of the achieved lateral and vertical performance, together with an indication of available flight technical error



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remaining; numeric displays of achieved navigation performance and, finally, the navigation map display. In general, a map display, or a numeric indicator is considered to be adequate for RNP 2 and higher, while deviation indicators such as CDI and HSI are required for lower RNP accuracy values, and NPS or L/DEV and V/DEV, together with FD and/or AP, are required for low RNP accuracy values.

APPENDIX B: EXAMPLE REGULATORY TEXT

XXX.1 APPLICATION FOR A SPECIFIC APPROVAL

a) An applicant for the initial issue of a specific approval shall provide the [Competent Authority] with the documentation required, as detailed on the application form, and the following information:

1. the official name, address and mailing address of the applicant; and
2. a description of the intended operation.

b) An applicant for a specific approval shall provide evidence to the [Competent Authority] that:

1. the applicant complies with the requirements;
2. the aircraft and required equipment fulfill the applicable airworthiness requirements, are maintained according to the approved maintenance programme and are approved when required;
3. a training programme has been established for flight crew and, as applicable, personnel involved in these operations; and
4. operating procedures in accordance with the requirements have been documented. Operating procedures should be documented in the operations manual. If an operations manual is not required, operating procedures may be described in a procedures manual.

c) An operator shall retain records relating to the requirements of a) and b) above at least for the duration of the operation requiring the specific approval.

XXX.2 PRIVILEGES OF AN OPERATOR HOLDING A SPECIFIC APPROVAL

The scope of the activity that the operator is approved to conduct shall be documented and specified:

- a) for commercial operators, in the operations specifications associated to the air operator certificate; and
- b) for non-commercial operators, in the list of specific approvals.

XXX.3 CHANGES TO OPERATIONS SUBJECT TO A SPECIFIC APPROVAL

In case of a change that affects the conditions of a specific approval, the operator shall provide the relevant documentation to the competent authority and obtain prior approval for the change to operation, documented by an amendment to the approval document XXX.003.

XXX.4 CONTINUED VALIDITY OF A SPECIFIC APPROVAL

Specific approvals shall be issued for an unlimited duration. They shall remain valid subject to the operator remaining in compliance.

XXX.PBN.001 PBN OPERATIONS

An aircraft shall be operated only in designated airspace, on routes or in accordance with procedures where compliance with performance-based navigation (PBN) specifications is required if the operator has been approved by the competent authority.

Guidance material for the global performance specifications, approval process, aircraft requirement (e.g. generic system performances, accuracy, integrity, continuity, signal-in-space, RNP specifications required for the on-board performance monitoring and alerting system), requirements for specific sensor technologies, functional requirements, operating procedures, flight crew knowledge and training and navigation database integrity requirements can be found in ICAO Doc 9613, *Performance-based Navigation (PBN) Manual* and the applicable documents listed in the table below.



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	Flight Phase								Applicable documents	Complementary guidance material
	En-route		STAR	Approach				SID		
	Oceanic/remote	Continental		Initial	Intermediate	Final	Missed			
RNAV 10	X								AC 91-001	EASA AMC 20-12 FAA 8400.12
RNAV 5		X							AC 91-002	EASA AMC 20-4 FAA AC 90-96()
RNP 4	X								AC 91-004	FAA 8400.33
RNP 2		X	X						TBD	TBA
RNAV 2		X	X						AC 91-003	EASA TGL No. 10 FAA AC 90-100()
RNP 1			X	X	X		X	X	AC 91-006	EASA TGL No. 10 FAA AC 90-105
RNAV 1			X	X	X		X	X	AC 91-003	EASA TGL No. 10 FAA AC 90-100()
A-RNP		X	X	X	X	X	X	X	TBD	TBA
RNP APCH (LNAV)				X	X	X	X		AC 91-008	EASA AMC 20-27 FAA AC 90-105
RNP APCH (LNAV/VNAV)				X	X	X	X		AC 91-010	
RNP APCH (LP/LPV)						X	X		TBD	EASA AMC 20-28 FAA AC 90-107
RNP AR			X	X	X	X	X	X	AC 91-009	EASA AMC 20-26 FAA AC 90-101
RF			X	X	X		X	X	TBD	FAA AC 90-105
Electronic data management		X	X	X	X	X	X	X	TBD	EASA Part 21, Subpart G FAA AC 20-153

XXX.PBN.002 PBN OPERATIONAL APPROVAL

To be issued a PBN operational approval by the [Competent Authority], the operator shall provide evidence that:

- a) the relevant airworthiness approval of the RNAV system has been obtained;
- b) a training programme for the flight crew involved in these operations has been established; and
- c) operating procedures have been established specifying:
 1. the equipment to be carried, including its operating limitations and appropriate entries in the minimum equipment list (MEL);
 2. flight crew composition and experience requirements;
 3. normal procedures;
 4. contingency procedures;
 5. monitoring and incident reporting; and
 6. electronic navigation data management.

XXX.PBN.003 ELECTRONIC NAVIGATION DATA MANAGEMENT

Electronic navigation data products that have been processed for application in the air and on the ground shall be used only once the [Competent Authority] has approved the operator's procedures for:

- a) ensuring acceptable standards of data integrity and compatibility with the intended function;
- b) continual monitoring of the related data processes and the products; and
- c) ensuring the timely distribution and insertion of electronic navigation data.



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APPENDIX C: EXAMPLE OPERATIONS SPECIFICATION (OPS SPEC) ENTRIES

Note.— The PBN approval is detailed within the Ops Spec.



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OPERATIONS SPECIFICATIONS (subject to the approved conditions in the operations manual)				
ISSUING AUTHORITY CONTACT DETAILS¹				
Telephone: _____		Fax: _____		E-mail: _____
AOC# ² : _____		Operator name ³ : _____		Date ⁴ : _____ Signature: _____
Dba trading name: _____				
Aircraft model ⁵ : _____				
Types of operation: Commercial air transportation <input type="checkbox"/> Passengers <input type="checkbox"/> Cargo <input type="checkbox"/> Other ⁶ : _____				
Area(s) of operation ⁷ : _____				
Special limitations ⁸ : _____				
SPECIAL AUTHORIZATIONS	YES	NO	SPECIFIC APPROVALS ⁹	REMARKS
Dangerous goods	<input type="checkbox"/>	<input type="checkbox"/>		
Low visibility operations				
Approach and landing	<input type="checkbox"/>	<input type="checkbox"/>	CAT ¹⁰ : _____ RVR: _____ m DH: _____ ft	
Take-off	<input type="checkbox"/>	<input type="checkbox"/>	RVR ¹¹ : _____ m	
RVSM ¹² <input type="checkbox"/> N/A	<input type="checkbox"/>	<input type="checkbox"/>		
EDTO ¹³ <input type="checkbox"/> N/A	<input type="checkbox"/>	<input type="checkbox"/>	Threshold time ¹⁴ : _____ minutes Maximum diversion time ¹⁴ : _____ minutes	
Navigation specifications for PBN operations ¹⁵	<input type="checkbox"/>	<input type="checkbox"/>		¹⁶
Continuing airworthiness	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	¹⁷	
Other ¹⁸	<input type="checkbox"/>	<input type="checkbox"/>		



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Notes.-

1. Telephone and fax contact details of the authority, including the country code. E-mail to be provided if available.
2. Insert the associated AOC number .
3. Insert the operator's registered name and the operator's trading name, if different. Insert "dba" before the trading name (for "doing business as").
4. Issuance date of the operations specifications (dd-mm-yyyy) and signature of the authority representative.
5. Insert the Commercial Aviation Safety Team (CAST)/ICAO designation of the aircraft make, model and series, or master series, if a series has been designated (e.g. Boeing-737-3K2 or Boeing-777-232). The CAST/ICAO taxonomy is available at: <http://www.intlaviationstandards.org/>.
6. Other type of transportation to be specified (e.g. emergency medical service).
7. List the geographical area(s) of authorized operation (by geographical coordinates or specific routes, flight information region or national or regional boundaries).
8. List the applicable special limitations (e.g. VFR only, day only).
9. List in this column the most permissive criteria for each approval or the approval type (with appropriate criteria).
10. Insert the applicable precision approach category (CAT I, II, IIIA, IIIB or IIIC). Insert the minimum RVR in metres and decision height in feet. One line is used per listed approach category.
11. Insert the approved minimum take-off RVR in metres. One line per approval may be used if different approvals are granted.
12. "Not applicable (N/A)" box may be checked only if the aircraft maximum ceiling is below FL 290.
13. If extended diversion time operations (EDTO) approval does not apply based on the provisions in Chapter 4, 4.7, select "N/A". Otherwise a threshold time and maximum diversion time must be specified.
14. The threshold time and maximum diversion time may also be listed in distance (NM), as well as the engine type.
15. Performance-based navigation (PBN): one line is used for each PBN specification authorization (e.g. RNAV 10, RNAV 1, RNP 4), with appropriate limitations or conditions listed in the "Specific Approvals" and/or "Remarks" columns.

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17. *Limitations, conditions and regulatory basis for operational approval associated with the performance-based navigation specifications (e.g. GNSS,DME/DME/IRU). Information on performance-based navigation, and guidance concerning the implementation and operational approval process, are contained in the Performance-based Navigation (PBN) Manual (Doc 9613).*

18. *Insert the name of the person/organization responsible for ensuring that the continuing airworthiness of the aircraft is maintained and the regulation that requires the work, i.e. within the AOC regulation or a specific approval (e.g. EC2042/2003, Part M, Subpart G).*

19. *Other authorizations or data can be entered here, using one line (or one multi-line block) per authorization (e.g. special approach authorization, MNPS, approved navigation performance).*

Example entries are illustrated below:

Special Authorizations	Yes	No	Specific Approvals	Remarks
Navigation specifications for PBN operations	<input checked="" type="checkbox"/>	<input type="checkbox"/>	RNAV 10	Primary sensor GNSS.
			RNAV 5	Also valid for B-RNAV routes. Approval based upon GNSS and DME/DME.
			RNAV 1 and 2	Also valid for P-RNAV routes/procedures.
			RNP 1	Authorized for RF legs.
			RNP APCH (LPV)	Approval based upon SBAS. Authorized for approaches to LPV, LNAV/VNAV or LNAV minima.
RNP AR APCH	RNP 0.15 Authorized for RF legs. RNP 0.2 in missed approach. AP required. Dual FMS/IRS required.			



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APPENDIX D: EXAMPLE APPLICATION FORM

APPLICATION FOR XXXX OPERATIONAL APPROVAL OR RENEWAL

Please complete the form in BLOCK CAPITALS using black or dark blue ink. This form is designed to elicit all the required information from those operators requiring [Insert PBN type] operations approvals. The completed form and supporting documentation should be submitted to [Insert Name of Authority] at the address listed below:

Xxxx _____

Xxxx _____

Xxxx _____

Xxxx _____

Section I Operator/airframe details (completion is mandatory)

Section II Notes for completion

Section III Signature (completion is mandatory)

Section IV Operator's submissions matrix (completion is mandatory)



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SECTION I. OPERATOR/AIRFRAME DETAILS

1. Applicant details		
Provide official name, address, mailing address, e-mail address and contact telephone/facsimile numbers.		
2. Aircraft details Aeroplane type(s), series and registration mark(s)		
Aeroplane type	Aeroplane series	Registration



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SECTION II. NOTES FOR COMPLETION

1. Applicability

General description of the operation with references to appropriate standards and guidance material.

2. Operator's submissions matrix

Section IV of this application form is the operator's submissions matrix. All applicants should complete this matrix in full. If more than one type of aircraft/fleet is included in a single application a completed matrix should be included for each aircraft/fleet.

FAILURE TO COMPLETE THE SUBMISSIONS MATRIX MAY RESULT IN A DELAY IN PROCESSING THE APPLICATION.

3. Documents to be included with the submission

Copies of all documents referred to in the operator's submissions matrix should be included when returning the completed application form to the [Insert Name of Authority]. Original documents should not be sent; photocopies are sufficient. Do not send complete manuals, only the relevant sections/pages.

FAILURE TO INCLUDE ALL RELEVANT DOCUMENTATION MAY RESULT IN A DELAY IN PROCESSING THE APPLICATION.

4. Submissions and enquiries

Address for submissions and contact details for enquiries.



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SECTION III. SIGNATURE

Signature:

Name (block letters):.....

Title:

Date:



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SECTION IV. OPERATOR'S SUBMISSIONS MATRIX

Reference documents	Submission based upon current regulatory material. Compliance statement should show how criteria have been satisfied.	List of appropriate documents
Airworthiness navigation system capability compliance statement	Specify to what standards the navigation system complies.	List of applicable standards/TSOs/guidance material
Aircraft flight manual	Copy of the extract from the AFM showing the certification standard for PBN operation.	
Navigation system FMS/autopilot interface capability	Full details of navigation system, FMS and autopilot including type, number, software version.	
Navigation accuracy	Statement of certified navigation accuracy.	
Navigation database	Details of the supplier of the navigation database, the supplier's approval status and, where necessary, additional quality assurance/data integrity checks applied by the operator or the supplier.	
Maintenance	Details of maintenance procedures applicable to the navigation system and associated databases.	



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Charts	Details of the supplier of charts, supplier's approval status and, where necessary, additional quality assurance/data integrity checks applied by the operator or the supplier.	
Error reporting	Outline of error reporting process and procedures for error analysis, prevention and correction, including feedback to the CAAT, navigation database and chart suppliers, as well as OEMs.	
Standard operating procedures	Details of applicable operating procedures. It is recommended that the manufacturer's procedures are used as a starting point.	
Operations manual	Details of dispatch requirements (navigation accuracy, MEL, RAIM, NOTAMs); RTF phraseology; SOPs; crew authorization requirements; training and testing requirements.	
Any further comments		

APPENDIX E: OPERATIONAL SAFETY ASSESSMENTS (FOSAS)

1. FOSA OVERVIEW

1.1 *Why is a FOSA needed?*

1.1.1 In some cases the operational needs of stakeholders lead to procedure designs which may or may not comply with ICAO Doc 9905 but which require the aircraft to be operated in a manner that was not considered in its airworthiness approval.

1.1.2 A FOSA is intended to address this nominal mismatch.

1.1.3 When RNP AR APCH is being implemented it is for a specific reason, e.g. improved access, safety, efficiency. The FOSA process helps to ensure that the operational needs, the limits of safe and efficient aircraft performance, the means of assuring repeatable and predictable flight operations, the means of safe flight operations when faced with aircraft failures and hazardous conditions, etc., are understood by all relevant stakeholders. As a result the aircraft operations, procedure design, contingency arrangements, training and maintenance will all be at the level necessary for flight and operational safety.

1.2 When should a FOSA be conducted?

A FOSA should be conducted for each RNP AR approach procedure where the more stringent aspects of the nominal procedure design criteria (as per ICAO Doc 9905) are applied (i.e. RF legs after the FAF, RNP missed approaches less than 1.0, RNP final approaches less than 0.3) or where the application of the default procedure design criteria is in an operating environment with special challenges or demands.

1.3 How should a FOSA be carried out?

1.3.1 The FOSA should ensure that for each specific set of operating conditions, aircraft and environment, all failure conditions are assessed and, where necessary, mitigations are implemented to meet the safety criteria. The assessment should give proper attention to the inter-dependence of the elements of procedure design, aircraft capability, crew procedures and operating environment.

1.3.2 The functional areas presented in Figure E-1 have been identified as elements to assess collectively in a typical FOSA. The FOSA should act as the “glue” to combine and analyse the risks associated with the RNP AR system.

2. Required Depth of a Fosa

The depth of a FOSA and the associated level of resources are very important issues for stakeholders. Three factors that influence the required depth of a FOSA are:

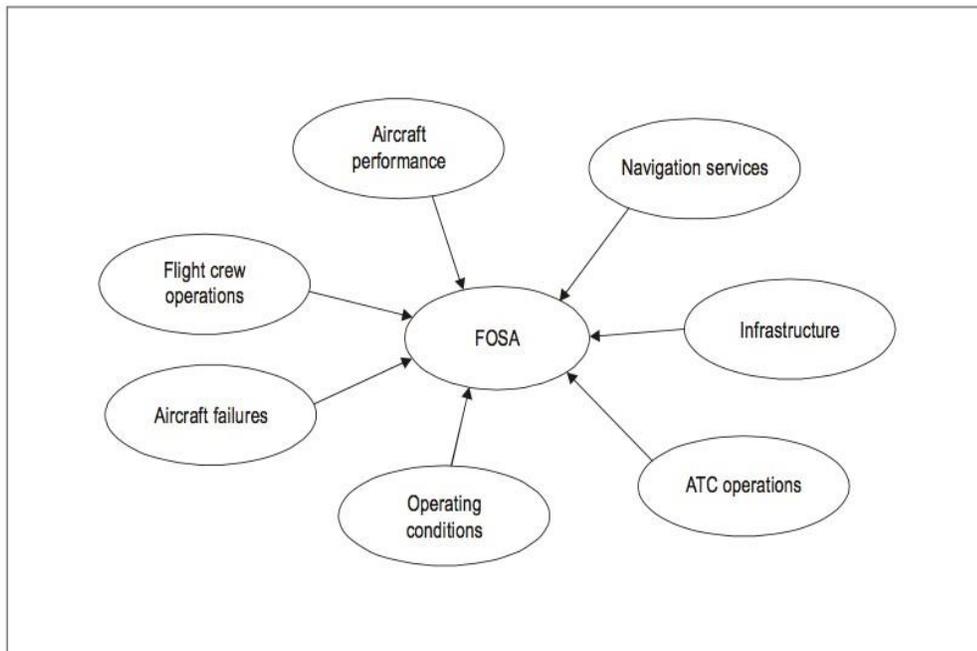


Figure E-1. Elements to consider in a FOSA

- a) how challenging the proposed procedure design is relative to the airworthiness approval/qualification;
 - a) the operational and obstacle environment; and
 - b) the previous experience of stakeholders and the availability of appropriate previous safety assessments.

2.1 Airworthiness approval/qualification

2.1.1 In order to meet the RNP AR eligibility requirements (Doc 9163, Volume II, Part 3, 6.3.3) the manufacturer needs to establish that the criteria for assessing probable failures during the aircraft qualification demonstrated that the aircraft trajectory is maintained:

- a) within 1 x RNP of the lateral track, 95 per cent of the flight time; and
- b) within $\sqrt{((6076.115)(1.225)RNP \tan \theta)^2 + (60 \tan \theta)^2 + 75^2 + ASE^2}$ of the vertical path, 99.7% of flight time

$$\sqrt{((6076.115)(1.225)RNP \tan \theta)^2 + (60 \tan \theta)^2 + 75^2 + ASE^2} \\ (ASE - -8.8 * 10^{-8} * H^2 + 6.5 * 10^{-3} * H + 50).$$

Proper documentation of this demonstration in the aircraft flight manual (AFM), AFM extension, or appropriate aircraft operational support document alleviates the need for operational evaluations.

2.1.2 RNP-significant improbable failure cases should also be assessed to show that, under these conditions, the aircraft can be safely extracted from the procedure. Failure cases may include dual system resets, flight control surface runaway and complete loss of flight guidance function.

2.1.3 The aircraft performance demonstration during the operational evaluations can be based on a mix of analyses and flight technical evaluations using expert judgement. Aircraft performance in the event of failures, as well as in normal conditions, should therefore be available in the AFM or an equivalent document.

2.2 Operational and obstacle environment

2.2.1 If the procedure is being introduced for noise alleviation purposes and there are no obstacles close to the route (within 2 x RNP), a less detailed FOSA may be appropriate. No FOSA is required if the default RNP values of 1, 1, 0.3 and 1 are used for the procedure.

2.2.2 If a very complex and challenging procedure is being introduced for better access to a runway surrounded by challenging terrain/obstacles, a more detailed FOSA may be considered advisable (if no prior examination/ assessment is found to be applicable — see below).

2.3 Previous experience of stakeholders and availability of appropriate previous FOSAs.

2.3.1 The specific history and circumstances of the RNP AR APCH implementation and the associated stakeholders will affect the depth of the FOSA. Important factors include whether:

- a) a new procedure is being developed, or one already exists, that is flown by other carriers and/or by other aircraft types;
- b) relevant FOSAs exist for the procedure or for other similar applications;
- c) a carrier with an RNP-certified aircraft already has the manufacturer’s AFM, operations manual, crew procedures, dispatch guidance, minimum equipment criteria for RNP, compliance assessments, etc., that were considered valid from a previous similar RNP AR application;
- d) the ANSP and regulator(s) have previous experience with RNP AR approaches and FOSA at this airport or similar locations.

2.3.2 When it is determined that no FOSA has to be performed, a rationale should be provided, e.g. “not applicable as covered by basic aircraft certification and/or prior operational approvals and FOSA”.

3. How to Conduct a FOSA

3.1 Overview of the main steps

Within aviation a number of safety assessment methodologies are in use. There is usually a large degree of commonality between them, and it is difficult to identify one as clearly the best in all situations. The method illustrated in Figure E-2 was developed to be consistent with previous FOSA material and more general safety assessment material. It is likely that many organizations planning RNP AR approaches will already have their own safety assessment processes in place. It is expected that the steps below will be represented within these processes.

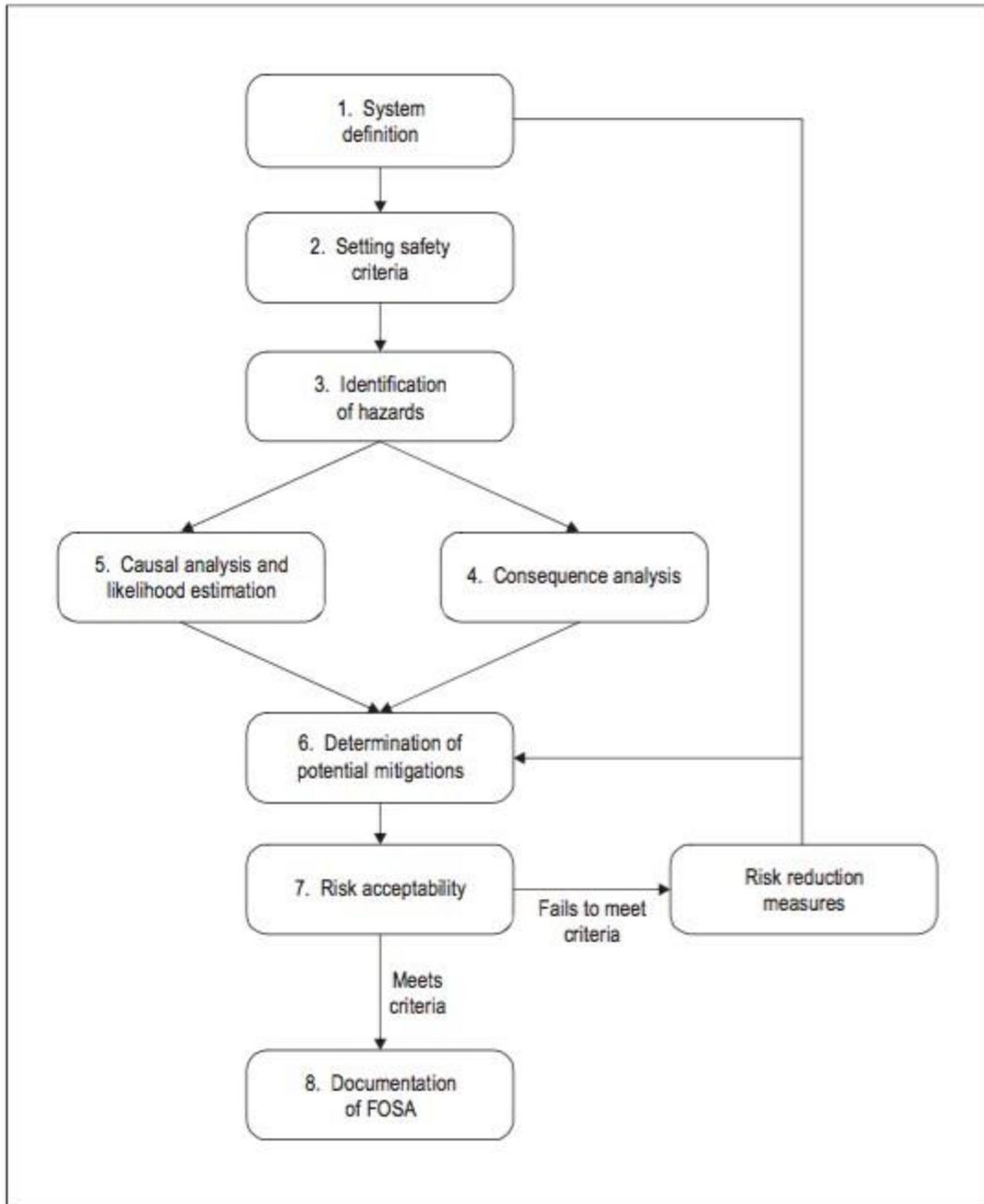


Figure E-2. Main steps in a FOSA

3.2 Details of each step

Step 1 – System definition

3.2.1 The following information should be gathered with respect to the proposed RNP AR APCH procedure:

- a) the proposed procedure design and details of the proposed operations including FMS coding issues;
- b) aircraft information, e.g. compliance documents against applicable States regulations, in particular the
- c) aircraft RNP system performance under operational, rare, normal and non-normal conditions which should be documented to support the FOSA exercise;
- d) flight crew procedures and training;
- e) dispatch procedures and training;
- f) proposed minimum equipment list (or RNP AR required equipment list);
- g) any special maintenance requirements;
- h) airport and airspace environment;
- i) navigation infrastructure;
- j) ATC facilities (including surveillance and communications), procedures and intended training with respect to RNP AR operations; and
- k) monitoring programme.

3.2.2 This should be used to put together a system description which is suitable and sufficient to conduct the FOSA. It should be ensured that all relevant elements are included, i.e. not just equipment hardware but human aspects, procedures, software, firmware and environmental aspects. As part of this step, assumptions made in AR guidance documents will need to be checked and validated.

3.2.3 With the system defined it is recommended that a small group of experts spend a short amount of time to identify the difficult elements of the approach, any human factors issues and any key hazards. This information will help to understand the exact requirements and necessary outcomes of the FOSA process. Subsequently an estimation of the depth of analysis required and the effort needed to complete the FOSA can be made.

Step 2 — Setting safety criteria

3.2.4 Safety criteria can be quantitative or qualitative. The PBN manual notes that a FOSA is likely to use a mix of quantitative and qualitative analysis so it would be expected that the safety criteria reflect this. The following criteria have been found to be useful and practical:

a) Quantitative safety objective criteria. Quantitative criteria work best in the airworthiness domain where relevant data on equipment failure rates are available and where consequences can be precisely defined. It should be noted that conversions between different units (e.g. per flight hour to per approach) need to take account of exposure times.

In the flight operations domain, human factors and the influence of procedures and training make it much more difficult to derive meaningful quantitative criteria. Hence qualitative criteria such as the following are generally more useful.

b) *Risk reduced as far as reasonably practicable (AFARP)*. This criterion is commonly used in aviation. It is sometimes referred to as the ALARP criterion, reducing risk as low as reasonably practicable. It is generally used in a qualitative manner although it can be used quantitatively via cost- benefit analysis. In the context of the FOSA it can be applied globally to the system, i.e. the system as a whole has reduced the risk AFARP, and it can also be applied hazard by hazard.

Risk reduced AFARP/ALARP is a flexible criterion suited to the mixture of techniques used in a FOSA. It has been found to be readily accepted by stakeholders in RNP AR case studies and has helped to define what extra risk reduction measures were needed by the AO and ANSP

c) *Risk no greater than current operations*. In a safety conscious industry such as aviation, great care is taken to ensure that operations do not become riskier; rather there is a drive to continue the downward trend in accident rates. This is potentially a useful criterion to apply hazard by hazard to check that there are adequate mitigations in place to ensure no risk increase. Potential difficulties with this relative criterion are:

1. Sometimes it is very difficult even for aviation experts to compare the risks from different approach types.
2. There is a range of risk associated with current approach operations (historically non-precision approaches are significantly higher risk than precision approaches). Hence the conclusions from use of this criterion will depend on what is being compared.
3. Some regulations require that the ATM risk should decrease in the future as traffic rises. Being as safe as today may not be good enough.

Therefore some care needs to be taken with this “no risk increase” criterion. On its own it will probably not be sufficient, but together with the other criteria above it can be part of a practical package. If a relative criterion is used, the other approach type for comparison needs to be defined in the same level of detail as described above in Step 1 for the RNP AR approach.

The choice of safety criteria is very important. It is advisable for AOs to consult with their regulators before undertaking a FOSA. Some regulators may be wary of an RNP AR approach that increases risk compared to an existing PA, for example, even if the new procedure meets an AO’s existing risk tolerability matrix. This could prevent an operational approval from being granted. The AFARP/ALARP principle is likely to be an important and possibly the most practical part of the criteria used in a FOSA.

Step 3 — Identification of hazards

3.2.5 There are a range of techniques that have been used in aviation to identify hazards. Some of these are based on analysis by a single person and others use a group of experts working as a team. Given the need for a FOSA to make use of a mix of disciplines, a group-based approach is likely to be the most successful.

3.2.6 The following points can help maximize the effectiveness of group-based hazard identification:

- a) ensure use of an experienced facilitator to guide the group;

- b) gather the required mix of skills and knowledge, i.e.:
 - i. procedure designers;
 - ii. aircraft and avionics manufacturers, if available;
 - iii. technical support experts;
 - iv. pilots (from relevant aircraft operators and test pilots if available);
 - v. AIM experts;
 - vi. ATCOs and ATC representatives with knowledge of airspace planning and technical facilities; and regulators.

Representatives from other disciplines which could be useful in a FOSA include flight operations, dispatch, maintenance and safety and quality. Running an effective group session involves obtaining a balance of skills but also having a manageable size of group.

Step 4 — Consequence analysis and severity evaluation

3.2.7 The manner in which the consequences of hazards are analysed will depend on the hazards. Aircraft failures will use the failure condition effects and severity classification detailed in the national advisory circulars/acceptable means of compliance and will have to satisfy the quantitative safety objectives set forth in the PBN manual and related documents. In this context, consequences are related to quantitative lateral and vertical excursions and, in the case of excursion beyond the 2 x RNP lateral corridor, whether or not the aircraft remains maneuverable and able to make a safe extraction. To assess consequences in this manner will require simulations. Where relevant analysis already exists from RNP certification activity this should be used and not duplicated.

3.2.8 For hazards in many of the other FOSA functional areas, human failures and procedural issues have a dominant effect. It is very difficult to assign a single severity level or determine a quantified excursion for such hazards. Thus the consequences are better described qualitatively for most of these other hazards. This information can then be used in the decision-making process concerning whether mitigations are sufficient to control risk to an acceptable level.

Step 5 — Causal analysis and likelihood estimation

3.2.9 The likelihood of aircraft equipment failures will already have been analyzed in the existing aircraft system safety assessment (SSA) documents. These often employ techniques that can model complex trees/chains linking multiple causes to the hazard. Data generally exists to populate these models and enable robust quantification of the hazard likelihood. This enables a check to be made that the safety objectives can be met. This work will already have been done during RNP AR certification activities, and it should not be necessary for the manufacturer to supply detailed technical analyses. Details of the hazards considered and their likelihood category should be sufficient for the FOSA.

3.2.10 For most of the other functional areas, where human failures and procedural issues have a dominant effect, such detailed quantification either may not be possible or may not be useful. A possible qualitative method used in the case studies was:

- a) identify and document the relevant causes of the hazard;
- b) map the causal mitigations (see step 6) to these causes;
- c) consider the likelihood of these causes implicitly when judging whether the mitigations are sufficient.

3.2.11 At the end of Step 5, potential combinations and sequences of causes leading to hazards and subsequent sequences of events to various consequences (from Step 4) will be apparent. It is important that common cause failures (CCFs) within these combinations and sequences are identified and their importance assessed. Critical CCFs that can significantly increase risk levels will need additional mitigations.

Step 6 — Determination of mitigations

3.2.12 Mitigations that reduce the chance of a hazard occurring (causal mitigations) and mitigations that reduce the severity of hazard consequences/effects should be considered and documented. Splitting out the potential causes and consequences can help this process.

3.2.13 As part of the analysis of consequential mitigations it would be expected that contingency procedures would be fully worked out covering a range of challenging hazards (e.g.

double FMS loss, loss of GNSS) occurring at various critical locations (e.g. in the RF leg, early in the procedure potentially requiring long extraction, at DA/ DH).

3.2.14 It is usually helpful to identify mitigations that are already in place or planned and then to allow the FOSA group time to also identify potential extra mitigations. Some of these potential extra mitigations may later be rejected as not needed or not practicable. However, this part of the process is a key stage in demonstrating that risk has been reduced AFARP.

Step 7 — Determination of risk acceptability

3.2.15 For aircraft failure hazards, the normal airworthiness criteria from 14 CFR 25.1309 will be used together with the PBN Manual, Volume II, Part C, Chapter 6, 6.3.3, i.e.:

- a) Criteria for assessing probable failures during the aircraft qualification will demonstrate that the aircraft trajectory is maintained within a 1 x RNP corridor, and 22 m (75 ft) vertical. Proper documentation of this demonstration in the AFM, AFM extension, or appropriate aircraft operational support document alleviates the operational evaluations.
- b) RNP-significant improbable failure cases should be assessed to show that, under these conditions, the aircraft can be safely extracted from the procedure. Failure cases might include dual system resets, flight control surface runaway and complete loss of flight guidance function
- c) *The aircraft performance demonstration during the operational evaluations can be based on a mix of analyses and flight technical evaluations using expert judgment.*

3.2.16 For most of the other hazards the most direct way to determine risk acceptability is for the expert group to look at the mitigations and decide if residual risk is acceptable. In making this decision the group will be making sure that risk is not going to be higher than current operations and that it has been reduced AFARP.

3.2.17 If the safety criteria are not satisfied, the FOSA steps in Figure E-2 show the need to consider further risk reduction measures either feeding back to Step 6 or potentially to a



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system re-design, e.g. updated procedure design, in Step 1.

Step 8 — Documentation of FOSA

3.2.18 Expected contents of a FOSA document include:

- a) introduction (including justification for the introduction of an RNP AR APCH, benefits, etc.);
- b) description of the system;
- c) overview of the safety assessment process and safety criteria used;
- d) analysis of procedures, including airport environment and procedure design;
- e) identification of relevant hazards, causes and consequences;
- f) documentation of relevant mitigations and determination of risk acceptability for RNP AR operations;
- g) key issues to be monitored in trials and in operations;
- h) assumptions and open items to be validated and closed out;
- i) conclusions/recommendations;
- j) appendices with supporting information, i.e. minutes from group sessions, hazard identification tables, hazard logs with action tracking.

3.3 Human factors issues

3.3.1 *Normal operating procedures*

3.3.1.1 The PBN manual contains guidance and requirements concerning:

- a) revision of the minimum equipment list (MEL) to address RNP AR requirements;
- b) use of autopilot and flight director;
- c) dispatch RNP assessment;
- d) NAVAID exclusion;
- e) navigation database currency;
- f) in-flight considerations including required equipment to start RNP AR approaches, RNP management, lateral and vertical deviation monitoring, special go-around procedures, altimeter setting and cross- checking and several others.

4.3.1.1 These have been developed based on the accumulated knowledge of RNP AR/SAAAR approaches conducted to date. An AO will need to develop a compliance checklist against these procedures when developing the system description.

4.3.2 *Abnormal and contingency procedures*

4.3.2.1 The PBN manual also contains guidance on procedures for flight crew reacting to a variety of possible equipment failures including:

- a) engine failure during approach or missed approach;
- b) loss of GNSS updates;
- c) degradation of external signal-in-space;
- d) failure of the RNP system components (e.g. failures of a GPS sensor, the flight director or automatic pilot).

4.3.2.2 Manufacturers will be able to supply detailed lists of equipment failures for which procedures should be available, e.g.:

- a) loss of one auto-pilot (AP);
- b) loss of both APs;
- c) loss of NAV mode before or during approach;
- d) loss of GPS as primary navigation (on one side);
- e) loss of GPS as primary navigation (on both sides);
- f) navigation accuracy downgrade (on one side);
- g) navigation accuracy downgrade (on both sides);
- h) GPS position disagrees with the FMS.

4.3.3 *Training requirements*

4.3.3.1 The PBN manual contains guidance and requirements concerning training for flight crew and dispatchers. For flight crew there is detailed guidance on the contents of ground training segments and flight training segments plus how these should be evaluated. The training covers the normal procedures and abnormal/contingency procedures listed above. Each pilot must complete at least two RNP approach procedures that employ the unique RNP AR APCH

characteristics of the operator’s approved procedures, one procedure culminating in a landing and one in a missed approach.

4.3.3.2 Manufacturers may supply additional training guidance specific to the relevant aircraft types.

4.3.4 *Recurrent training*

The PBN manual also contains guidance on recurrent training. An AO should incorporate recurrent RNP training that employs the unique (AR) approach characteristics of the operator’s approved procedures as part of the overall programme. A minimum of two RNP AR APCHs must be flown by each pilot for each duty position (pilot flying and pilot monitoring), with one culminating in a landing and one culminating in a missed approach, and may be substituted for any required “precision-like” approach.

4.3.5 *FOSA and HF issues*

4.3.5.1 Having used the information in the previous sections to establish what is to be proposed, the subsequent FOSA steps establish the adequacy of the procedures and training for the specific RNP AR procedure.

4.3.5.2 The simple approach adopted in the case studies was to involve groups with knowledge of the proposed procedures and training in the specific hazards to directly determine the adequacy of the procedures and training. Where potential improvements were identified these were listed for further consideration under steps 6 and 7 of the FOSA.

4. FOSA and ANSP Considerations

4.1 ANSP’s role in a FOSA

4.1.1 The personnel from an ANSP may be asked to participate in a FOSA, particularly in the case of a new RNP AR procedure being implemented.

4.1.2 An ANSP may fulfill the following roles:

- a) providing relevant information in step 1, “System definition”, of the FOSA including the proposed procedure design, ATC facilities, procedures, intended controller training and navigation infrastructure;
- b) participating in safety workshops addressing hazard identification, consequence and causal analysis and helping to determine appropriate risk mitigations (steps 3 to 6 of the FOSA);
- c) Reviewing and providing comments on the FOSA documentation.

4.1.3 Typically an ANSP will supply procedure designers, controllers, ATC engineers, AIM experts and airspace planners to carry out these roles.

4.1.4 In addition to participating in these formal steps of the FOSA, it is likely that the procedure designer will also liaise at an early stage with the AO to understand the key operational needs for the RNP AR APCH.

4.2 How an ANSP can use FOSA outputs

4.2.1 There will be many outputs from the AO’s FOSA that the ANSP can use. For an RNP AR APCH where the main safety issues relate to separation from terrain, typically in low traffic density situations, FOSA outputs of use to the ANSP will include the following:

- a) the impact of the procedure design on the flight crew. The procedure may be compliant with ICAO’s RNP AR procedure design guidance but could still lead to unacceptable or unnecessary increases in pilot workload. Feedback from the FOSA could lead to the ANSP’s procedure designer needing to make changes;
- b) adequacy of ATC phraseology including clearance for the RNP AR APCH; adequacy of ATC procedures relating to constraints on any vectoring or “direct to”, provision of local pressure data, any changes in monitoring and in the event of RNP-related aircraft failures;
- c) adequacy of ATC training given the hazard identification and analysis performed for the FOSA.

4.2.2 For an RNP AR APCH where the main safety issues relate to separation from other traffic, perhaps in a busy terminal/airport environment, additional useful FOSA outputs could include analysis of the:

4.2.2.1 adequacy of ATC procedures to handle mixed-mode traffic (RNP AR and other approach types) including how to identify aircraft with different approach capabilities and how to handle potentially different missed approach paths;

4.2.2.2 adequacy of existing monitoring systems, e.g. non-transgression zones;

4.2.2.3 impact of wide area GNSS failure on multiple aircraft.

4.2.3 It is anticipated that more detailed guidance with respect to traffic separation safety issues will be provided in a subsequent version of this document.

4.2.4 These and similar outputs can be brought into the ANSP safety assessment and analyzed using the existing ANSP safety assessment processes.

4.3 Additional issues to include in an ANSP safety case

4.3.1 Within an ANSP safety case, as well as documenting the safety assessment of the ATM aspects of a new RNP AR APCH, an ANSP may also need to cover the following safety assurance activities:

a) demonstration that the revised ATM system operates correctly and safely through ATC simulations. If, for example, a new RNP AR APCH procedure is being introduced for closely spaced parallel approaches this could represent a significant ATM change with implications for controller workload. A consideration of the dynamics via fast and/or real-time simulation may be required evidence from a regulator. Real-time simulations can also be used to investigate controller reaction to hazards identified in the FOSA. When a new RNP AR APCH involves only minimal ATC changes, such ATC simulations would not be required;

b) flight trials under controlled conditions to ensure that the initial implementation is safely managed. An ANSP will be involved in the coordination between the AO and the regulator to ensure that flight trials occur initially only in VMC conditions, or only with a limited subset of aircraft and crews, for example. The ANSP will sometimes also collect data,

e.g. radar track data, during these trials and early operations to provide evidence to support the safety case;

c) an RNP monitoring programme to record and investigate any ATM significant events.

4.3.2 In addition, an ANSP safety case will need to demonstrate how ATM assumptions and open issues from the FOSA have been closed out, e.g. testing for GNSS interference prior to implementation, investigation of terrain masking, checks on accuracy of obstacle and terrain survey data, etc.

5. Simulations, Trials and Monitoring

5.1 Simulations and trials

5.1.1 Simulations (additional to those carried out during the airworthiness approval) can provide valuable support to the safety assessment. Reasons for conducting simulations could be to:

- a) help evaluate alternative procedure designs;
- b) evaluate the significance of a hazard for the proposed procedure design in a specific operating environment;
- c) familiarize a carrier new to RNP AR APCH with some of the key safety issues.

5.1.2 In the absence of any failures, simulations may investigate:

- a) varying cross-winds;
- b) increasing aircraft speeds above the recommended values on final approach and missed approach to study the impact on guidance in the RF legs; and
- c) guidance in heavy tailwinds (well beyond what would realistically be flown).

5.1.3 In addition, the following failures may be simulated:

- a) one-engine inoperable in cross-wind during the RF leg;
- b) manually steering away from centre line to observe what indications are provided to the crew;

- c) 10-hPa pressure setting error to observe the TAWS alert parameters;
- d) map shift; and
- e) autopilot disconnect just before the RF leg.

Note.— Aircraft operators' simulators are unlikely to be able to model as wide a range of failures as the development simulators used by aircraft manufacturers. Therefore assistance from aircraft manufacturers may be required. From a safety perspective simulations must reflect real situations as accurately as possible. There is a need to be able to judge how close the simulation is to reality. Additional hazards and risks can be introduced if simulations do not reflect real- world circumstances.

5.1.4 Trials can also be used to address safety issues, for example:

- a) Initial flights can be conducted in VMC to check the navigation database.
- b) A carrier new to RNP AR APCH might elect for an extended trial period in order to train flight crew, dispatchers, etc., and to check that the operational procedures are robust. This can help provide a smoother transition to full operations.
- c) The safety of the proposed operation may be demonstrated by the track-keeping achieved under different metrological conditions and different system failures/ contingencies.

5.1.5 Trials may have extra mitigations associated with them which would not be subsequently used in full operations, e.g. VMC conditions, compulsory use of autopilot.

5.1.6 Some States operate a process of “interim authorization”, where for the first 90 days and at least 100 AR approaches in each aircraft type, the operator will be authorized to conduct RNP approaches with AR using minima associated with RNP 0.3. For approach procedures with no line of minima associated with RNP 0.3, the procedure must be flown in VMC. The interim authorization is removed after completion of the applicable time period and number of approaches and upon a review of the reports from the RNP AR monitoring programme by the regulator. In certain circumstances it has been possible to use flight evaluation to determine if an operation is possible.

5.2 Monitoring programme

5.2.1 The PBN manual notes the requirement for an RNP monitoring programme.

5.2.2 In the context of this FOSA guidance material it should be highlighted that:

- a) One of the outputs of a FOSA should be an identification of key safety performance indicators that will be part of the RNP monitoring programme. Some likely candidates for safety performance indicators are already listed the PBN manual; however, a local FOSA may identify certain hazards as the main risk drivers, and therefore monitoring the precursors to these hazards will be important to controlling risk during the operational phase.
- b) A FOSA may also identify key assumptions or open issues which are difficult to validate without operational data. Again these should be fed forward to the monitoring programme.

5.2.3 Compare to other types of approaches (e.g. ILS approaches) there are still relatively few RNP AP approaches worldwide. Thus it is important to pool information from monitoring programmes to see whether the predictions from FOSAs (e.g. on deviation frequencies) are realistic.



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PUBLICATIONS

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ICAO DOCUMENTS

Convention on International Civil Aviation (Doc 7300)

Annexes to the Convention on International Civil Aviation

Annex 6 — Operation of Aircraft

Part I — International Commercial Air Transport — Aeroplanes Part III — International Operations — Helicopters

Procedures for Air Navigation Services

ATM — Air Traffic Management (PANS-ATM, Doc 4444)

Regional Supplementary Procedures (Doc 7030)

Manuals

Manual of Procedures for Operations Inspection, Certification and Continued Surveillance (Doc 8335) Performance-based Navigation (PBN) Manual (Doc 9613)

Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual (Doc 9905)



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Regional Safety Oversight Cooperation System (SRVSOP) Advisory Circulars

AC 91-001	Aircraft and Operators Approval for RNAV 10 Operations (Designated and Authorized as RNP 10)
AC 91-002	Aircraft and Operators Approval for RNAV 5 Operations
AC 91-003	Aircraft and Operators Approval for RNAV 1 and RNAV 2 Operations
AC 90-004	Aircraft and Operator Approval for RNP 4 Operations
AC 90-006	Aircraft and Operator Approval for Basic-RNP 1 Operations
AC 90-008	Aircraft and Operators Approval for RNP Approach (RNP APCH) Operations
AC 91-010	Aircraft and Operators Approval for Approach Operations with Vertical Guidance/ Barometric Vertical Navigation (APV/baro-VNAV)
AC 91-011	Aircraft and Operators Approval for RNP APCH Operations Down to LP and LPV Minima Using GNSS Augmented by SBAS



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DOCUMENTS OF OTHER STATES/ORGANIZATIONS

Australia	
DCAP B-RNAV-1	Approval of Australian Operators and Aircraft to Operate Under Instrument Flight Rules in European Airspace Designated for Basic Area Navigation
AC 91U-II-Attachment(0)	Navigation Authorizations — APV baro-VNAV
AC 91U-II-B- 3(0)	Navigation Authorizations — RNAV 1 and RNAV 2
AC 91U-II-C- 3(0)	Navigation Authorizations — RNP 1
AC 91U-II-C- 5(0)	Navigation Authorizations — RNP APCH
AC 91U-II-C- 6(0)	Navigation Authorizations — RNP AR Operations
AC 91U-2(0)	Required Navigation Performance 10 (RNP 10) Operational Authorization
AC 91U-3(0)	Required Navigation Performance 4 (RNP 4) Operational Authorization



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ARINC	
ARINC Specification 424-13	Navigation System Data Base
Canada	
AC 700-015	En Route Area Navigation Operations RNAV 5 (Formerly B-RNAV)
European Aviation Safety Agency (EASA)	
AMC 20-4	Airworthiness Approval and Operational Criteria for the Use of Navigation Systems in European Airspace Designated for Basic RNAV Operations
AMC 20-5	Airworthiness Approval and Operational Criteria for the Use of the NAVSTAR Global Positioning System (GPS)
AMC 20-12	Recognition of FAA Order 8400.12a for RNP 10 Operations
AMC 20-26	Airworthiness Approval and Operational Criteria for RNP Authorization Required (RNP AR) Operations



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AMC 20-27	Airworthiness Approval and Operational Criteria for RNP APPROACH (RNP APCH) Operations Including APV BARO-VNAV Operations
AMC 20-28	Airworthiness Approval and Operational Criteria Related to Area Navigation for Global Navigation Satellite System Approach Operation to Localizer Performance with Vertical Guidance Minima Using Satellite Based Augmentation System
CS-25	Certification Specifications for Large Aeroplanes
CS-25-1529	Instructions for Continued Airworthiness
EASA Part-21 Subpart G	Production Organization Approval
ETSO-C129a	Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS)
ETSO-C145	Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)
ETSO-C146	Stand-Alone Airborne Navigation Equipment Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)



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TGL No. 10	Airworthiness and Operational Approval for Precision RNAV Operations in Designated European Airspace
European Organization for Civil Aviation Equipment (EUROCAE)	
ED-76	Standards for Processing Aeronautical Data
New Zealand	
AC 91-10	Required Navigational Performance 4 (RNP 4) Operational Approval
RTCA	
DO-200A	Standard for Processing Aeronautical Data
DO-236()	Minimum Aviation System Performance Standards: Required Navigation Performance for Area Navigation
United States Federal Aviation Administration (FAA)	
AC 20-130	Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors



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AC 20-138	Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment Acceptance of Data Processes and Associated Databases
AC 20-153	Inertial Navigation System (INS)
AC 25-4	Approval of Flight Management Systems in Transport Category Airplanes
AC 25-15	Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors
AC 90-45	Approval of Area Navigation Systems for Use in the U.S. National Airspace System
AC 90-96	Approval of U.S. Operators and Aircraft to Operate under Instrument Flight Rules (IFR) in European Airspace Designated for Basic Area Navigation (B-RNAV/RNP-5)
AC 90-100	U.S. Terminal and En Route Area Navigation (RNAV) Operations Approval Guidance for RNP Procedures with SAAAR
AC 90-101	Approval Guidance for RNP Operations and Barometric Vertical Navigation in the U.S. National Airspace System
AC 90-105	Approval of Area Navigation Systems for Use in the U.S. National Airspace System



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AC 90-107	Guidance for Localizer Performance with Vertical Guidance and Localizer
FAA Form 8110-3	Statement of Compliance with Airworthiness Standards
Order 7110.82	Monitoring of Navigation/Altitude Performance in Oceanic Airspace
Order 8400.12	Required Navigation Performance 10 (RNP 10) Operational Approval
Order 8400.33	Procedures for Obtaining Authorization for RNP-4 Oceanic and Remote Area Operations
TSO-C66c	Distance Measuring Equipment (DME) Operating within the Radio Frequency Range of 960-1215 Megahertz
TSO-C129	Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)
TSO-C145	Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Satellite Based Augmentation System
TSO-C146	Stand-Alone Airborne Navigation Equipment Using the Global Positioning System (GPS) Augmented by the Satellite Based Augmentation System
14 CFR 25.1309	Equipment, Systems, and Installations



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14 CFR 25.1529	Instructions for Continued Airworthiness
14 CFR 60	Flight Simulation Training Device Initial and Continuing Qualification and Use Manual Requirements
14 CFR 121, Subpart G	Doppler Radar and Inertial Navigation System (INS): Request for Evaluation; Equipment and Equipment Installation; Training Program; Equipment Accuracy and Reliability; Evaluation Program
14 CFR 121, Appendix G	Equipment, Systems, and Installations