CIVIL AVIATION AUTHORITY OF NEPAL

PERFORMANCE BASED NAVIGATION OPERATIONAL APPROVAL MANUAL

Second Edition – March 2021

FOREWORD

This Second Edition of the PBN Operational Approval Manual has been developed and approved for providing guidance on the operational approval process in the context of performance based navigation (PBN) operations. It is intended for Airworthiness Inspectors, Flight Operations Inspectors and other personnel involved in the regulation of PBN operations. It has been developed keeping in conformity to the ICAO *PBN Operational Approval Manual* (DOC 9997) and its latest revisions.

The policy and procedures contained in this Manual shall be adhered to by CAA Nepal personnel in addition to the requirements of the *Flight Operations Requirements, ATS Requirements for PBN in Nepalese Airspace, AIC 001/2011*and other national regulations when authorizing PBN operations.

Considering the wide scope and complexity of operations involved and the many variables that can be encountered in aircraft equipment, it is impossible to anticipate all situations, therefore CAAN personnel must exercise common sense and good judgment in the application of these policies and procedures.

Flight Safety Standards Department (FSSD), CAA Nepal will maintain this Manual as complete, accurate and updated as required. Comments or suggestions for revision or amendment of this Manual should be forwarded to the FSSD.

This PBN Operational Approval Manual Second Edition comes into effect from 16 March 2021.

Rajan Pokhrel
Director General
Civil Aviation Authority of Nepal

RECORD OF REVISIONS

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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
CAA	Civil aviation authority
CAAN	Civil Aviation Authority Nepal
CAAP	Civil aviation advisory publication
CASA	Civil Aviation Safety Authority (Australia)
CAT	Commercial air transport
CCF	Common cause failure
CDI	Course deviation indicator
CDU	Control display unit
CS	Certification specification
DA	Decision altitude
DA/H	Decision altitude/height
DF	Direct to a fix
DGCAAN	Director General of CAAN
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
HPL	Horizontal protection limit
HSI	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
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
SAM	South American
SB	Service bulletin
SBAS	Space-based augmentation system
SID	Standard instrument departure
SL	Service letter
SOP	Standard operating procedure
SPA	Specific approvals
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

VA	Heading to an altitude
VAE	Vertical angle error
V/DEV	Vertical deviation
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 omnidirectional radio range
WAAS	Wide area augmentation system
WDM	Wiring diagram manual
WPR	Waypoint resolution error
WPT	Waypoint

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 the *Performance-based Navigation (PBN) Manual* (Doc 9613), 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 omnidirectional 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 ofequipment 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.

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.

Table 1-1. Navigation specifications published to date

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

Notes:

a) 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.

b) RNAV 1 and RNAV 2 are issued as a single approval.

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

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

e) Optional; requires higher continuity.

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

g) The RNP 0.3 specification is primarily intended for helicopter operations.

h) The RNP APCH navigation specification is divided into two sections. RNP 0.3 is applicable to RNP APCH Section A (LNAV and LNAV/VNAV). Different angular performance requirements are applicable to RNP APCH Section B (LP and LPV).

i) This value applies during the initial straight ahead missed approach segment for RNP APCH Section B (LP and LPV).

j) 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.

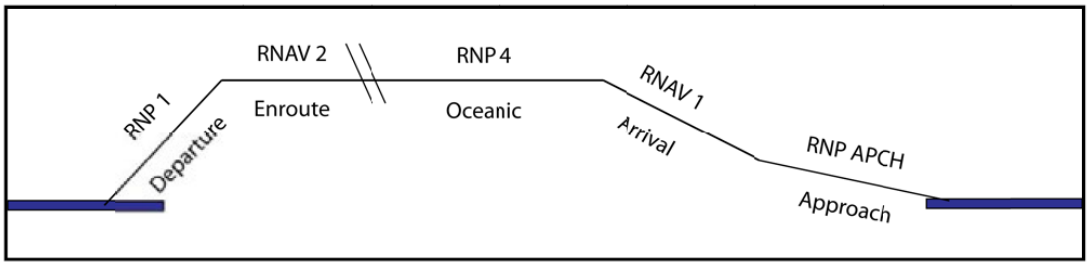

Figure 1-1. Navigation specifications to support a particular airspace concept.

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 the regulatory authority of the State of Registry/State of the Operator that the specific aircraft are in compliance with the relevant airworthiness standard and that the continued airworthiness and flight operations requirements are satisfied.

a) 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.

b) 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.

c) 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. This is illustrated in Figure 2-1.

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.

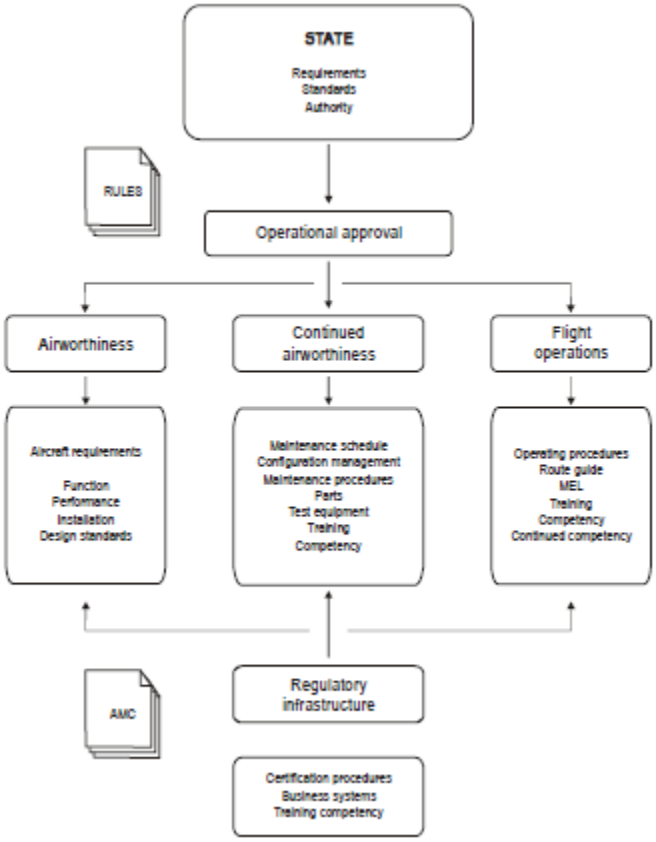

Figure 2-1. Overview of operational approval responsibilities

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

a) *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).

b) *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 ofspecified PBN operations.

c) *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 States should not re-approve technical data approved by another State; re-approving already approved 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 State of the Operator 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:

a) 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;

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

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

d) 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;

e) 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

f) 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 State 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, States 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 State guidance is in place. States 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. Some States have identified a hierarchy of navigation specifications where, for example, an RNP 2 (continental) authorization could automatically include RNAV 2 and RNAV 5 authorizations. Other States have determined that operational approval is not required for a core set of navigation specifications (RNAV 10, RNAV 5, RNAV 2, RNAV 1, RNP 4, RNP 2, RNP APCH) as pilot knowledge and training should be covered by instrument and type rating, procedures should be covered by the basic regulation, and aircraft eligibility should be documented in AFM, TC or STC.

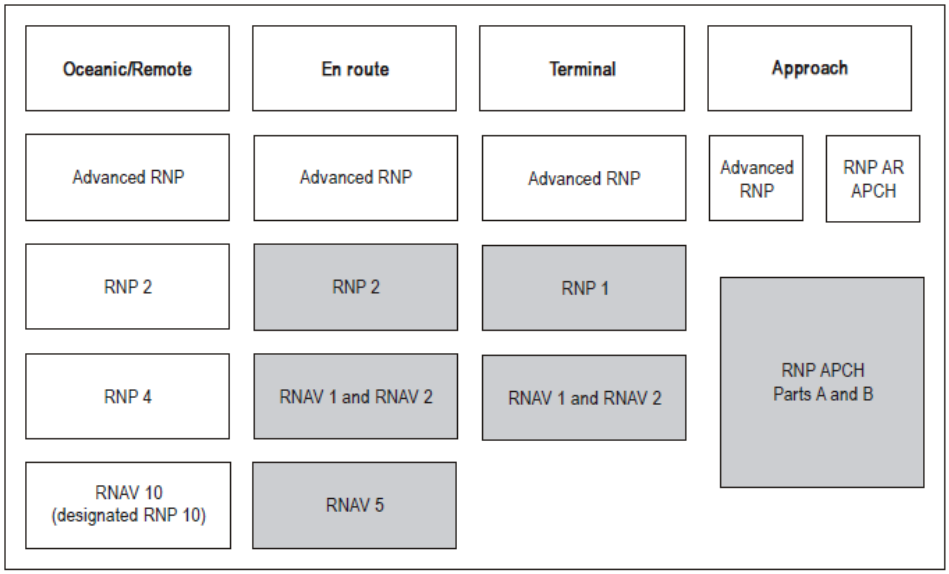

Figure 2-2. Bundling of navigation specifications

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, 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:

a) aircraft eligibility and airworthiness compliance (any limitations, assumptions or specific procedures considered in the framework of the airworthiness approval must be addressed);
b) operating procedures for the navigation systems used;
c) control of operating procedures (documented in the operations manual);
d) flight crew initial training and competency requirements and continuing competency requirements;
e) dispatch training requirements; and
f) 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:

a) the TC; or
b) the STC; or
c) the associated documentation — AFM or equivalent document; or
d) 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 CAA 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.

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 airworthiness, this is incorporated within the Certification Specification (CS) and Acceptable Means of Compliance (AMC) for Airborne Communications, Navigation and Surveillance (ACNS).

Operational approval aspects are covered in Air-Ops Regulation Part ARO (authority requirements for air operations), Part ORO (organization requirements for air operations), Part CAT (commercial air transport), Part SPA (specific approvals), Part NCC (complex motor-powered aircraft). Part NCO (non-

complex aircraft) and Part SPO (specialized operations). The Federal Aviation Administration (FAA), similarly, publishes advisory circulars (ACs) and orders for operations in United States 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) preflight 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

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).

d) actions to be taken in the event of a contingency, including the reporting to the operator and to the CAA 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
5) problems with ground navigation facilities leading to significant navigation errors.

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, provided by the manufacturer, covering all these areas.

Table 2-2. EASA and FAA certification standards

Navigation specification	*EASA*	*FAA*
RNAV 10	CS-ACNS AMC 20-12	AC 90-105( )
RNAV 5	CS-ACNS AMC 20-4	AC 90-105( )
RNAV 1 and RNAV 2	JAA TGL-10	AC 90-100( )
RNP 4	Expected in 2015	AC 90-105( )
RNP 2	Expected in 2015	AC 90-105( )
RNP 1	Expected in 2015	AC 90-105( )
Advanced RNP	Expected in 2015	AC 90-105( )
RNP 0.3	Expected in 2015	AC 90-105( )
RNP APCH (LNAV)	CS-ACNS AMC 20-27	AC 90-105( )
RNP APCH (LNAV/VNAV)	CS-ACNS AMC 20-27	AC 90-105( )
RNP APCH (LPV)	CS-ACNS AMC 20-28	AC 90-107( )
RNP AR APCH	CS-ACNS 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 analysed 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 CAA 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 CSs 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 CAA 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( )		AC 700-006
RNAV 5	AC 91-002	CAAP B-RNAV-1		AC 700-015
RNAV 1 and RNAV 2	AC 91-003	AC 91U-II-B-3		AC 700-019
RNP 4	AC 91-004	AC 91U-3	AC 91-10	AC700-006
RNP 1	AC 91-006	AC 91U-II-C-3		AC 700-025
A-RNP	—	—		
RNP 0.3	—	—		
RNP APCH (LNAV)	AC 91-008	AC 91U-II-C-5		AC 700-023
RNP APCH (LNAV/VNAV)	AC 91-010	AC 91U-II-Attachment( )		AC 700-023
RNP APCH (LPV)	AC 91-011	—		AC 700-023
RNP AR APCH	AC 91-009	AC 91U-II-C-6		AC 700-024
RF Attachment		—		AC 700-027

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 CAA 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.* The CAA 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 CAA 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 CAA, 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 the Manual of Procedures for Operations Inspection, Certification and Continued Surveillance (Doc 8335), *Part III,* The AOC — Application, Evaluation and Certification.

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 manoeuvring within its territory shall comply with the rules and regulations relating to the flight and manoeuvre 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 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 CAA, 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 CAAs 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 CAA 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 is 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, and RNAV 1 and RNAV 2.

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 *Preflight planning requirements*

a) the flight plan should contain the appropriate statements of capability applicable to the PBN operations anticipated during the flight;

b) the on-board navigation database, where applicable, must be current and must contain the appropriate procedures, routes, waypoints and NAVAIDS;

c) 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;

d) an alternate approach must be identified in the event of loss of PBN capability;

e) 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:

a) ATC must be advised of any loss of PBN capability and a proposed course of action;

b) 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 singlepilot aircraft, normally requires multiple in-flight exercises, each with preflight 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. 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.

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 SPECIFICATION JOB AIDS

4.1 GENERAL

4.1.1 In order to facilitate a standardized approach to the process of applying for PBN approval, a structured form, known as a "job aid", has been developed.

4.1.2 In the absence of national pro forma, the job aid can be used by the operator to detail the application for approval and to demonstrate that the specific requirements with respect to aircraft eligibility, operating procedures, training and database management have been met.

4.1.3 Much of the application process is common to all navigation specifications but each specification has specific elements that must be addressed. The following describes the process to complete an application for approval for a PBN navigation specification:

1) complete the generic job aid from section 4.2;

2) complete the job aid specific elements for the navigation specification, from sections 4.3 to 4.12 as applicable; and

3) combine the generic job aid and specific elements to form the complete approval application job aid.

4.2 GENERIC JOB AID

APPLICATION TO CONDUCT *(INSERT NAVIGATION SPECIFICATION)* **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 followup 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 CAA 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.

3. **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 (ATM)
	Doc 7030	Regional Supplementary Procedures
	Doc 9613	Performance-based Navigation (PBN) Manual
Insert State of regulator	*Insert relevant regulatory reference*	*Insert title of relevant regulatory reference*

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 eligibility1.	
3	Schedule a pre-application meeting with the inspector.	
4		During the pre-application meeting establish: • form and contents of the application; • documents required to support the application; • target date for the application submission; • requirement for flight validation.
5	Submit the application at least XX days prior to startup 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.

[1] *Having the navigation specification capabilities listed in a document approved by the State of Design or State of Registry facilitates determining aircraft eligibility.*

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 CAA: _____

Date when operator intends to begin *(insert navigation specification)* operations: _____

Is the CAA 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** Showing provisions for LRNS.		
F	**Training** GA operators or equivalent: • course completion records. AOC holders/CAT operators or equivalent: • training programmes for flight crew, flight dispatchers and maintenance personnel.		
G	**Operating policies and procedures** GA operators or equivalent: • extracts from the operations manual corresponding to the application. AOC holders/CAT operators or equivalent: • operations manual and checklists.		
H	**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, …….)	(AC/AMC/CA, etc.)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)

Note.— A detailed table is provided for each navigation specification.

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, …….)	(AC/AMC/CA, etc.)	(Document reference/ method)	(Accepted/ not accepted)	(Status and date)

Note.— A detailed table is provided for each navigation specification.

PART 6. CONTINGENCY PROCEDURES

#	Topic	*Specific ICAO reference*	*Specific State guidance reference*	*Operator compliance description*	*Inspector disposition/ comments*	*Follow-up by inspector (optional)*
		(Doc 4444, Chapters 5 and 15)	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*

Note.— A detailed table is provided for each navigation specification.

4.3 RNAV 10

4.3.1 General

4.3.1.1 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.

4.3.1.2 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.

4.3.1.3 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.

4.3.2 System requirements

4.3.2.1 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). The aircraft requirements are detailed in the PBN manual (Doc 9613), Volume II, Part B, Chapter 1, 1.3.4.

4.3.3 Operating procedures

The operating procedures are addressed in the PBN manual (Doc 9613), Volume II, Part B, Chapter 1, 1.3.5. 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.

4.3.4 Pilot knowledge and training

4.3.4.1 Pilot knowledge and training requirements are detailed in the PBN manual (Doc 9613), Volume II, Part B, Chapter 1, 1.3.10. Flight crews should possess the necessary skills to conduct RNAV 10 operations with minimal additional training.

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

4.3.5 Job aid specific elements

PART 3. OPERATOR APPLICATION

Add following rows:

Annex	*Title*	*Inclusion by Operator*	*Comments by Inspector*
J	**Aircraft group** A statement by the operator of the method used to determine eligibility of the aircraft/LRNS combination.		
K	**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.		
L	**Performance record** Evidence of previous problems, incidents or path-keeping errors, together with corrective action applied.		
M	**Withdrawal of approval** The need for follow-up action on navigation error reports, with the possibility of removal of approval.		

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)	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Authorization request** Statement of intent to obtain authorization.	1.3.3.2				
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				
2b	**Dual LRNS** At least 2 LRNSs with displays and functions suitable for oceanic operations.	1.3.4				
3	**Time limit for aircraft equipped with INS/IRU and no GNSS**	1.3.4.2.2 1.3.9.6				
4	**Area of operation for aircraft equipped with INS/IRU and no GNSS**	1.3.9.6				

5	**Training** Details of courses completed (GA operators). Details of training programmes (AOC holders).	1.3.3.2.2.2 1.3.10				
6	**Operating policies and procedures** Extracts from the operations manual or other documentation (GA operators). Operations manual and checklists (AOC holders).	1.3.3.2.2.3 1.3.5				
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				
8	**MEL update** Applicable only to operations requiring a MEL.	1.3.3.2.2.4				
9	**Past performance** Record of operating history, including problems, incidents, track-keeping errors and corrective actions.	1.3.3.2.2.6				
10	**Withdrawal of RNP 10 authority**	1.3.12				
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)	*(AC/AMC/CA, etc.)*	*(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				
1b	Verify that two LRNSs are operational.	1.3.6				
1c	Verify that the RNP 10 time limit has been taken into account (INS/IRU only).	1.3.5.2				
1d	Verify that FDE is available (GNSS only).	1.3.5.2 1.3.8				
1e	Verify the FPL: "R" should appear in field 10 and PBN/A1 in field 18.	1.3.7				
1f	Verify operational restrictions as appropriate.	1.3.5.2				
1g	Verify the flight-planned route including diversions.	1.3.7				
2	**Preflight**					
2a	Verify equipment conditions: • review flight technical records; • confirm that maintenance actions are complete.	1.3.5.3				
2b	Check the condition of navigation antennas and surrounding fuselage skin.	1.3.5.3				
2c	Review the emergency	1.3.5.3				

	procedures for RNP 10 operations.					
3	**En route**					
3a	Verify that both LRNSs are RNP 10 capable at the oceanic point of entry.	1.3.9.1				
3b	Prior to the oceanic point of entry, the aircraft position must be independently checked and updated if necessary.	1.3.9.2				
3c	Other mandatory navigation cross-checks.	1.3.9.3				
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				
3e	Follow route centre line within 5 NM.	1.3.9.5				
4	**Update LRNS position**	1.3.9.7				

PART 6. CONTINGENCY PROCEDURES

#	Topic	***Specific ICAO reference***	***Specific State guidance reference***	***Operator compliance description***	***Inspector disposition/ comments***	***Follow-up by inspector (optional)***
		(Doc 4444, Chapters 5 and 15)	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Contingencies**	15.2.1 and 15.2.2				
1a	Inability to comply with ATC clearance due to meteorological conditions, aircraft performance or pressurization failure.	15.2.1.1				
1b	Weather deviation	15.2.3				
1c	Air-ground communications failure.	5.4.2.6.3.2 15.3				

4.4 RNAV 5

4.4.1 General

4.4.1.1 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.

4.4.1.2 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.

4.4.1.3 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.

4.4.2 System requirements

The aircraft requirements are detailed in the PBN manual (Doc 9613), Volume II, Part B, Chapter 2, 2.3.3.

4.4.3 Operating procedures

The operating procedures are addressed in the PBN manual (Doc 9613), Volume II, Part B, Chapter 2, 2.3.4. Normal area navigation operating procedures will usually meet the requirements of RNAV 5.

4.4.4 Pilot knowledge and training

4.4.4.1 The pilot knowledge and training requirements are detailed in the PBN manual (Doc 9613), Volume II, Part B, Chapter 2, 2.3.5. Flight crews should possess the necessary skills to conduct RNAV 5 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.

4.4.5 Operational approval

4.4.5.1 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.

4.4.5.2 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.

4.4.5.3 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.

4.4.6 Job aid specific elements

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)	*(AC/AMC/CA, etc.)*	*(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.	2.3.2.1 2.3.2.2.1				
3	**Training** Details of courses completed (GA operators). Details of training programmes (AOC holders).	2.3.2.2.2 2.3.5				
4	**Operating policies and procedures** Extracts from the operations manual or other documentation (GA operators). Operations manual and checklists (AOC holders).	2.3.2.2.3				
5	**Maintenance practices** Document references for navigation database maintenance practices.	2.3.2.2.5 2.3.6				
6	**MEL update**	2.3.2.2.4				

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)	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/not accepted)*	*(Status and date)*
1	**Flight planning**					
1a	Verify that the aircraft is approved for RNAV 5 operations.	2.3.4.2.1				
1b	Verify RAIM availability (GNSS only).	2.3.4.3				
1c	Verify the availability of NAVAIDS (non-GNSS).	2.3.4.2.4				
1d	Verify that the navigation database (if carried) is current and appropriate for the region.	2.3.4.2.3				
1e	Verify the FPL: “R” should appear in field 10 and PBN/B1–B5 (as appropriate) in field 18.	2.3.4.2.1				
1f	Verify the operational restrictions as appropriate.	2.3.4.4.3				
1g	Verify the flight-planned route including diversions.	2.3.4.4.1				
2	**General operating procedures**					
2a	Advise ATC if unable to comply.	2.3.4.4.1				
2b	Confirm that the navigation database is up to date (if appropriate).	2.3.4.4.4				
2c	Cross-check the chart with the RNAV system display.	2.3.4.4.5				

2d	Cross-check with conventional NAVAIDS to monitor for navigational reasonableness.	2.3.4.4.6				
2e	Follow route centre lines within 2.5 NM.	2.3.4.4.8				
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				

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)**	*(AC/AMC/CA, etc.)*	*(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				
1b	Air-ground communications failure.	2.3.4.5.2 (Doc 4444, Chapter 15, 15.3)				
1c	GNSS RAIM alert or loss of RAIM.	2.3.4.5.3				

*All references are to the PBN manual (Doc 9613), Volume II, Part B, Chapter 2, unless otherwise indicated.

4.5 RNAV 1 AND RNAV 2

4.5.1 General

4.5.1.1 RNAV 1 and RNAV 2 use GNSS or DME/DME positioning and support operations on:

a) ATS routes (continental 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).

4.5.1.2 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.

4.5.1.3 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.

4.5.2 System requirements

4.5.2.1 The aircraft requirements are detailed in the PBN manual (Doc 9613), Volume II, Part B, Chapter 3, 3.3.3.

4.5.2.2 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 manoeuvre and adequately monitor cross-track deviation.

4.5.2.3 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.

4.5.3 Operating procedures

The operating procedures are addressed in the PBN manual (Doc 9613), Volume II, Part B, Chapter 3, 3.3.4. 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

4.5.4 Pilot knowledge and training

The pilot knowledge and training requirements are detailed in the PBN manual (Doc 9613), Volume II, Part B, Chapter 3, 3.3.5. 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.

4.5.5 Job aid specific elements

PART 4. CONTENTS OF THE OPERATOR APPLICATION

#	Topic	***Specific ICAO reference*** *(Doc 9613, Volume II, Part B, Chapter 3)*	***Specific State guidance reference*** *(AC/AMC/CA, etc.)*	***Operator compliance description*** *(Document reference/ method)*	***Inspector disposition/ comments*** *(Accepted/ not accepted)*	***Follow-up by inspector (optional)*** *(Status and date)*
1	**Authorization request** Statement of intent to obtain authorization.	3.3.2.1				
2	**Aircraft/navigation system eligibility** Documents that establish eligibility.	3.3.2.2 3.3.2.3.1				
3	**Training** Details of courses completed (GA operators). Details of training programmes (AOC holders).	3.3.2.3.2 3.3.5				
4	**Operating policies and procedures** Extracts from the operations manual or other documentation (GA operators). Operations manual and checklists (AOC holders).	3.3.2.3.3				
5	**Maintenance practices** Document navigation database maintenance practices.	3.3.2.3.5 3.3.6				
6	**MEL update**	3.3.2.3.4				

PART 5. OPERATING PROCEDURES

#	Topic	***Specific ICAO reference*** *(Doc 9613, Volume II, Part B, Chapter 3)*	***Specific State guidance reference*** *(AC/AMC/CA, etc.)*	***Operator compliance description*** *(Document reference/ method)*	***Inspector disposition/ comments*** *(Accepted/ not accepted)*	***Follow-up by inspector (optional)*** *(Status and date)*
1	**Flight planning**					
1a	Verify that the aircraft is approved for RNAV 1 and RNAV 2 operations.	3.3.4.1				
1b	Verify RAIM availability (GNSS only).	3.3.4.3.1 3.3.4.3.2				
1c	Verify the availability of NAVAIDS (non-GNSS).	3.3.4.2.3 3.3.4.3.4				
1d	Verify that the navigation database (if carried) is current and appropriate for the region.	3.3.4.2.2 3.3.4.5.3				
1e	Verify the FPL: “R” should appear in field 10 and PBN/C1-D4 (as appropriate) in field 18.	3.3.4.2.1				
2	**General operating procedures**					
2a	Verify the flight-planned route.	3.3.4.5.3				
2b	Advise ATC if unable to comply with the requirements for RNAV 1 / RNAV 2.	3.3.4.5.2				
2c	Confirm that the navigation database is up to date.	3.3.4.5.3				
2d	Retrieve SIDs/ STARs only from the database.	3.3.4.5.4				

2e	Cross-check the chart with the RNAV system display.	3.3.4.5.3 3.3.4.5.6				
2f	Cross-check with conventional NAVAIDS to monitor for navigational reasonableness.	3.3.4.5.7				
2g	Use an appropriate display	3.3.4.5.8 3.3.4.5.9				
2h	Use appropriate scaling.	3.3.4.5.10				
2i	Follow route centre line within 1 or 0.5 NM.	3.3.4.5.11				
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.	3.3.4.5.12				
3	**RNAV SID requirements**					
3a	Prior to take-off, check the RNAV system, aerodrome and procedure loaded and the displayed position.	3.3.4.6.1				
3b	Engage LNAV no later than 153 m (500 ft) above aerodrome elevation.	3.3.4.6.2				
3c	If DME/DME only, do not use RNAV until within adequate DME coverage.	3.3.4.6.4				
3d	If DME/DME/IRU only, confirm navigation position within 0.17 NM of the start of the take-off roll.	3.3.4.6.5				
3e	If GNSS, acquire signal before start of take-off roll.	3.3.4.6.6				

4	**RNAV STAR requirements**					
4a	Verify that the correct STAR is loaded and displayed.	3.3.4.7.1				
4b	Contingency preparations.	3.3.4.7.3				
4c	Procedure modification in response to ATC instructions.	3.3.4.7.4				
4d	Observance of speed and altitude constraints.	3.3.4.7.6				

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 3)**	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Contingencies**					
1a	Advise ATC if unable to comply with the requirements for RNAV 1/ RNAV 2.	3.3.4.8.1				
1b	Air-ground communications failure.	3.3.4.8.2 (Doc 4444 Chapter 15, 15.3)				
*All references are to the PBN manual (Doc 9613), Volume II, Part B, Chapter 3, unless otherwise indicated.						

4.6 RNP 4

4.6.1 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.

4.6.2 System requirements

The aircraft requirements are detailed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 1, 1.3.3.

4.6.3 Operating procedures

The operating procedures are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 1, 1.3.4. Some additional provisions may need to be added to the standard operating procedures to specifically address RNP 4 operations.

4.6.4 Pilot knowledge and training

4.6.4.1 The pilot knowledge and training requirements are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 1, 1.3.5. Flight crews should possess the necessary skills to conduct RNP 4 operations with minimal additional training.

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

4.6.5 Job aid specific elements

PART 3. OPERATOR APPLICATION

Add following row:

Annex	Title	Inclusion by Operator	Comments by Inspector
J	**Aircraft Eligibility group** Statement by the operator as to which eligibility group the aircraft/RNP system combinations belong.		

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)	*(AC/AMC/CA, etc.)*	*(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. For RNP 4, the eligibility groups(s) used and a list of the airframes included in each group.	1.3.2.2				
3	**Training** Details of courses completed (GA operators). Details of training programmes (AOC holders).	1.3.2.3.2 1.3.5				
4	**Operating policies and procedures** Extracts from the operations manual or other documentation (GA operators). Operations manual and checklists (AOC holders).	1.3.2.3.3				
5	**Maintenance practices** Document references for RNP 4 maintenance practices.	1.3.2.3.5				
6	**MEL update**	1.3.2.3.4				

PART 5. OPERATING PROCEDURES

#	Topic	***Specific ICAO reference*** *(Doc 9613, Volume II, Part C, Chapter 1)*	***Specific State guidance reference*** *(AC/AMC/CA, etc.)*	***Operator compliance description*** *(Document reference/ method)*	***Inspector disposition/ comments*** *(Accepted/ not accepted)*	***Follow-up by inspector (optional)*** *(Status and date)*
1	**Flight planning**					
1a	Verify that the aircraft is approved for RNP 4 operations.	1.3.4.1				
1b	Verify that the navigation database is current.	1.3.4.2.1				
1c	Verify the availability of FDE (if applicable).	1.3.4.3				
1d	Verify the FPL: “R” should appear in field 10 and PBN/ L1 in field 18.	1.3.4.2.1				
1e	Verify equipment conditions: • review flight technical records; • confirm that maintenance actions are complete.	1.3.4.2.2				
2	**En-route**					
2a	Two LRNSs must be RNP 4 capable at the oceanic point of entry.	1.3.4.4.1				
2b	Other mandatory navigation cross-checks.	1.3.4.4.2				
2c	ATC notified if unable to comply with the requirements for RNP or of any deviation required for a contingency.	1.3.4.4.3				
2d	Follow route centre line within 2 NM.	1.3.4.4.4				

PART 6. CONTINGENCY PROCEDURES

#	Topic	***Specific ICAO reference***	***Specific State guidance reference***	***Operator compliance description***	***Inspector disposition/ comments***	***Follow-up by inspector (optional)***
		(Doc 4444, Chapter 15)	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Contingencies**					
1a	Inability to comply with ATC clearance due to meteorological conditions, aircraft performance or pressurization failure.	15.2.1.1				
1b	Weather deviation.	15.2.3				
1c	Air-ground communications failure.	15.3				

4.7 RNP 2

4.7.1 General

RNP 2 is intended to support en-route applications in oceanic, remote and continental airspace. The continuity requirements for continental applications are lower than those for oceanic/remote applications.

4.7.2 Aircraft requirements

The aircraft requirements are detailed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 2, 2.3.3. The requirements for RNP 2 applications in oceanic/remote airspace are different to those for en-route continental airspace. In particular, oceanic/remote applications have a more strict continuity requirement which usually necessitates at least two long-range navigation systems.

4.7.3 Operating procedures

4.7.3.1 The operating procedures are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 2, 2.3.4. Some additional provisions may need to be added to the standard operating procedures to specifically address RNP 2 operations.

4.7.3.2 A review of the operator's procedure documentation against the requirements of the the PBN manual (Doc 9613) and the (State) regulatory requirements should be sufficient to ensure compliance.

4.7.4 Pilot knowledge and training

4.7.4.1 The pilot knowledge and training requirements are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 2, 2.3.5. Flight crews should possess the necessary skills to conduct RNP 2 operations with minimal additional training.

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

4.7.5 Oceanic/remote requirements

Navigation equipage for oceanic/remote continental RNP 2 operations will require dual independent GPS long-range navigation systems with FDE to meet the continuity requirement. Integration of positioning data from other sensors may be allowed provided that this does not cause the TSE to be exceeded. Manual entry/creation of waypoints using latitude and longitude values should be permitted to support flexible track ATS systems.

4.7.6 Job aid specific elements

PART 4. CONTENTS OF THE OPERATOR APPLICATION

#	Topic	***Specific ICAO reference*** *(Doc 9613, Volume II, Part C, Chapter 2)*	***Specific State guidance reference*** *(AC/AMC/CA, etc.)*	***Operator compliance description*** *(Document reference/ method)*	***Inspector disposition/ comments*** *(Accepted/ not accepted)*	***Follow-up by inspector (optional)*** *(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 2.3.2.3.1				
3	**Training** Details of courses completed (GA operators). Details of training programmes (AOC holders).	2.3.2.3.2 2.3.5				
4	**Operating policies and procedures** Extracts from the operations manual or other documentation (GA operators). Operations manual and checklists (AOC holders).	2.3.2.3.3				
5	**Maintenance practices** Document navigation database maintenance practices.	2.3.2.3.5 2.3.6				
6	**MEL update**	2.3.2.3.4				

PART 5. OPERATING PROCEDURES

#	Topic	***Specific ICAO reference*** *(Doc 9613, Volume II, Part C, Chapter 2)*	***Specific State guidance reference*** *(AC/AMC/ CA, etc.)*	***Operator compliance description*** *(Document reference/ method)*	***Inspector disposition/ comments*** *(Accepted/ not accepted)*	***Follow-up by inspector (optional)*** *(Status and date)*
1	**Flight planning**					
1a	Verify that the aircraft and crew are approved for RNP 2 operations.	2.3.4.1				
1b	Verify RAIM availability	2.3.4.2.3 2.3.4.3				
1c	Verify that the navigation database is current.	2.3.4.2.2				
1d	Verify the FPL: “R” should appear in field 10 and PBN/TBD in field 18.	2.3.4.2.1				
2	**General operating procedures**					
2a	Comply with the manufacturer’s instructions/procedures.	2.3.4.4.1				
2b	Advise ATC if unable to comply with the requirements for RNP 2.	2.3.4.4.2				
2c	Verify aircraft position and entry of assigned route.	2.3.4.4.3				
2d	Retrieve RNP 2 route from the database or build route using waypoints from the database.	2.3.4.4.4				
2e	Cross-check the chart with the RNAV system display.	2.3.4.4.4				
2f	Use an appropriate display.	2.3.4.4.6				
2g	Use appropriate scaling	2.3.4.4.6				
2h	Follow route centre line within 1 NM.	2.3.4.4.7				
2i	Do not use bank limiting functions	2.3.4.4.8				
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.	2.3.4.4.9				
2k	If RNP input is required, select RNP 2 or lower.	2.3.4.4.10				

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 2)	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Contingencies**					
1a	Advise ATC if unable to comply with the requirements for RNP 2.	2.3.4.5				
*All references are to the PBN manual (Doc 9613), Volume II, Part C, Chapter 2, unless otherwise indicated.						

4.8 RNP 1

4.8.1 General

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

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

4.8.2 System requirements

The aircraft requirements are detailed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 3, 3.3.3.

4.8.3 Operating procedures

The operating procedures are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 3, 3.3.4.

4.8.4 Pilot knowledge and training

4.8.4.1 The pilot knowledge and training requirements are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 3, 3.3.5. Flight crews should possess the necessary skills to conduct RNP 1 operations with minimal additional training.

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

4.8.5 Job aid specific elements

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)	*(AC/ AMC/ CA, etc.)*	*(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.	3.3.2.2 3.3.2.3.1				
3	**Training** Details of courses completed (GA operators). Details of training programmes (AOC holders).	3.3.2.3.2 3.3.5				

4	**Operating policies and procedures** Extracts from the operations manual or other documentation (GA operators). Operations manual and checklists (AOC holders).	3.3.2.3.3				
5	**Maintenance practices** Document navigation database maintenance practices.	3.3.2.3.5 3.3.6				
6	**MEL update**	3.3.2.3.4				

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)	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Flight planning**					
1a	Verify that the aircraft and crew are approved for RNP 1 operations.	3.3.4.1				
1b	Verify RAIM availability	3.3.4.2.3 3.3.4.3				
1c	Verify that the navigation database is current.	3.3.4.2.2				
1d	Verify the FPL: “R” should appear in field 10 and PBN/O2 in field 18.	3.3.4.2.1				
2	**General operating procedures**					
2a	Comply with the manufacturer’s instructions/procedures.	3.3.4.4.1				
2b	Advise ATC if unable to comply with the requirements for RNP 1.	3.3.4.4.2				
2c	Verify aircraft position and entry of assigned route.	3.3.4.4.3				
2d	Retrieve SIDs/STARs only from the database.	3.3.4.4.4				

2e	Cross-check the chart with the RNAV system display.	3.3.4.4.5				
2f	Cross-check with conventional NAVAIDS to monitor for navigational reasonableness.	3.3.4.4.6				
2g	Use an appropriate display.	3.3.4.4.7				
2h	Use appropriate scaling.	3.3.4.4.7				
2i	Follow route centre line within 0.5 NM.	3.3.4.4.8				
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.	3.3.4.4.9				
2k	If RNP input is required, select RNP 1 or lower.	3.3.4.5				
3	**RNP 1 SID requirements**					
3a	Prior to take-off, check the RNAV system, the aerodrome and procedure loaded and the displayed position	3.3.4.6.1				
3b	Engage LNAV no later than 153 m (500 ft) above aerodrome elevation.	3.3.4.6.2				
3c	Use an authorized method to achieve RNP 1 (AP/FD/Map/L/DEV indicator).	3.3.4.6.3 3.3.4.6.5				
3d	If GNSS, signal must be acquired before start of takeoff roll.	3.3.4.6.4				
4	**RNP 1 STAR requirements**					
4a	Verify that the correct STAR is loaded and displayed.	3.3.4.7.1				
4b	Contingency preparations.	3.3.4.7.3				
4c	Procedure modifications in response to ATC instructions.	3.3.4.7.4				

4d	Verify the correct operation of the navigation system and that the correct procedure, transition and runway are loaded.	3.3.4.7.5				
4e	Observance of speed and altitude constraints.	3.3.4.7.6				
4f	If the procedure is more than 30 NM from ARP use FD/AP or set FSD to 1 NM.	3.3.4.7.7				

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 3)**	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Contingencies**					
1a	Advise ATC if unable to comply with the requirements for RNP 1.	3.3.4.8.1				
1b	Air-ground communications failure.	3.3.4.8.2 (Doc 4444 Chapter 15, 15.3)				

*All references are to the PBN manual (Doc 9613), Volume II, Part C, Chapter 3, unless otherwise indicated.

4.9 RNP APCH

4.9.1 General

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

4.9.1.2 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.

4.9.1.3 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.

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

4.9.2 System requirements

4.9.2.1 The aircraft requirements for RNP APCH to LNAV minima are detailed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 5, Section A, 5.3.3.

4.9.2.2 The aircraft requirements for RNP APCH to LNAV/VNAV minima are detailed in the PBN manual (Doc 613), Volume II, Part C, Chapter 5, Section A, 5.3.3, and Attachment A, 4.3.

4.9.2.3 The aircraft requirements for RNP APCH to LP and LPV minima are detailed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 5, Section B, 5.3.3.

4.9.3 Operating procedures

4.9.3.1 The operating procedures for RNP APCH to LNAV minima are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 5, Section A, 5.3.4.

4.9.3.2 The operating procedures for RNP APCH to LNAV/VNAV minima are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 5, Section A, 5.3.4, and Attachment A, 4.17.

4.9.3.3 The operating procedures for RNP APCH to LP and LPV minima are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 5, Section B, 5.3.4.

4.9.4 Flight crew knowledge and training

4.9.4.1 The pilot knowledge and training requirements for RNP APCH to LNAV minima are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 5, Section A, 5.3.5.

4.9.4.2 The pilot knowledge and training requirements for RNP APCH to LNAV/VNAV minima are detailed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 5, Section A, 5.3.5, and Attachment A, 4.21.

4.9.4.3 The pilot knowledge and training requirements for RNP APCH to LP and LPV minima are detailed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 5, Section B, 5.3.5.

4.9.4.4 Successful RNP 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.

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.

4.9.5 Navigation database

4.9.5.1 RNP APCH operations are critically dependent on valid data.

4.9.5.2 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.

4.9.5.3 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.

4.9.6 Job aid specific elements

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 Sections A & B)	*(AC/AMC/CA, etc.)*	*(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				
3	**Training** Details of courses completed (GA operators). Details of training programmes (AOC holders).	5.3.2.3.2 5.3.5				
4	**Operating policies and procedures** Extracts from the operations manual or other documentation (GA	5.3.2.3.3				

	operators). Operations manual and checklists (AOC holders).					
5	**Maintenance practices** Document navigation database maintenance practices.	5.3.2.3.5 5.3.6 (Section A) 5.3.6 (Section B)				
6	MEL update	5.3.2.3.4				

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 5 Sections A & B)	*(AC/AMC/ CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Flight planning**					
1a	Verify that the aircraft and crew are approved for RNP APCH operations to LNAV, and/or LNAV/VNAV and/or LP and/or LPV minima.	5.3.4 (LNAV/VNAV) 5.3.4.1 (LP and/or LPV)				
1b	Verify RAIM and/or SBAS availability.	5.3.4.1.3 (Section A) 5.3.4.2 (Section A) 5.3.4.3 (Section B)				
1c	Verify that the navigation database is current.	5.3.4.1.1 (Section A) 5.3.4.1.2 a) (Section A) 5.3.4.2.1 (Section B) 5.3.4.2.2 (Section B)				
1d	Verify the FPL: “R” and “B” (LPV only) should appear in field 10 and PBN/S1 or PBN/S2 (LNAV/VNAV only) in field 18.	5.3.4.1.1 (Section A) 5.3.4.2.1 (Section B)				
2	**Prior to commencing procedure**					

2a	Verify that the correct procedure is loaded.	5.3.4.3.1 (Section A) 5.3.4.4.1 (Section B)				
2b	Cross-check the chart with the RNAV system display.	5.3.4.3.2 (Section A) 5.3.4.4.1 (Section B)				
2c	Verify the GNSS sensor in use (only multi-sensor systems).	5.3.4.3.3 (Section A)				
2d	Input the barometric altimeter setting (only LNAV/VNAV requires barometric input).	5.3.4.3.4 (Section A)				
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 (Section A)				
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. Manual entry of coordinates within the terminal area is not permitted. “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 (Section A) 5.3.4.4.2 (Section B)				
2g	Do not modify the final approach segment.	5.3.4.3.7 (Section A)				
2h	Use VTF to respect ATC clearances when appropriate	5.3.4.4.3 (Section B)				
3	**During procedure**					
3a	Establish the aircraft on the final approach course before starting descent.	5.3.4.4.1 (Section A) 5.3.4.5.4 (Section B)				
3b	Verify that the approach mode is activated 2 NM prior to FAF/FAP.	5.3.4.4.2 (Section A) 5.3.4.5.3 (Section B)				
3c	Use an appropriate display.	5.3.4.4.3 (Section A) 5.3.4.5.5 (Section B)				

3d	Discontinue the approach if: • the navigation display is flagged invalid; • loss of integrity alert; • loss of integrity alerting function prior to the FAF; • FTE is excessive.	5.3.4.4.4 (Section A) 5.3.4.5.7 5.3.4.5.8 (Section B)				
3e	Do not use the RNP system in missed approach if the: • RNP system is not operational; or • missed approach is not loaded from the database.	5.3.4.4.5 (Section A)				
3f	Follow the route centre line within 0.5/0.15/0.5 NM.	5.3.4.4.6 (Section A)				
3g	If baro-VNAV is used, follow vertical path ±22 m (±75 ft).	5.3.4.4.7 (Section A)				
3h	Execute a missed approach if the lateral or vertical deviations exceed the limits in 3f and 3g above (LNAV and LNAV/VNAV) or if excessive deviations are encountered and cannot be corrected in time (LP and LPV).	5.3.4.4.8 (Section A) 5.3.4.5.9 (Section B)				
4	**General operating procedures**					
4a	Advise ATC if unable to meet the requirements for an RNP APCH.	5.3.4.5.1 (Section A) 5.3.4.6.1 (Section B)				
4b	Comply with the manufacturer's instructions/procedures.	5.3.4.5.2 (Section A) 5.3.4.6.2 (Section B)				
4c	If the missed approach is based on conventional means, appropriate navigation equipment must be installed and serviceable.	5.3.4.5.3 (Section A) 5.3.4.6.3 (Section B)				
4d	Use FD or AP if available.	5.3.4.5.4 (Section A) 5.3.4.6.4 (Section B)				

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)**	*(AC/AMC/CA, etc.)*	*(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 (Section A) 5.3.4.7.2 (Section B)				
1b	Air-ground communications failure.	5.3.4.6.2 (Section A) 5.3.4.7.3 (Section B) (Doc 4444 Chapter 15, 15.3)				
*All references are to the PBN manual (Doc 9613), Volume II, Part C, Chapter 5, unless otherwise indicated.						

4.10 RNP 0.3

4.10.1 General

RNP 0.3 is primarily intended to support helicopter operations — en-route, arrivals, departures and approaches. However, it does not exclude fixed wing operations where the demonstrated performance is sufficient to meet the functional and accuracy requirements for all phases of flight.

4.10.2 System requirements

The aircraft requirements are detailed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 7, 7.3.3.

4.10.3 Operating procedures

The operating procedures are addressed in the PBN manual (Doc 9613) Volume II, Part C, Chapter 7, 7.3.4. Some additional provisions may need to be added to the standard operating procedures to specifically address RNP 0.3 operations.

4.10.4 Pilot knowledge and training

4.10.4.1 The pilot knowledge and training requirements are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 7, 7.3.5. Flight crews should possess the necessary skills to conduct RNP 0.3 operations with minimal additional training.

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

4.10.5 Job aid specific elements

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 7)	*(AC/AMC/CA, etc.)*	*(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.	7.3.2.2 7.3.2.3.1				

3	**Training** Details of courses completed (GA operators). Details of training programmes (AOC holders).	7.3.2.3.2 7.3.5				
4	**Operating policies and procedures** Extracts from the operations manual or other documentation (AOC operators). Operations manual and checklists (AOC holders).	7.3.2.3.3				
5	**Maintenance practices** Document navigation database maintenance practices.	7.3.2.3.5 7.3.6				
6	**MEL update**	7.3.2.3.4				

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 7)	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Flight planning**					
1a	Verify that the aircraft and crew are approved for RNP 0.3 operations.	7.3.4.1				
1b	Verify RAIM/SBAS availability.	7.3.4.3 7.3.4.4.3				
1c	Verify that the navigation database is current.	7.3.4.2				
1d	Verify the FPL: “R” should appear in field 10 and PBN/TBD in field 18.	7.3.4.2				
2	**General operating procedures**					
2a	Comply with the manufacturer’s instructions/procedures.	7.3.4.4.1				

2b	Advise ATC if unable to comply with the requirements for RNP 0.3.	7.3.4.4.2				
2c	Verify aircraft position and entry of assigned route.	7.3.4.4.4				
2d	Retrieve SID/STAR/APP from the database; retrieve ATS route from database or construct route with waypoints from database.	7.3.4.4.5				
2e	Cross-check the chart with the RNAV system display.	7.3.4.4.6				
2f	Follow route centre line within 0.15 NM.	7.3.4.4.8				
2g	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.	7.3.4.4.9				
2h	Do not select bank limiting functions.	7.3.4.4.10				
2i	If manual selection, set RNP 0.3 for all loaded RNP 0.3 routes.	7.3.4.5				
3	**RNP 0.3 SID requirements**					
3a	Prior to take-off, check the RNAV system, the aerodrome and procedure loaded and the displayed position.	7.3.4.6.1				
3b	If GNSS, signal must be acquired before start of takeoff roll.	7.3.4.6.2				
3c	Engage FGS before first waypoint.	7.3.4.6.3				
4	**RNP 0.3 STAR requirements**					
4a	Verify that the correct STAR is loaded and displayed.	7.3.4.7.1				
4b	Manual entry of waypoints not authorized.	7.3.4.7.2				
4c	Contingency preparations.	7.3.4.7.3				
4d	Procedure modifications in response to ATC instructions.	7.3.4.7.4				

4e	Verify the correct operation of the navigation system and that the correct procedure, transition and runway are loaded.	7.3.4.7.5				

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 7)**	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Contingencies**					
1a	Advise ATC if unable to comply with the requirements for RNP 0.3.	7.3.4.8				
1b	Air-ground communications failure.	7.3.4.8 (Doc 4444 Chapter 15, 15.3)				
*All references are to the PBN manual (Doc 9613), Volume II, Part C, Chapter 7, unless otherwise indicated.						

4.11 ADVANCED RNP (A-RNP)

4.11.1 General

A-RNP is intended to support operations in oceanic airspace and en-route continental airspace, on SIDs, on STARs and on approaches. It is intended to provide a single assessment of aircraft eligibility covering a range of accuracy requirements across all phases of flight. It incorporates RNAV 5, RNAV 2, RNAV 1, RNP 2, RNP 1 and RNP APCH (A and/or B). Fixed radius turn functionality within terminal airspace (RF) is a requirement while fixed radius turn functionality in the en-route (FRT) is an option. RNP scalability, time of arrival control (TOAC) and Baro-VNAV functionalities are all optional. Higher continuity requirements are applied for RNP 2 in oceanic/remote airspace. The navigation specification does not specifically address the oceanic and remote applications RNAV 10 and RNP 4, and an operator would need to obtain separate approval before operating with an A-RNP approved aircraft in such airspace. It is not anticipated that this additional application will represent a significant burden to the operator particularly if the aircraft already meets the RNP 2 oceanic criteria.

4.11.2 Aircraft requirements

The aircraft requirements are detailed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 4, 4.3.3 and Appendices 1, 2 and 3 to Part C. An aircraft approved for A-RNP will meet the requirements of all the above-mentioned navigation specifications.

4.11.3 Operating procedures

The operating procedures are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 4, 4.3.4. Some additional provisions may need to be added to the standard operating procedures to specifically address A-RNP operations.

4.11.4 Pilot knowledge and training

4.11.4.1 The pilot knowledge and training requirements are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 4, 4.3.6. Flight crews should possess the necessary skills to conduct A-RNP operations with minimal additional training.

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

4.11.5 Job aid specific elements

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 4)	*(AC/AMC/CA, etc.)*	*(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.	4.3.2.5 4.3.2.6.6				
3	**Training** Details of courses completed (GA operators). Details of training programmes (AOC).	4.3.2.6.2 4.3.6				
4	**Operating policies and procedures** Extracts from the operations manual or other documentation (GA operators). Operations manual and checklists (AOC holders).	4.3.2.6.3				
5	**Maintenance practices** Document navigation database maintenance practices.	4.3.2.6.5 4.3.5				
6	**MEL update**	4.3.2.6.4				

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 4)	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Flight planning**					
1a	Verify that the aircraft and crew are approved for A-RNP operations.	4.3.4				
1b	Verify RAIM/SBAS availability.	4.3.4.1.3				
1c	Verify that the navigation database is current.	4.3.4.2.2				
1d	If dispatch predicated on procedure with RF leg, verify AP/FD is operational.	Appendix 1 to Part C 5.5.3				
1e	Verify the FPL: “R” should appear in field 10 and PBN/TBD in field 18.	4.3.4.1.1				

2	**General operating procedures**					
2a	If system does not set RNP automatically, smallest navigation accuracy value must be entered manually for loaded route.	4.3.4.3				
3	**A-RNP SID requirements**					
3a	Prior to take-off, check the RNAV system, the runway and procedure loaded and the displayed position.	4.3.4.4.1				
3b	Engage LNAV no later than 153 m (500 ft) above aerodrome elevation.	4.3.4.4.2				
3c	Use an authorized method to achieve appropriate RNP performance (AP/FD/Map/ L/DEV indicator).	4.3.4.4.3				
3d	If GNSS, signal must be acquired before start of takeoff roll.	4.3.4.4.4				
4	**A-RNP STAR requirements**					
4a	Verify that the correct STAR is loaded and displayed.	4.3.4.5.1				
4b	Contingency preparations.	4.3.4.5.3				
4c	Route modification in response to ATC instructions.	4.3.4.5.4				
4d	Verify the correct operation of the navigation system and that the correct procedure, transition and runway are loaded.	4.3.4.5.5				
4e	Observance of speed and altitude constraints.	4.3.4.5.6				

5	**RF requirements**					
5a	Be established on procedure prior to RF leg.	Appendix 1 to Part C 5.5.5				
5b	Cross-track deviation not to exceed ½ RNP.	Appendix 1 to Part C 5.5.6				
5c	Do not exceed maximum airspeed associated with design.	Appendix 1 to Part C 5.5.7				

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 4)**	*(AC/AMC/CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Contingencies**					
1a	Advise ATC if unable to comply with the requirements for A-RNP.	4.3.4.6.1				
1b	Air-ground communications failure.	4.3.4.6.2 (Doc 4444, Chapter 15, 15.3)				
1c	If unable to follow RF turn due to system failure, maintain bank and roll out on charted exit course. Inform ATC.	Appendix 1 to Part C 5.5.8				

*All references are to the PBN manual (Doc 9613), Volume II, Part C, Chapter 4, unless otherwise indicated.

4.12 RNP AR

4.12.1 General

4.12.1.1 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 the *Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual* (Doc 9905), there are a number of RNP AR APCH procedures in commercial use which have been designed according to private, proprietary criteria.

4.12.1.2 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.

4.12.2 System requirements

The aircraft requirements are detailed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 6, 6.3.3.

4.12.3 RNP AR APCH operations

The operating procedures are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 6, 6.3.4. 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.

4.12.4 Flight crew knowledge and training

4.12.4.1 The pilot knowledge and training requirements are addressed in the PBN manual (Doc 9613), Volume II, Part C, Chapter 6, 6.3.5. 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.

4.12.4.2 *Ground training*

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

4.12.4.3 *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 Appendix F.

4.12.5 Navigation database

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

4.12.5.2 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 to ensure that there are no discrepancies.

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

4.12.5.4 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.

4.12.6 TAWS database

The procedure validation process should include a compatibility check with the installed TAWS. The TAWS data should only be obtained from a qualified source and operators should have procedures in place for the management of the TAWS data.

4.12.7 Safety assessments

4.12.7.1 The RNP AR procedure design criteria in *Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual* (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 II, RNP AR navigation specifications, 6.3.3.2.7 and 6.3.3.4.1.2.).

4.12.7.2 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.

4.12.7.3 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 CAAN has 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.

4.12.7.4 CAAN shall 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 CAA 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.

4.12.8 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.

4.12.9 Documentation supporting the application for approval

4.12.8.1 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.

4.12.8.2 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.

4.12.10 Job aid specific elements

PART 3. OPERATOR APPLICATION

Amend rows:

Annex	Title	*Inclusion by Operator*	*Comments by Inspector*
C	**Aircraft eligibility — modifications (if applicable)** Maintenance records documenting installation or modification of aircraft systems to achieve eligibility. *Note: If aircraft were not delivered in an RNP AR operations compliant state, provide details as to how each aircraft was modified to become RNP AR compliant. Where possible, reference should be made to aircraft OEM documentation.*		

D	**Continuing Airworthiness** Navigation database and RNP AR APCH system maintenance practices. Provide details of procedures for: — Revising the electrical load analysis for each aircraft when it is modified and the electrical load is changed. — Assessing modification documentation and managing the aircraft configuration; including procedures to modify any affected synthetic training devices (aircraft simulators or other training systems). — Software configuration management to an individual aircraft level. Aircraft operational data updating procedures e.g. navigation, terrain, SATCOM calling databases.		
I	**Navigation database** Validation programme and procedures.		
J	**Withdrawal of approval** Possibility of withdrawal of approval following navigation error reports.		
K	**Monitoring programme** Data collection plan.		
L	**Flight operational safety assessment (FOSA)** An established methodology for a formal safety assessment of the proposed operation.		

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)	*(AC/AMC/ CA, etc.)*	*(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				

3	**Training** Details of courses completed (GA operators). Details of training programmes (AOC holders).	6.3.2.6.2 6.3.5				
4	**Operating policies and procedures** Extracts from the operations manual or other documentation (GA operators). Operations manual and checklists (AOC holders).	6.3.2.6.3				
5	**Maintenance practices** Document navigation database maintenance practices.	6.3.2.6.5 6.3.6				
6	**MEL update**	6.3.2.6.4				

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 6)	*(AC/AMC/ CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Flight planning**					
1a	Verify that the aircraft and crew are approved for RNP AR operations.	6.3.2				
1b	If dispatch predicated on procedure with RF leg, verify AP/FD is operational.	Appendix 1 to Part C 5.5.3				
1c	Verify MEL.	6.3.4.1.1				
1d	Verify RNP availability.	6.3.4.1.3				
1e	Verify procedures for NAVAID exclusion.	6.3.4.1.4				
1f	Verify that the navigation database is current.	6.3.4.1.5				
1g	Review contingency procedures/options.	6.3.4.2.20 6.3.4.2.21				
1h	Verify FPL: “R” should appear in field 10 and PBN/T1 or T2 in field 18.					

2	**Prior to commencing procedure**					
2a	Verify that the correct procedure is loaded.	6.3.4.2.1 6.3.4.2.6				
2b	Verify correct RNP accuracy requirements.	6.3.4.2.3				
2c	Cross-check the chart with the RNAV system display.	6.3.4.2.1 6.3.4.2.6				
2d	Verify GNSS sensor in use (only for multi-sensor systems).	6.3.4.2.4				
2e	Inhibit specific NAVAIDS as required.	6.3.4.2.5				
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				
2g	Confirm that the aircraft is capable of complying with the missed approach climb gradient.	6.3.4.2.16				
3	**During procedure**					
3a	Maintain centre line; monitor track deviation; lateral deviation limited to ±1/2 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				
3b	Maintain vertical path; monitor vertical deviation — limited to −22 m (−75 ft). Execute a missed approach if −22 m (−75 ft) is exceeded.	6.3.4.2.8 6.3.4.2.9				
3c	For RNP < 0.3, cross-check lateral and vertical guidance against other data sources.	6.3.4.2.10				
3d	Do not exceed aircraft category speeds in RF Legs.	6.3.4.2.11				
3e	Apply temperature compensation as appropriate.	6.3.4.2.12				

3f	Ensure that the local QNH is set before FAF.	6.3.4.2.13				
3g	Cross-check altimeters after IAF and before FAF ±30 m (±100 ft).	6.3.4.2.14				
3h	Do not exceed 30 m (100 ft) vertical deviation at VNAV capture.	6.3.4.2.15				
3i	If LNAV is disengaged at TOGA, re-engage as quickly as possible.	6.3.4.2.18				
3j	Manage speed to maintain track in any go-around.	6.3.4.2.19				
3k	Comply with the manufacturer's instructions/procedures.	6.3.4.2.5				
3l	Use FD and/or AP.	6.3.4.2.7				
4	**RF requirements**					
4a	Be established on procedure prior to RF leg.	Appendix 1 to Part C 5.5.5				
4b	Cross-track deviation not to exceed ½ RNP.	Appendix 1 to Part C 5.5.6				
4c	Do not exceed maximum airspeed associated with design.	Appendix 1 to Part C 5.5.7				

PART 6. CONTINGENCY PROCEDURES

#	Topic	***Specific ICAO reference***	***Specific State guidance reference***	***Operator compliance description***	***Inspector disposition/ comments***	***Follow-up by inspector (optional)***
		(Doc 4444, Chapter 15)	*(AC/AMC /CA, etc.)*	*(Document reference/ method)*	*(Accepted/ not accepted)*	*(Status and date)*
1	**Contingencies**					
1a	Advise ATC if unable to comply with the requirements for an RNP AR APCH.	15.2.1.1				
1b	Air-ground communications failure.	15.3				
1c	If unable to follow RF turn due to system failure, maintain bank and roll out on charted exit course. Inform ATC.	Doc 9613, Volume II, Appendix 1 to Part C 5.5.8				

4.13

RESERVED

4.14 RNP AR DEPARTURE

4.14.1 GENERAL

4.14.1.1 Presently, RNP AR Manual, Doc 9905 contains the flight procedure design criteria for RNP AR Approach procedures only. However, it clearly mentions in its foreword that the similar design criteria for RNP AR departure procedures will be incorporated in the manual when developed. Similarly, the PBN Manual, Doc 9613 does not contain the provisions of RNP AR departure specification. PBN Operational Approval Manual, Doc 9997 also doesn't have any provisions for operational approval of such specification.

4.14.1.2 This manual has used RNP AR DP as the designator for RNP AR departure procedures which require further additional levels of scrutiny, control and authorization than that required for RNP AR APCH. Therefore, the provisions mentioned in this section 4.14 is in addition to the provisions for the approval of RNP AR APCH. Very few States have implemented RNP AR departures. So regulatory provisions for both operational as well as procedure approval of RNP AR departures are very limited. This section has been developed to support FOIs of CAA Nepal providing some basic guidelines for the authorization of RNP AR DP navigation application to the airline operators.

4.14.1.3 RNP AR DP applications can range from simple straight departures to a very complex curved approaches with RF legs used in some or many portions of the procedure, with a minimum track-keeping accuracy requirement from RNP 1 to RNP 0.3. RNP AR DP procedures designed basically according to RNP AR APCH criteria as mentioned in ICAO Doc 9905.

4.14.1.4 The RNP AR APCH and RNP AR DP operational approvals are separate approvals. Operators can hold a RNP AR APCH approval without holding a RNP AR DP approval. However, if the RNP AR DP approval is required, the operator must hold the RNP AR APCH approval or must be qualified for such approval.

4.14.1.5 To acquire the approval or authorization for RNP AR DP, operators must demonstrate that they are qualified for such navigation application. Operators can demonstrate their qualification in the RNP AR DP validation flight.

4.14.1.6 A simplified Job Aid for the approval and authorization of RNP AR departure has been mentioned at the end of this chapter.

4.14.2 OPERATORS' QUALIFICATION

4.14.2.1 Before authorizing operators for RNP AR DP application, FOIs must ensure that the following criteria are met:

a. Application for authorization of RNP AR DP procedure with RNP value not less than RNP 0.3
b. Aircraft must hold authorization for RNP AR APCH or be qualified for this NAVSPEC
c. Availability of RNP AR EOSID or RNP AR DP procedure capable to accommodate engine out performance
d. Aircraft qualification- AFM indicating the aircraft capability for RNP AR DP

e. Crew Qualification- Ground/SIM training for RNP AR DP
f. MEL concerning RNP AR DP
g. FOSA addressing the RNP AR DP

4.14.3 SYSTEM REQUIREMENT

4.14.3.1 Besides equipment required as mentioned in para 4.8.3.2, following system are required for RNP AR DP operations at minimum:

a. Use of aircraft performance tool(s) necessary to ensure compliance with take-off/climb performance demands of RNP AR DP
b. Able to loading and executing a flight plan where the RNP AR DP defined path begins at or just beyond the DER, including use of an RF leg
c. Able to provide lateral path guidance (i.e. engage LNAV) no later than 50FT above the DER during take-off
d. Capable of reversion to IRS-only navigation in case of the loss of GNSS at any point during the procedure

4.14.3.2 Equipment required

Following equipment are required for RNP AR DP operational approval:

a. 2 GNSS Receivers (TSO C129a or equivalent; TSO C145a/TSO C146a or equivalent)
b. 2 FMS (TSO C115b or equivalent)
c. 2 IRSs/IRUs
d. 2 ADSs
e. 2 FDs
f. 2 APs (RNP < 1)
g. 1 Class A TAWS/EGPWS
h. Duplicated PFDs/NDs
i. 2 Baro-VNAV system
j. 2 Flight Mode Annunciators
k. 2 Radio Altimeters

4.14.4 OM AND CHECKLIST

4.14.4.1 Operator's OM contains RNP AR DP procedure, which should at minimum contain the following:

a. Preflight procedure, including cockpit preparation
b. Take-off and climb-out procedure
c. RNP AR DP contingency
d. ATC flight planning
e. LNAV performance verification for close-in RF legs
f. Aircraft performance analysis for the take-off and climb-out phase

4.14.4.2 RNP AR DP checklist

Operators have developed the RNP AR DP Checklist.

4.14.5 CONDITIONS OF OPERATION

a. The operators must conduct RNP AR DP validation flight for getting authorization or approval.
b. Operators will initially get conditional authorization until completion of 100 trial operations.
c. At all times during the departure, the pilot in command must ensure that the departure is flown in accordance with the current approved navigation database and the navigation performance scales showing the ANP are displayed to both pilots.
d. Before the trial begins for an aerodrome, operators must give CAAN a study, acceptable to CAAN, of:
   - the likely environmental effects of the conduct of the trial at the aerodrome; and
   - the measures that would be taken by the Operator to mitigate those effects.
e. Operators must ensure that all RNP AR departures are monitored by its Quality Assurance program, which must record at least the following events and inform to CAAN at every three months:
   - UNABLE RNP Messages (NAV accuracy downgrade information);
   - Cross track error appropriate to the RNP value of the departure;
   - Vertical deviation of 100 ft above or 50 ft below the VNAV path;
   - EGPWS or TAWS warning;
   - AP disconnect;
   - NAVDATA errors
   - Pilot report of any anomaly

Note 1: The provisions for authorization or approval of RNP AR DP mentioned in this section 4.14 have been developed taking into reference of the following:

a. ICAO Doc 9613, Doc 9905 and Doc 9997
b. the discussions in the ICAO forums
c. the procedures adopted by the States who have already implemented RNP AR DP and
d. Industry practices.

Note 2: The provisions for authorization or approval of RNP AR DP as mentioned in this section will be modified if Doc 9613 and/or Doc 9997 will incorporate the provisions for RNP AR DP in future, or at any time when it is deemed necessary in the interest of safety of aircraft operation.

RNP AR DP Job Aid
(Simplified)

#	Topic	*Supporting Document Reference numbers*	*Operator compliance description*	*Inspector disposition/ comment*	*Follow-up by inspector (optional)*
		CAAN PBN OPS Approval Manual Procedures & Policies etc	*Document reference/ method*	*Accepted/ not accepted*	*Status and date*
1	**Authorization request** Statement of intent to obtain authorization for RNP AR DP.	4.14.2.1 a.			
2	**RNP AR APCH capability** Aircraft holding authorization for RNP AR APCH or be qualified for this NAVSPEC	4.14.2.1 b.			
3	**Availability of EOSID** Availability of RNP AR EOSID or RNP AR DP procedure capable of accommodating engine out performance	4.14.2.1 c.			
4	**Aircraft system eligibility** AFM endorsement for RNP AR DP.	4.14.2.1 d.			
5	**Crew Qualification/Training** Details of courses/training completed including SIM Training programmes addressing RNP AR DP	4.14.2.1 e.			
6	**MEL** MEL update concerning RNP AR DP	4.14.2.1 f.			
7	**Safety assessment** FOSA addressing RNP AR DP related risks	4.14.2.1 g.			

8	**System requirement** 8.1 Use of performance tool(s) necessary to ensure Compliance with take-off/ climb performance demands of RNP AR DP	4.14.3.1 a.			
	8.2 Able to loading and executing a flight plan where the RNP AR DP defined path begins at or just beyond the DER, including use of an RF leg	4.14.3.1 b.			
	8.3 Able to provide lateral path guidance (i.e. engage LNAV) no later than 50FT above the DER during take-off	4.14.3.1 c.			
	8.4 Capable of reversion to IRS-only navigation in case of the loss of GNSS at any point during the procedure	4.14.3.1 d.			
	8.5 Equipment required for RNP AR DP as mentioned in para 4.14.3.2	4.14.3.2			

9	**Operating Policies and Procedures** Procedures in OM and checklists concerning RNP AR DP 9.1 OM should at minimum contains: a. Pre-flight procedure, including cockpit preparation b. Take-off/Climb procedure c. RNP AR DP contingency d. ATC flight planning especially considering Field 10 a and Field 18 e. LNAV performance verification for close-in RF legs f. Aircraft performance analysis for take-off/climb-out phase 9.2 RNP AR DP checklist Operators have developed the RNP AR DP Checklist	4.14.4.1 4.14.4.1 a. 4.14.4.1 b 4.14.4.1 c. 4.14.4.1 d. 4.14.4.1 e. 4.14.4.1 f. 4.14.4.2			

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.

1.3 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.

1.4 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).

1.5 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, which 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

4.1 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. BARNA;

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, 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[1] 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 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.

1. ARINC 424 is a de facto industrial standard for navigation databases developed for use in airborne area navigation systems and is referenced in a number of ICAO documents.

Appendix B

EXAMPLE REGULATORY TEXT

XXX.001 APPLICATION FOR A SPECIFIC APPROVAL

a) An applicant for the initial issue of a specific approval shall provide the DG, CAAN 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 DG, CAAN that:

1) the applicant complies with the requirements;
2) the aircraft and required equipment fulfil 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.002 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.003 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.004 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 the PBN manual (Doc 9613) and the applicable documents listed in the table below.

Flight Phase									Applicable documents	Complementary guidance material
	En-route		STAR	Approach				SID		
	Oceanic/ remote	Continental		Initial	Intermediate	Final	Missed			
RNAV 10	×								AC 91-001	EASA AMC 20-12 FAA AC 90-105( )
RNAV 5		×							AC 91-002	EASA AMC 20-4 FAA AC 90-105( )
RNP 4	×								AC 91-004	FAA AC 90-105( )
RNP 2		×	×						TBD	FAA AC 90-105( )
RNAV 2		×	×						AC 91-003	EASA TBA FAA AC 90-100( )
RNP 1			×	×	×		×	×	AC 91-006	EASA TBA FAA AC 90-105( )
RNAV 1			×	×	×		×	×	AC 91-003	EASA JAA TGL10 FAA AC 90-100( )
A-RNP		×	×	×	×	×	×	×	TBD	FAA AC 90-105( )
RNP APCH (LNAV)				×	×	×	×		AC 91-008	EASA AMC 20-27 FAA AC 90-105( )
RNP APCH (LNAV/VNAV)				×	×	×	×		AC 91-010	
RNP APCH (LP/LPV)						×	×		TBD	EASA AMC 20-28 FAA AC 90-107
RNP AR			×	×	×	×	×	×	AC 91-009	EASA AMC 20-26 FAA AC 90-101
RF			×	×	×		×	×	TBD	FAA AC 90-105( )
Electronic data management		×	×	×	×	×	×	×	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.

Appendix C

EXAMPLE OPERATIONS SPECIFICATION (OPS SPEC) ENTRIES

Example entries are illustrated below:

Special Authorizations	*Yes*	*No*	*Specific Approvals*	*Remarks*
Navigation specifications for PBN operations	☒	☐	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.

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 the Chief, Flight Safety Standards Department, CAA Nepal at the address listed below:

The Chief
Flight Safety Standards Department
CAAN Complex, Sinamangal, Kathmandu

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)

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*

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.

SECTION III. SIGNATURE

Signature: .....

Name (block letters): .....

Title: .....

Date: .....

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.	
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 CAA, 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

FLIGHT 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 *Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual* (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 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:

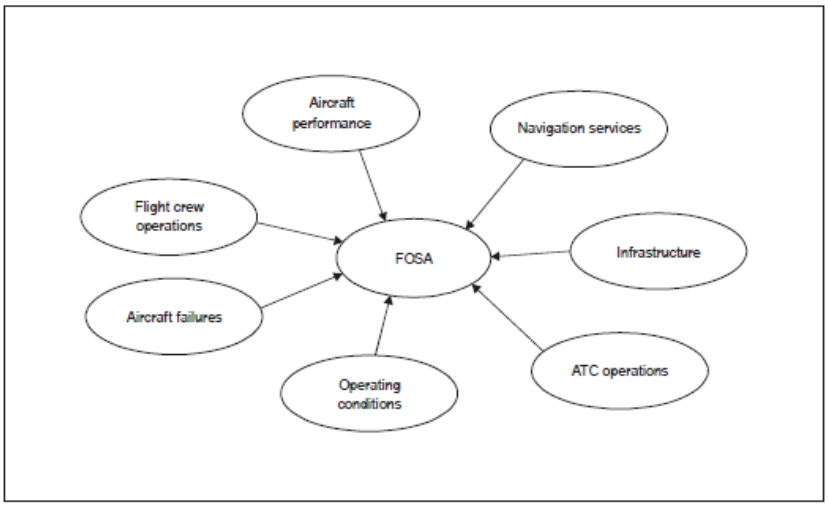

Figure E-1. Elements to consider in a FOSA

a) how challenging the proposed procedure design is relative to the airworthiness approval/qualification;
b) the operational and obstacle environment; and
c) 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 (the PBN manual (Doc 9613), Volume II, Part C, 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 the vertical path, 99.7% of flight time.

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 × 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.

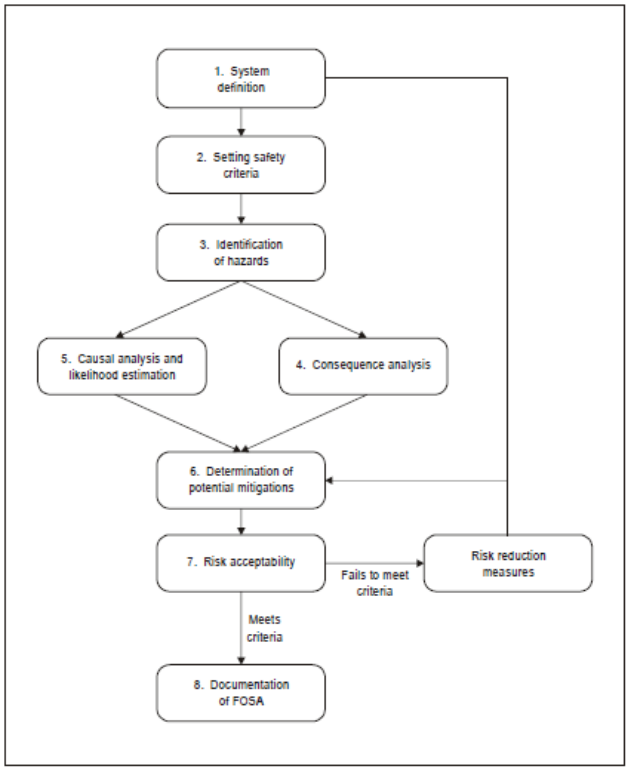

Figure E-2. Main steps in a FOSA

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 aircraft RNP system performance under operational, rare, normal and non-normal conditions which should be documented to support the FOSA exercise;
c) flight crew procedures and training;
d) dispatch procedures and training;
e) proposed minimum equipment list (or RNP AR required equipment list);
f) any special maintenance requirements;
g) airport and airspace environment;
h) navigation infrastructure;
i) ATC facilities (including surveillance and communications), procedures and intended training with respect to RNP AR operations; and
j) 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.[1] 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.:
1) procedure designers;
2) aircraft and avionics manufacturers, if available;
3) technical support experts;
4) pilots (from relevant aircraft operators and test pilots if available);
5) AIM experts;
6) ATCOs and ATC representatives with knowledge of airspace planning and technical facilities; and
7) 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.

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1. The term hazard is used in this document to refer to events that form convenient pinch points between sets of consequences and causes. Hazard can be defined as "a condition that could credibly cause or contribute to an aircraft incident or accident. *(This may include a natural hazard or a condition with the potential for causing injuries or death to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function, as it relates to the safe operation of aircraft)*". This broader definition is covered by the full set of hazards, causes and consequences that would be generated in a FOSA.

Step 4 — Consequence analysis and severity evaluation

3.2.7 The manner in which the consequences[2] 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 manoeuvrable 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 analysed 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).

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2. Termed “effects” in some safety assessment methods.

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 judgement.

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 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 crosschecking and several others.

3.3.1.2 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.

3.3.2 *Abnormal and contingency procedures*

3.3.2.1 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).

3.3.2.2 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.

3.3.3 *Training requirements*

3.3.3.1 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.

3.3.3.2 Manufacturers may supply additional training guidance specific to the relevant aircraft types.

3.3.4 *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.

3.3.5 *FOSA and HF issues*

3.3.5.1 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.

3.3.5.2 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 fulfil 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;

c) 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;

d) 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:

a) 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;

b) adequacy of existing monitoring systems, e.g. non-transgression zones;

c) 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 analysed 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 Compared to other types of approaches (e.g. ILS approaches) there are still relatively few RNP AR 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.

Appendix F

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 (FTSD) 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.

— END —