CIVIL AVIATION AUTHORITY OF NEW ZEALAND

Advisory Circular

AC91-21

Revision 1

13 October 2020

Performance-Based Navigation—Operational Approvals

General

Civil Aviation Authority advisory circulars contain guidance and information about standards, practices, and procedures that the Director has found to be an **acceptable means of compliance** with the associated rules and legislation.

However the information in the advisory circular does not replace the requirement for participants to comply with their own obligations under the Civil Aviation Rules, the Civil Aviation Act 1990 and other legislation.

An advisory circular reflects the Director's view on the rules and legislation. It expresses CAA policy on the relevant matter. It is not intended to be definitive. Consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices, or procedures are found to be acceptable they will be added to the appropriate advisory circular. Should there be any inconsistency between this information and the rules or legislation, the rules and legislation take precedence.

An advisory circular may also include **guidance material** generally, including guidance on best practice as well as guidance to facilitate compliance with the rule requirements. However, guidance material must not be regarded as an acceptable means of compliance.

An advisory circular may also include **technical information** that is relevant to the standards or requirements.

Purpose

This advisory circular provides an acceptable means of compliance with the airworthiness, continued airworthiness, and operational requirements for operators to obtain approval by the Director to conduct Performance-Based Navigation (PBN) operations within New Zealand. Approval by the Director may be granted when the operator has demonstrated compliance with the relevant airworthiness, continued airworthiness, and flight operations requirements. The navigation specifications provided, or referenced, in this advisory circular provide a basis for this approval.

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Authorised by
Manager International and Regulatory Strategy

Related Rules

This advisory circular relates specifically to the applicable provisions of New Zealand Civil Aviation Rules 91.246, 91.519 and Part 19 Subpart D.

It also relates to the pilot training and qualification requirements in Parts 61, as well as operator approvals required by New Zealand Civil Aviation Rule Parts 119, 121, 125 and 135.

Change Notice

Revision 1 updates the advisory circular in its entirety, and provides clarification and simplification of the PBN operation application and approval process, and relocates the detailed technical and operational content to the Appendixes.

Version History

This revision history log contains a record of revision(s) made to this advisory circular.

AC Revision No.	Effective Date	Summary of Changes
AC91-21 Rev.0.3	5 September 2016	This revision will develop the equipment requirements for operational approvals.

Table of Contents

1. Introduction

The purpose of this Advisory Circular (AC) is to provide an acceptable means of compliance for operators to obtain a PBN operational approval from the Director, which authorises an operator to carry out defined PBN operations with specific aircraft in designated airspace.

The requirements for operational approval are based on Rule 91.246 and 91.519 and an operational approval may be issued when the operator has demonstrated compliance with the relevant airworthiness, continuing airworthiness, and flight operations requirements. The navigation specifications provided in this advisory circular provide an acceptable means of compliance and are derived from international standards (ICAO). The approval will be specific to an operator and aircraft, with conditions related to the applicable navigation specification(s).

A reference to "PBN operational approval" in this AC means approval by the Director in writing to conduct flight operations in accordance with any of the following navigation specifications:

i. RNAV 10 (RNP 10)[a]
ii. RNP 4[b]
iii. RNAV 5[c]
iv. RNAV 1 and RNAV 2[d]
v. RNP 2
vi. RNP 1
vii. A-RNP
viii. RNP APCH (LNAV minima) and RNP APCH (LNAV/VNAV minima)
ix. RNP APCH (LP minima) and RNP APCH (LPV minima)
x. RNP AR APCH
xi. RNP 0.3(H)

The following additional, optional capabilities are also addressed in this AC:

xii. Baro-VNAV
xiii. RF Legs

This AC does not provide guidance regarding the operational approval criteria for ILS/MLS/GLS approaches.

Note a: *This AC does not include acceptable means of compliance for RNAV 10 (RNP 10) operational approval, which is contained in AC91-7.*

Note b: *This AC does not include acceptable means of compliance for RNP 4 operational approval, which is contained in AC91-10.*

Note c: *This AC does not include acceptable means of compliance for RNAV 5 (BRNAV) operational approval, which is contained in AC91-8.*

Note d: *Existing 'GNSS IFR en-route' approvals may operate RNAV 2 until [future date TBC], after this date the operator must have applied for and been approved for RNAV 2/RNP 2 operations as defined in this advisory circular.*

It should be noted that not all navigation specifications are implemented in NZ airspace, however, operators may be approved by the Director for navigation specifications not implemented in NZ FIR, provided the technical and operational requirements of that navigation specification are complied with.

An overview of the navigation specifications are included in Section 5 - Background.

An overview of the operational approval process is included in Section 6 and high-level requirements for each element of the operational approval are included in Sections 7 through 10.

The detailed technical and operational requirements of each navigation specification are included in Appendix I through XIII.

This AC provides one acceptable means of compliance. If it is not practical for an aircraft operator to gain operational approval as specified in this AC, then the operator may apply to the Director to achieve compliance by an alternative means which provides an equivalent level of safety. It is recommended that the operator contact the CAA at their earliest convenience should an alternative means of compliance be contemplated.

The CAA is receptive to any comments on how this AC can be improved in the New Zealand context, and any changes will be highlighted in subsequent versions. The CAA acknowledges the contribution of industry stakeholders in the development of this document.

2. Abbreviations

The following abbreviations specifically pertaining to this advisory circular are included below. See also Civil Aviation Rules Part 1 for other abbreviations not specific to this advisory circular

ABAS	Aircraft-Based Augmentation System
AC	Advisory Circular
ADS-C	Automated Dependent Surveillance – Contract
AFM	Aircraft Flight Manual
AFMS	Aircraft Flight Manual Supplement
AIRAC	Aeronautical Information Regulation and Control
AMC	Acceptable Means of Compliance
ANP	Actual Navigation Performance
ANSP	Air Navigation Service Provider
AP	Auto Pilot
APCH	Approach
A-RNP	Advanced Required Navigation Performance
ARINC	Aeronautical Radio, Incorporated
ARP	Aerodrome Reference Point
ASE	Altimetry System Error
ATS	Air Traffic Service
ATT	Along-Track Tolerance
Baro-VNAV	Barometric Vertical Navigation
CS	Certification Specification
CDI	Course Deviation Indicator
CFR	Code of Federal Regulations
CNS	Communication, Navigation & Surveillance
CRC	Cyclic redundancy check
DA	Decision Altitude
DB	Data Block
DF	Direct Fix
DME	Distance Measuring Equipment
Doc	Document
DCPC	Direct Controller-Pilot Communications
EASA	European Aviation Safety Agency
EHSI	Electronic Horizontal Situation Indicator
EPE	Estimated Position Error
EPU	Estimated Position Uncertainty
ETSO	European Technical Standard Order

EUROCAE	European Organisation for Civil Aviation Equipment
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FAS	Final Approach Segment
FCOM	Flight Crew Operating Manual
FD	Fault Detection, or; Flight Director
FDE	Fault Detection and Exclusion
FGS	Flight Guidance System
FMS	Flight Management System
FRT	Fixed Radius Transition
Ft	Foot / Feet
FTE	Flight Technical Error
GBAS	Ground-Based Augmentation System
GLS	GBAS Landing System
GNSS	Global Navigation Satellite system
HIL	Horizontal Integrity Limit
HPL	Horizontal Protection Level
HSI	Horizontal Situation Indicator
IAP	Instrument Approach procedure
IF	Initial Fix
INS	Inertial Navigation System
INU	Inertial Navigation Unit
IRU	Inertial Reference Unit
JAA	Joint Aviation Authority
LNAV	Lateral Navigation
LOA	Letter of Acceptance
LP	Localiser Performance (without Vertical Guidance)
LPV	Localiser Performance with Vertical Guidance
LRCS	Long Range Communication System
LRNS	Long Range Navigation System
MDA	Minimum Descent Altitude
MPS	Minimum Performance Specification
MSL	Mean Sea Level
NAA	National Airworthiness Authority
NSE	Navigation System Error
NSS	New Southern Skies

NZ	New Zealand
OEM	Original Equipment Manufacturer
OPMA	On-board Performance Monitoring and Alerting
PANS-OPS	Procedures for Air Navigation Services - Operations
PBN	Performance Based Navigation
PDE	Path Definition Error
POH	Pilot's Operating Handbook
PPR	Pilot Position Report
P-RNAV	Precision Area Navigation
RAIM	Receiver Autonomous Integrity Monitoring
RF	Radius to Fix
RNP APCH	Required Navigation Performance Approach
RNP AR APCH	Required Navigation Performance (Authorisation Required) Approach
RTCA	Radio Technical Commission for Aeronautics
SBAS	Satellite-Based Augmentation System
SID	Standard Instrument Departure
SIS	Signal In Space
SOP	Standard Operating Procedure
STAR	Standard Instrument Arrival
STC	Supplemental Type Certificate
TC	Type Certificate
TF	Track Fix
TGL	Temporary Guidance Leaflet
TSE	Total System Error
TSO	Technical Standard Order
VDI	Vertical Deviation Indicator
VNAV	Vertical Navigation

3. Definitions

The following terms specifically pertaining to this advisory circular are included below. See also Civil Aviation Rules Part 1 for other terms not specific to this advisory circular.

Continental (en-route): This term replaces "Domestic (en-route)" as used in previous versions of this AC. The term has been replaced to align with ICAO nomenclature and to avoid possible confusion that Domestic (en-route) approvals are tied to any operation within a nation's political borders. Any existing approvals using the term Domestic (en-route) should be taken to mean Continental (en-route)

4. Related Reading Material

The standards and guidance material used in developing this AC are contained in the following ICAO documents:

1. Annex 10 Volume 1 – Aeronautical telecommunications
2. Doc 4444 – Air traffic management
3. Doc 7030 – Regional Supplementary Procedures
4. Doc 8168 – Aircraft Operations (PANs-OPS)
5. Doc 9613 – Performance Based Navigation (PBN) Manual
6. Doc 9849 – Global Navigation Satellite System (GNSS) Manual, and
7. Doc 9997 – Performance-Based Navigation (PBN) Operational Approval Manual
8. Doc 9905 – RNP AR Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual

The following documents are referenced within this AC:

1. CAA AC61-17
2. CAA AC91-7
3. CAA AC91-8
4. CAA AC91-10
5. CAA AC91-18
6. FAA AC20-129
7. FAA AC20-130A
8. FAA AC20-138()
9. FAA AC20-138D Change 2
10. FAA AC20-153
11. FAA AC90-100
12. FAA AC90-100A
13. FAA AC90-101A
14. FAA AC90-105
15. FAA AC90-107
16. EASA CS-ACNS Issue 2
17. EASA ACM 20-4
18. EASA ACM 20-26
19. EASA ACM 20-27
20. EASA ACM 20-28
21. JAA TGL-3
22. JAA TGL-10

5. Background

PBN Specifications used in New Zealand FIR

The following Table 1 outlines the use and availability of PBN specifications, and implementation in New Zealand domestic flight information region (FIR) for en-route, terminal and approach operations, as of the date of publication of this AC.

Table 1 – PBN Specifications in relation to Flight Phase

	Flight Phase							
	En-route		Terminal		Approach			
Navigation Specification	Oceanic/ Remote	Continental /Domestic	Arrival	Departure	Initial	Intermediate	Final	Missed
RNAV 10 (RNP 10)	**10**							
RNP 4	**4**							
RNAV 5 (BRNAV)		*5*	*5*					
RNAV 2[a]		**2**	*2*	*2*				
RNAV 1 (PRNAV)		*1*	**1**	**1**	*1*	*1*		*1*
RNP 2	*2*	*2*						
RNP 1			**1**	**1**	*1*	*1*		*1*
A-RNP	*2*	*2 or 1*	*1-0.3*	*1-0.3*	*1-0.3*	*1-0.3*	*0.3*	*1-0.3*
RNP APCH (LNAV)					**1**	**1**	**0.3**	**1**
RNP APCH (LNAV/VNAV[b]**)**					**1**	**1**	**0.3**	**1**
RNP APCH (LP)					*1*	*1*		*1*
RNP APCH (LPV)					*1*	*1*		*1*
RNP AR APCH					**1-0.1**	**1-0.1**	**0.3-0.1**	**1-0.1**
RNP 0.3(H)		*0.3*	*0.3*	*0.3*	*0.3*	*0.3*		*0.3*

Note a: *RNAV 2 PANS OPS design criteria are used for those routes that are designated as ATC monitored. Currently, RNAV 2 routes outside of surveillance are based on basic GNSS criteria to account for 'GPS IFR en-route' approved receivers and those without on board monitoring and alerting (XTT 4 NM, ATT 2 NM, semi width 8 NM). Existing 'GNSS IFR en-route' approvals may operate RNAV 2 until [future date TBC], after this date the operator must have applied for and been approved for RNAV 2/RNP 2 operations as defined in this advisory circular.*

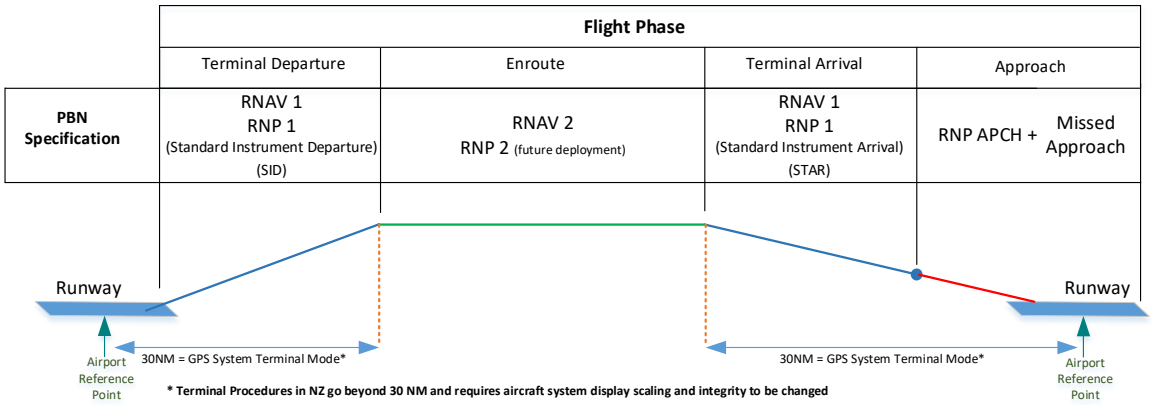
Note b: *Including Baro-VNAV. Baro-VNAV is the only VNAV provision available in NZFIR as there is no SBAS or GBAS coverage in NZ currently.*

The **shaded areas** indicate those PBN specifications implemented in the NZ FIR, whilst the *italicised areas* indicate the PBN operational approvals that may be issued to support international operations, but not yet implemented in NZ FIR. The number in the above table specifies the required accuracy level.

A pictorial presentation is shown in Figure 1, followed by a sub section for each phase of flight providing the PBN application and performance summary. A more detailed explanation of each

navigation specification, including those not currently implemented in NZ, is provided in Appendix I through XIII.

Figure 1: PBN Specifications in relation to flight phase in NZ FIR



En-route Operations

Applicable en-route PBN specifications:

- **RNAV 2** (reliant on GNSS, GPS)
- **RNP 2** (reliant on GNSS, GPS)

A summary of PBN application and performance specifications for en-route operations is provided in Table 2.

Table 2: RNAV 2 and RNP 2 Application and Performance Summary

Purpose	RNAV 2 and RNP 2 support en-route navigation.
Surveillance Environment	RNAV 2 is expected to be conducted in a surveillance environment; operation outside surveillance or below Minimum Vectoring Altitude requires a state safety case. RNP 2 can be conducted outside of a surveillance environment. **Note:** *RNP 2 requires on board performance monitoring and alerting.*
Communications Environment	RNAV 2 and RNP 2 are conducted in direct controller-pilot communication.
Applicable ICAO Specification:	RNAV 2: ICAO PBN Doc 9613 Volume II, Part B, Chapter 3 RNP 2: ICAO PBN Doc 9613 Volume II, Part C, Chapter 2

Note: *As RNAV is expected to be conducted in a surveillance environment, the aircraft it is in must be suitably equipped to support the surveillance requirement for its intended operation*

Total System Error (TSE):	RNAV 2 and RNP 2: The PBN navigation system lateral and along track total system error must be within +/-2 NM for at least 95% of the total flight time.
Flight Technical Error (FTE)	FTE relates to the air crew or autopilot's ability to follow the defined path or track, including any display error (e.g. CDI centring error). FTE can be monitored by the autopilot or air crew procedures. FTE only applies to the lateral cross track TSE. FTE is not to exceed 1/2 of the lateral TSE, in the case of RNAV 2 and RNP 2 the lateral FTE alert is 1 NM.
Navigation infrastructure supporting the navigation specification	New Zealand implementation of RNAV 2 and RNP 2 is based upon GNSS, specifically GPS. **Note:** *The RNAV 2 specification can be supported by DME/DME or DME/DME/Inertial, however this has not been implemented in New Zealand.*

Terminal Operations

Applicable terminal PBN Specifications:

- **RNAV 1** SIDs and STARs (reliant on GNSS, GPS) (RNAV specifications are likely to be replaced by RNP Specifications by 2023)
- **RNP 1** SIDs and STARs (reliant on GNSS, GPS)
- **RNP AR** (Authorisation Required) Departures/SIDs (reliant on GNSS, GPS) currently published as charts titled RNAV (RNP) DEPARTURE RWY xx, and procedures include a statement "for operators with CAANZ RNP-AR approvals only" or "for approved operators only". These are specific authorisation approvals granted to operators and can include specific operating procedures and special crew training. These are not currently defined by the ICAO PBN Manual.

Note: *New Zealand implements SIDs and STARs beyond 30NM, this will require the navigation system and/or flight crew procedures to set navigation lateral indication scaling and GNSS integrity alert to 1NM when operating RNP 1 beyond 30NM of the airport reference point.*

A summary of PBN application and performance specifications for terminal operations is provided in Table 3.

Table 3: RNAV 1 and RNP 1 Application and Performance Summary

Purpose	RNAV 1 and RNP 1 supports terminal SID and STAR operations and can be applied to initial and intermediate approach segments.
Surveillance Environment	RNAV 1 is expected to be conducted in a surveillance environment; operation outside surveillance or below Minimum Vectoring Altitude requires a state safety case. RNP 1 can be conducted outside of a surveillance environment. **Note:** *RNP 1 requires on board performance monitoring and alerting.*

Communications Environment	RNAV 1 and RNP 1 are conducted in direct controller-pilot communication.
Applicable ICAO Specification:	RNAV 1: ICAO PBN Doc 9613 Volume II, Part B, Chapter 3 RNP 1: ICAO PBN Doc 9613 Volume II, Part C, Chapter 3
Total System Error (TSE):	RNAV 1 and RNP 1: The PBN system lateral and along track total system error must be within +/-1 NM for at least 95% of the total flight time.
Flight Technical Error (FTE)	FTE relates to the air crew or autopilot's ability to follow the defined path or track, including any display error (e.g. CDI centring error). FTE can be monitored by the autopilot or air crew procedures. FTE only applies to the lateral cross track TSE. FTE is not to exceed 1/2 of the lateral TSE, in the case of RNAV 1 and RNP 1 the lateral FTE alert is 0.5 NM.
Navigation infrastructure supporting the navigation specification	New Zealand implementation of RNAV 1 and RNP 1 is based upon GNSS, specifically GPS. **Note:** *The RNAV 1 specification can be supported by DME/DME or DME/DME/Inertial, however this has not been implemented in New Zealand.*

Approach Operations

Applicable approach PBN Specifications:

- **RNP APCH**, currently published as charts titled RNAV (GNSS) RWY xx in NZFIR. Procedures may be published as charts titled RNP APCH in other States. Provides approach procedures to:
    - Lateral navigation (LNAV) minima without approved vertical guidance.
    - Lateral and Vertical navigation (LNAV/VNAV) minima. SBAS vertical guidance and Baro-VNAV systems support these approaches.

      Note: *New Zealand does not have a Satellite Based Augmentation System (SBAS) service area, this* ***limits VNAV operations in NZ to aircraft with certified Baro-VNAV systems*** *and suitably qualified pilots.*

      Note: *Aircraft with* ***advisory*** *vertical navigation systems* ***cannot*** *be used to conduct LNAV/VNAV approaches to LNAV/VNAV minima. Advisory vertical navigation systems may be used to conduct approaches to LNAV minima only. The pilot remains responsible for adherence to minimum procedure altitudes.*
    - Localiser Performance (LP) and Localiser Performance with Vertical guidance (LPV) requires SBAS coverage and is therefore not implemented in NZ FIR.
- **RNP AR APCH** (Authorisation Required), currently published as charts titled RNAV (RNP) RWY xx, and procedures include a statement "for operators with CAANZ RNP-AR approvals only" or "for approved operators only". These are specific authorisation approvals granted to operators and can include specific operating procedures, special crew training and approach minima.

Note: *despite the published chart titles there are no RNAV approach specifications, i.e. all PBN approaches require onboard monitoring and alerting.*

A summary of PBN application and performance for approach operations is provided in Table 3.

Table 4: RNP APCH Application and Performance Summary

Purpose	RNP APCH supports lateral navigation (LNAV) along straight segments of the approach and missed approach. The missed approach can be predicated on GNSS (GPS) or conventional navigation aids. In addition to LNAV, Vertical navigation (VNAV) can be included in the final approach segment, based upon a certified Baro-VNAV system. **Note:** *RNP APCH requires on board performance monitoring and alerting, which is achieved by means of RAIM for NSE, the FTE monitoring is the pilot's responsibility.*
Surveillance Environment	RNP APCH does not have specific requirements for surveillance, adequate obstacle clearance is achieved through aircraft performance and operating procedures.
Communications Environment	RNP APCH does not have specific requirements for communications, this is determined by complexity and density of the operating environment.
Applicable ICAO Specification:	RNP APCH: ICAO PBN Doc 9613 Volume II, Part B, Chapter 5, Section A Barometric VNAV (Baro VNAV): ICAO PBN Doc 9613 Volume II, Attachment A
Total System Error (TSE):	RNP APCH For the initial and intermediate segments of the approach and missed approach segment the lateral and along track total system error must be within +/-1 NM for at least 95% of the total flight time. For the final approach segment down to LNAV or LNAV/VNAV minima the lateral and along track total system error must be within +/-0.3 NM for at least 95% of the total flight time.
Flight Technical Error (FTE)	FTE relates to the air crew or autopilot's ability to follow the defined path or track, including any display error (e.g. CDI centring error). FTE can be monitored by the autopilot or air crew procedures. FTE only applies to the lateral cross track TSE. For the initial and intermediate segments of the approach and missed approach segment, lateral FTE alert is 0.5 NM. For the final approach segment the lateral FTE alert is 0.25 NM. If a certified Baro-VNAV system supports LNAV/VNAV the pilot must monitor vertical deviation from the vertical defined path and take action if deviation exceeds +/- 75 ft (+/- 22 m) (FAS only).
Navigation infrastructure supporting the navigation specification	RNP APCH (LNAV) based upon GNSS, using GPS. RNP APCH (LNAV/VNAV) based upon aircraft certified Baro-VNAV system. Missed approach can be based upon GNSS (GPS) or a conventional navigation aid.

6. Operational approval process

Operational Approval Process overview

PBN Operational Approval by the Director may be granted when the operator has demonstrated compliance with the relevant airworthiness, continued airworthiness, and flight operations requirements. The navigation specifications provided, or referenced, in this advisory circular provide a basis for this approval.

Where appropriate, operators may refer to previous operational approvals in order to expedite the approval process where airworthiness, continued airworthiness or flight operations requirements are applicable to the current request for operational approval.

The approval process consists of the following phases:

1. **Pre-application:** the CAA holds a meeting with the applicant or operator (pre-application meeting) in which it is informed of all the requirements it must meet during the approval process.

2. **Application:** the applicant or operator submits a formal application, accompanied by all the relevant documentation required as supporting evidence, as established below.

3. **Assessment:** the CAA assesses the documentation and the navigation system to determine their admissibility and what approval method is to be applied with respect to the aircraft. As a result of this analysis and assessment, the CAA may accept or reject the formal application together with the documentation.

4. **Demonstration:** the operator will provide training to its personnel and conduct the validation flights, if so required.

5. **Approval:** the CAA issues the PBN operational approval once the operator has met the approval and operational requirements. For Part 119 operators, the CAA will issue/amend Operator Specifications (Ops Specs), and for operators under Part 91, CAA will issue/amend a Letter of Operational Approval (LOA).

Pre-application

A pre-application meeting is recommended for Part 119 operators, applicants that are seeking operational approval for the first time, where demonstration of proposed operations to the CAA is likely, or where applicants that have limited experience in the operations being sought.

The primary purpose of this meeting is to establish what the challenges and risks are to the operator and regulator in this approval process, and to mitigate as much risk from the approval process through open dialogue.

Non-complex or follow-on operational approvals (e.g. adding another aircraft of the same type and configuration to the existing fleet, Part 91 private operator approval of non-complex types, etc.) may not require a pre-application meeting.

Complex assessments, flight evaluations and implementation of new specifications (e.g. RNP AR APCH, A-RNP and RNP 0.3(H)) are likely to require pre-application meetings to agree on approval requirements.

Application

An applicant will be required to seek operational approval and submission of the associated compliance data. The application should include at least the following:

Form CAA091-10: for Part 91 Operators /
Form CAA 24091/07: for Part 119 Operators
This application form should be completed and identify the applicant/applicant organisation, operational approvals being sought, reference aircraft and equipment details, aircraft documentation, continued airworthiness organisation/practices/procedures etc., operational training/competency, applicable organisation exposition/operating procedure and the applicant's declaration.

The application form prompts submission of the following supporting documentation:

Aircraft Eligibility:

The applicant may submit these documents in support of how to operate the system, determine limitations or as evidence of compliance of the system to the navigation specifications for which operational approval is sought:

Form CAA 2129
This document forms the basis for assessing the aircraft and systems configuration at the time of application and lists all navigation, air data, surveillance and communication equipment installed on the aircraft and identified the Level associated with the equipment. (Refer to AC43-10 regarding Form CAA 2129)

AFM/AFMS/FCOM/SB/SL
These documents form the basis for assessing the aircraft and systems airworthiness approval and PBN capability. The statements therein form the basis of aircraft and equipment eligibility for the PBN operations to be approved.

Operators must provide evidence that the aircraft and systems are eligible for the navigation specification sought, and evidence that the instruments and equipment comply with the airworthiness CNS requirements. This may be in the form of compliance statements within the Aircraft Flight Manual (AFM), AFM Supplements (AFMS) or Original Equipment Manufacturer (OEM) statements of compliance. Aircraft with existing installations may not have a statement of compliance relating directly to the navigation specification. Guidance about these cases is given in the legacy aircraft information in the relating navigation specification appendix. The aircraft instrument and equipment requirements must comply with rule 91.501(2)(ii)(A) and rule 91.519, as well as any air operator certification instrument and equipment requirements (e.g. CAR 121.353, 125.353, 135.353).

Note: *The design approval holder will demonstrate compliance, and the approval will be documented in manufacturer documentation. Such documentation usually indicates that the aircraft and equipment meet the technical requirements of this element.*

Continued Airworthiness:

Maintenance Programme
The applicant must submit a maintenance programme including procedures for the test and inspection of each instrument, system and item of equipment required by rule 91.519 for RNP operations. The procedures should also specify the intervals at which the testing and inspection of the instrument and item are carried out to ensure that the RNP performance required for the particular operation is maintained. (Refer to 91.246(e)(4)(i)).

Minimum Equipment List
The applicant should submit an amended MEL, or MEL to be approved, in accordance with rule 91.539, and requirements defined in Section 8 of this AC for the operations being conducted. If there is no change required to an existing CAA-approved MEL, this should be noted in the application. PBN provisions must be included in the MEL approved by the CAA.

The operator must demonstrate that the navigation system will be maintained compliant with the type design. There are a few additional continued airworthiness requirements, relative to traditional navigation systems, for PBN system installations, including database and configuration management, systems modifications and software revision control.

The operator must submit continuing airworthiness instructions for the aircraft configuration, including a reliability program for monitoring equipment. The operator must have a means to verify and accept subsequent changes or service bulletins to the aircraft ensuring they do not invalidate the operational approval.

Note: *If the aircraft was delivered by the aircraft manufacturer with PBN capability the maintenance requirements may already exist in the maintenance schedule and/or instructions for continued airworthiness.*

Operator Procedures:

For Part 91 operators - the AFM/POH may contain sufficient information to address the requirements of 91.246, if not, the NSS SOP guidance material may be useful for development of a SOP to meet the requirements (https://www.nss.govt.nz/dmsdocument/67-pbn-standard-operating-procedures-guidance-material-with-additional-guidance).

Note: *a PBN Procedures Manual for Part 91 operators is only required for operations in exclusively RNP designated airspace (i.e. Auckland Oceanic FIR in NZ per the AIP).*

For Part 119 operators –

PBN Procedures Manual
This document shall address all requirements of rule 91.246(e) and Section 9. Operational Considerations of this AC.

Standard Operating Procedures
The applicant may produce a Procedures Manual as defined above, or include the requirements of rule 91.246(e) and Section 9. Operational Considerations of this advisory circular in the organisations standard operating procedures or exposition.

These procedures must be documented in a PBN manual (as applicable), or as part of the operator's exposition in the case of operations being conducted under Part 119. The operator must have procedures in place to ensure crews comply with the requirements of rules 91.409(b), 121.169, 125.165, and 135.165.

For RNP operations in RNP designated airspace (i.e. Auckland Oceanic FIR) the documented procedures must include, as a minimum, the information required under Rule 91.246(e). The general requirements of Rule 91.246(e) also provide a basis for operator procedures for PBN operations in non-oceanic/remote airspace.

Training and Qualification:

Training Programme
The applicant should submit the training syllabus implemented for the relevant Navigation Specifications.

Qualifications
The applicant should submit the documentation to demonstrate the flight crew are qualified for the relevant Navigation Specifications.

Pilots operating under Part 91 who meet the standards specified in Section 10. Pilot Knowledge and Training (referring to AC 61-17) will require a logbook endorsement for each operation (i.e. navigation specification) and equipment type approved.

Pilots operating under a Part 119 certificated organisation shall be trained, assessed and authorised by that organisation in accordance with their exposition for each operation (i.e. navigation specification) on the specific aircraft type.

Assessment

Upon receipt of the application and associated compliance documentation the CAA will review the data pack content and advise the applicant of any missing data.

Incomplete applications will not be processed until all data is submitted, following which an assessment will be carried out by flight operations and airworthiness staff.

The CAA Operational Approval is assessed based upon the following elements:

Aircraft Eligibility:

Refer to Section 7 Aircraft Eligibility for further detail on these requirements.

Refer to the Aircraft and Systems Eligibility sections of the navigation specifications (Appendix I through XIII) being sought for specific criteria.

Continued Airworthiness:

Refer to Section 8 Continued Airworthiness for further detail on these requirements.

Operational Considerations:

Refer to Section 9 Operational Considerations for further clarity on these requirements.

Pilot Knowledge and Training:

Refer to Section 10. Pilot Knowledge and Training for further details on these requirements.

Human Factors:

There are a number of human factors issues associated with the transition to PBN that can present hazards. Care must be taken in the installation of the equipment, the design and charting of the procedures, the use of navigation databases, and the operational practices developed to minimise the risks.

The use of autopilots is recommended as a means of minimising tracking errors, particularly where the accuracy requirement is more stringent, or if the procedures are complex or have vertical and/or speed constraints (e.g. RNP 0.3(H)).

Aircraft that have been modified by installing new navigation or display systems will be assessed from a human factors perspective, considering the crew's ability to use the systems and carry out their duties independently and as a crew (e.g. Pilot Flying and Pilot Monitoring roles).

Where human factors and ergonomic concerns are raised from the assessment stage, the assessor will seek further advice from the CAA subject matter experts. Such assessment may require evaluation of the impact on crew situational awareness, workload management and fatigue. It is important to note that even if the installation has an airworthiness approval, if there are adverse human factors or ergonomic issues then the PBN operational approvals could be subjected to operational limitations.

Navigation Specifications:

The submitted data is assessed against the technical and operational requirements of the navigation specifications for the operational approvals requested. The specific technical and operational criteria for each navigation specification are included in the following Appendices:

i. Appendix I – RNAV 10 (RNP 10) Technical and Operational Criteria
ii. Appendix II – RNP 4 Technical and Operational Criteria
iii. Appendix III – RNAV 5 (BRNAV) Technical and Operational Criteria
iv. Appendix IV – RNAV 1 and RNAV 2 Technical and Operational Criteria
v. Appendix V – RNP 2 Technical and Operational Criteria
vi. Appendix VI – RNP 1 Technical and Operational Criteria
vii. Appendix VII – A-RNP (Advanced-RNP) Technical and Operational Criteria
viii. Appendix VIII - RNP APCH (LNAV and LNAV/VNAV) Technical and Operational Criteria
ix. Appendix IX – RNP APCH (LP and LPV minima) Technical and Operational Criteria
x. Appendix X – RNP AR APCH Technical and Operational Criteria
xi. Appendix XI – RNP 0.3(H) Technical and Operational Criteria
xii. Appendix XII – Baro-VNAV Technical and Operational Criteria
xiii. Appendix XIII – RF Legs Technical and Operational Criteria

It should be noted that the navigation specifications do not necessarily imply a need for recertification to the technical and operational criteria. Technical data approved by another State that meet the technical requirements of this AC are generally accepted by the CAA without the need for re-approval (e.g. aircraft with a AFM stating compliance of the RNP 1 navigation system installed that complies with the airworthiness requirements of Appendix VI does not require a CAANZ airworthiness approval, but the local operator's procedures may require CAANZ assessment).

Any non-compliance will be identified to the applicant; it may be necessary for the applicant to contact the OEM or Part 146 design organisation for further evidence or demonstration of compliance.

Demonstration

If considered necessary, the CAA may require an inspection and/or flight evaluation to confirm function and performance requirements are satisfied. Operational procedures may also require demonstration for flight evaluation prior to certification of those operator procedures (e.g. RNP AR APCH).

Issue of Operational Approval

Where an applicant is successful the following will be issued by the CAA:

1. **Operational Approval document –**

    a. **Operational Specifications:** In the case of Part 119 operators, stating the PBN operational approvals granted, and any associated limitations or conditions, or

    b. **Letter of Operational Approval:** In the case of Part 91 operators, stating the PBN operational approval levels granted, and any associated limitations or conditions,

    and,

2. **Endorse CAA Form 2129** issued stating aircraft and system eligibility with any associated limitations or conditions e.g. RNAV1, RNP APCH to LNAV minima only, etc.

7. Aircraft Eligibility

Aircraft-level airworthiness compliance

The PBN specifications for which the aircraft complies with the relevant airworthiness criteria are usually stated in the AFM, together with any limitations to be observed.

Where such a reference cannot be found in the AFM, other information provided by the aircraft manufacturer as TC holder, the STC holder or the design organisation that approved the design changes may be considered.

The following documents are considered acceptable sources of information:

i. AFM, supplements thereto, and documents directly referenced in the AFM;
ii. FCOM or similar document;
iii. Service Bulletin or Service Letter issued by the TC holder or STC holder;
iv. approved design data or data issued in support of a design change approval;
v. any other formal document issued by the TC or STC holders stating compliance with PBN specifications, AMC, Advisory Circulars (AC) or similar documents issued by the State of Design; and
vi. written evidence obtained from the State of Design.

Since functional and performance requirements are defined for each navigation specification, an aircraft/system approved for an RNP specification is not automatically approved for all RNAV specifications. Similarly, an aircraft/system approved for an RNP or RNAV specification having a stringent accuracy requirement (e.g. RNP 0.3 specification) is not automatically approved for a navigation specification having a less stringent accuracy requirement (e.g. RNP 4).

In all cases, the limitations in the AFM need to be checked; in particular, the use of AP or FD which can be required to reduce the FTE primarily for RNP APCH, RNAV 1, and RNP 1.

As some PBN equipment and installations may have been certified prior to the publication of the ICAO PBN Manual and the adoption of its terminology for the navigation specifications, it is not always possible to find a clear statement of aircraft PBN capability in the AFM. However, aircraft eligibility for certain PBN specifications can rely on the aircraft performance certified for PBN procedures and routes prior to the publication of the ICAO PBN Manual.

Various references are listed in the Appendixes which may be found in the AFM or other acceptable documents (see listing above) in order to consider the aircraft's eligibility for a specific PBN specification if the specific term is not used.

System-level airworthiness compliance

Equipment qualification data (e.g. TSO-Cxxx approval), in itself, is not sufficient to assess the PBN capabilities of the aircraft, since the latter depends on installation, integration and aircraft-level performance. Nevertheless, the equipment/system eligibility for each navigation specification is presented in the relevant Appendices to this AC. Qualified equipment would require installation and integration airworthiness approval under Part 21 processes (e.g. STC or design change installed in accordance with FAA AC20-138D), which is beyond the scope of this AC and is not part of the operational approval process.

The system-level compliance is assessed by considering each of the CNS elements of the navigation specification, namely the equipment requirements for the navigation, communication and surveillance instrument and equipment requirements.

Navigation equipment: refer to the System Requirements within the Appendices for each navigation specification for a breakdown of the navigation equipment technical and performance requirements.

For RNP 4, at least two LRNSs, capable of navigating to RNP 4, and listed in the AFM, may be operational at the entry point of the RNP 4 airspace. If an item of equipment required for RNP 4 operations is unserviceable, then the flight crew may consider an alternate route or diversion for repairs. For multi-sensor systems, the AFM may permit entry if one GNSS sensor is lost after departure, provided one GNSS and one inertial sensor remain available.

Communication equipment: refer to the Appendix – summary

Surveillance equipment: refer to the Appendix summary

Table 5 provides an overview of the types of equipment and service that can be used to achieve compliance with the navigation specification itself. The table does not reflect operational equipment requirements under the various CARs that may apply to the operation.

Table 5 Equipment requirement per Nav Spec.

Navigation Specification	NAV	COM	Surveillance
RNAV 10	2x INS 2x GNSS INS + GNSS	HF	Periodic Pilot Position Reports (PPR)
RNP 4	2x GNSS INS + GNSS	Data link (CPDLC) HF	ADS-C 14-min PPR
RNAV 5	GNSS (VOR/DME) (DME/DME) (INS) (DME/DME/IRU)	HF VHF	No
RNP 2	GNSS (2x GNSS – Oceanic/remote)	VHF Data Link (Oceanic/remote)	No ADS-C (Oceanic/remote)
RNAV 1	GNSS (DME/DME) (DME/DME/IRU)	VHF	Yes
RNAV 2	GNSS (DME/DME) (DME/DME/IRU)	VHF	Yes

A-RNP	GNSS	VHF	Yes
RNP 1	GNSS	VHF	No
RNP APCH (LNAV & LNAV/VNAV)	GNSS (& OPMA - RAIM)		
RNP APCH (LP & LPV)	GNSS (& SBAS service)		
RNP 0.3(H)	GNSS (& OPMA)	VHF	No

Note: *GNSS receivers with approved fault detection exclusion (FDE) functionality provide capability to exclude satellite vehicle integrity failures and continue to provide a navigation solution. Those GNSS receivers without FDE (most TSO-C129()[1] receivers) will not provide a navigation solution upon a single satellite vehicle integrity failure; the aircraft systems will need to be assessed for particular risk analysis relating to satellite vehicle integrity failures.*

[1] The () symbol means the basic version plus any later versions a, b etc.

8. Continued Airworthiness Considerations

To comply with the rule requirements in 91.246 and 91.519 the operator must have procedures to ensure continued airworthiness for the equipment required per the appropriate navigation specification.

Aircraft where the equipment was fitted by the OEM may meet most of these requirements by the OEM specified maintenance program for the aircraft. Aircraft that have alterations to or introducing the required equipment must include the Instructions for Continued Airworthiness into their maintenance program.

It must be noted and addressed by the operator that electronic navigation data and equipment software form part of the continued airworthiness requirements. Appropriate procedures must be included to ensure there is valid navigation data to carry out the operation per the appropriate navigation specification. The operator must also control the equipment software and its configuration to ensure they are valid and appropriate for the equipment installation the PBN approval is based on. Refer to *AC91-18 Aircraft Software Configuration Management.*

Additionally, the operator must assess the impact and effect design changes (modification, service bulletins, etc.) may have on the operational approvals of the aircraft.

When operating in RNP designated airspace the maintenance record must be maintained to include the details of each discontinued RNP operation. (91.246(e)(4)(ii)).

Minimum Equipment List

To ensure PBN operations are carried out per the applicable navigation specification the operator MEL should reflect the PBN operational equipment requirements. This requirement is in line with ICAO Annex 6 Part 1, section 7.2 "*For all operations where a navigation specification for performance-based navigation (PBN) has been prescribed, an aeroplane shall […] have information relevant to the aeroplane navigation specification capabilities included in the MEL.*" As operational approval is granted by the state of registry this includes state of registry instrument and equipment requirements as covered in subpart F of Part 91, 121, 125 and/or 135.

Rules 121.353, 125.353, and 135.353 (a)(1)(iii) state: "*Except as provided in paragraph (b), a holder of an air operator certificate must ensure that an air transport operation does not commence unless [...] the aeroplane is equipped with [...] the number of instruments and equipment to ensure that the failure of any independent system required for either communication or navigation purposes, or both, does not result in the inability to communicate and navigate safely as required for the route being flown.*"

As PBN relies on containment within the specified boundaries of the track to be able to navigate safely along the route being flown implies that the equipment on which the specification is operated at dispatch of the aircraft is in such a number that any independent failure does not result in the inability to carry on navigating in the PBN boundary. This applies to the entire navigation system, as in receiver/transceiver, CDI, as well as any means of navigation source switching in case of single pilot operation.

As stated in this AC RNP operation puts in place a requirement for an RNP manual. Operators developing an MEL and RNP manual must ensure that the MEL remains the dispatching document. Any requirements for RNP operations in the RNP manual must be included (usually in the form of limitations to the operation) in the MEL.

To aid the development of a suitable MEL operators can refer to the table 6 in section 7 of this AC which provides a simple outline of the Navigation, Communication and Surveillance requirements in this AC. Part 91 operators need to provide for the equipment required for the desired navigation specification (refer to the relevant appendix for more detail), Part 119 operators need to provide for

the equipment required for the desired navigation specification in such a number that they can comply with 121.353, 125.353 and/or 135.353.

The following table gives an example of the minimum required equipment consolidating both the navigation specification as well and operational requirements for the most common PBN navigation specifications. The table only shows as it relates to the navigation specification and omits additional equipment. It does not relieve the operator from minimum equipment required by rules and operational requirements that exist outside the navigation specification requirements.

Table 6 Example Consolidated MEL

Navigation Specification	Part 91 Operation	Operation under Part 119 certification
RNAV 1 / RNAV 2	Qty 1 GNSS Qty 1 Alternate non-GNSS means of navigation external to GNSS LRU Qty 1 Transponder Qty 1 VHF Com	Qty 2 GNSS Qty 2 Alternate non-GNSS means of navigation Qty 2 Transponder Qty 2 VHF Com
RNP 1	Qty 1 GNSS Qty 1 Alternate non-GNSS means of navigation external to GNSS LRU* Qty 1 VHF Com	Qty 2 GNSS Qty 2 Alternate non-GNSS means of navigation Qty 2 VHF Com
RNP 2 (En-route continental)	Qty 1 GNSS Qty 1 Alternate non-GNSS means of navigation external to GNSS LRU* Qty 1 VHF Com	Qty 2 GNSS Qty 2 Alternate non-GNSS means of navigation Qty 2 VHF Com
RNP 2 (remote / Oceanic)	Qty 2 GNSS Qty 1 Alternate non-GNSS means of navigation Qty 1 VHF Com Qty 1 Level 1 Long range com	Qty 2 GNSS Qty 2 Alternate non-GNSS means of navigation Qty 2 VHF Com Qrt 2 Level 1 long range com
RNP APCH	Qty 1 GNSS Qty 1 Alternate non-GNSS means of navigation external to GNSS LRU* Qty 1 VHF Com	Qty 2 GNSS Qty 2 Alternate non-GNSS means of navigation Qty 2 VHF Com

*Many GNSS systems also include VHF Nav and VHF Com solutions within the same LRU. When this is the case this unit cannot be counted as the Alternate means of navigation as it would be lost on unit failure.

9. Operational Considerations

Airworthiness certification alone does not authorise an operator to conduct a PBN operation. Operational approval is also required to confirm the adequacy of the operator's normal and contingency procedures for the particular equipment installation.

The application and operator approval process is described in section 6 of this AC.

Part 91 Operators:

The application shall include a copy of the operations manual/standard operating procedures required by rule 91.246(a) through (f).

The following must be included:

(a) The operating procedures for the equipment to be used, including:

- Selection and checking of SIDs, routes, STARs, and approaches from the navigation database.
- Selection of the aerodrome of departure prior to take off to ensure a RNP 1 alert capability during departures.
- The actions to be taken in the event of inability to maintain PBN standards in flight due to RAIM outage, system malfunction, or intentional or unintentional interference.

(b) Control of the navigation database process.

(c) Pre-flight planning including RAIM prediction if appropriate, and contingency planning for loss of GNSS navigation capability (fuel, extraction and diversion considerations).

(d) Management of lateral deviation limits, RAIM limits and FTE.

(e) Management of an inflight loss of integrity, including ATC communication.

(f) The operator maintenance programme, procedures, and monitoring must satisfy the requirements of rule 91.246(e) for RNP operations and must include similar requirements for RNAV operations.

Operations in RNP Designated Airspace:

In addition to the details specified above, for RNP operations in RNP designated airspace (i.e. Auckland Oceanic FIR) the documented procedures must include, as a minimum, the information required under Rule 91.246(e).

The general requirements of Rule 91.246(e) also provide a good basis for operator procedures for PBN operations in non-oceanic/remote airspace.

Part 119 operators:

In addition to the above, Part 119 operators must include in their checklists/manuals the operational and training requirements defined in ICAO Doc 9613 as follows:

RNAV1/2:
Volume II, Part B, Chapter 3, 3.3.4 Operating Procedures

RNP2:
Volume II, Part C, Chapter 2, 2.3.4 Operating Procedures

RNP1:
Volume II, Part C, Chapter 3, 3.3.5 Operating Procedures

RNP APCH:
Volume II, Part C, Chapter 5, A.5.3.4 Operating Procedures

BARO VNAV:
Volume II, Attachment A, 4.16 Operating Procedures

Use of Aerodromes, Extraction and Recovery

Consideration must be given to contingencies in the event of degraded navigation performance at any point in the flight, but in particular, during a PBN instrument procedure (SID/STAR/IAP). The pilot-in-command must ensure there are sufficient means available to conduct an extraction procedure (if required), navigate to, and land at the destination aerodrome, or at an alternate aerodrome, in the case of loss of GNSS capability. The aircraft must be fuelled to allow for a loss of GNSS at any point in the flight.

The pilot-in-command may only select an alternate aerodrome if it is serviced by an instrument approach procedure that does not rely on GNSS. The aircraft must be equipped with fully operational navigation equipment capable of using the radio navigation aid on which the instrument approach is based, and the pilot(s) must meet applicable qualification and currency requirements.

For further guidance on Extraction and Recovery, see AC91-XXX.

Navigation database

The navigation database should be obtained from a supplier that complies with RTCA DO-200A/EUROCAE document ED-76, Standards for Processing Aeronautical Data, and the database must be compatible with the intended function of the equipment. An LOA (or other equivalent document) issued by the appropriate regulatory authority demonstrates compliance with this requirement (e.g. FAA LOA issued in accordance with FAA AC 20-153 or EASA LOA issued in accordance with EASA Opinion Nr. 01/2005).

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

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

Aircraft operators should consider the need to conduct ongoing checks of the operational navigation databases in order to meet existing quality system requirements.

RNP APCH operations are critically dependent on valid data.

Oversight of operators

Operators are responsible for monitoring their operation to ensure compliance with requirements and achievement of safety standards. This requires robust reporting of deviations and occurrences by crew members, and appropriate investigation and response by operators. For RNP operations, operators must monitor navigation performance and record deviations in accordance with rule 91.246. In the case of RNAV operations, operators are also encouraged to conduct navigation performance monitoring and report deviations to promote system safety.

The CAA will also conduct ongoing monitoring of operators to ensure compliance and safety. This will include auditing of operators systems and observation of flights. In the case of deviations, deficiencies or occurrences pertaining to operational approvals specified in this AC, the CAA will monitor to ensure the operator is taking appropriate corrective and preventative action.

It is in the interest of all stakeholders that good communication of safety issues takes place to improve the system and avoid serious occurrences.

10. Pilot Knowledge and Training

Pilot training and qualification requirements for RNAV and RNP are detailed in:

- Rule part 61, Subpart Q Instrument ratings;
- Rule 91.246(a)(4) Operations in RNP designated airspace;
- Rules 119.53 and 19.103 Personnel competency requirements;
- Rule part 121 subpart I training, and subpart J Crew Member Competency Requirements;
- Rule part 125 subpart I Training, and subpart J Crew Member Competency Requirements; and
- Rule part 135 subpart I Training, and subpart J Crew Member Competency Requirements.

The applicant for operational approval must demonstrate that they have systems in place to ensure that pilots are appropriately trained in accordance with the applicable rule requirements.

The route design and operational approval are tightly coupled to provide safety of the operation.

This advisory circular details the requirements for obtaining operational approval to conduct these operations.

Pilots may not perform any of the types of operation specified in this AC unless they have been trained and certificated in accordance with Appendix III to AC61-17.

For pilots within a Part 119 organisation, pilot competency is achieved through operator compliance with their training programme and adherence to the standard operating procedures specified in their exposition.

The PBN navigation specification outlined in this AC cover a wide range of operations, and training needs to be appropriate to the particular circumstances. Although ICAO Doc 9613 includes guidance for flight crew training for the published navigation specifications the guidance is not consistent in detail and scope across the range of specifications. The amount and type of training required will vary significantly upon a number of factors including:

1. previous training and experience;
2. complexity of operations;
3. aircraft equipment.

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

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

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.

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.

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.

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

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.

Contingency procedures. Knowledge to apply contingency considerations that are appropriate to the operation, including extraction procedures and consideration of loss of GNSS at the flight planning stage. For further information, refer to AC91-XX Extraction and Recovery.

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

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.

Appendix I – RNAV 10 (RNP 10) Technical and Operational Criteria

[Reserved]

Refer to AC91-7.

Appendix II – RNP 4 Technical and Operational Criteria

[Reserved]

Refer to AC91-10.

Appendix III – RNAV 5 (BRNAV) Technical and Operational Criteria

[Reserved]

Refer to AC91-8.

Appendix IV – RNAV 1 and RNAV 2 Technical and Operational Criteria

Purpose

This specification is the result of the harmonization of European and United States RNAV criteria into a single ICAO RNAV 1 and 2 specification.

This appendix provides guidance to operators seeking RNAV 1 and/or RNAV 2 approval, and references to the applicable guidance material that supports the implementation of RNAV 1 and RNAV 2.

For existing systems, compliance with both P-RNAV (TGL-10) and U.S. RNAV (FAA AC 90-100) assures automatic compliance with this specification. Operators with compliance to only TGL-10 or AC 90-100 should refer to the legacy aircraft section in this appendix to confirm whether their system gives automatic compliance to this specification.

Implementation in New Zealand

This navigation specification is currently implemented on ATS routes in NZ FIR.

Applicable Specification

The content of this appendix is based on the ICAO PBN Manual, Doc 9613, Volume II, Part B, Chapter 3.

The content of the specification has been split into airworthiness requirements and operational requirements.

The airworthiness requirements may be used the operator to determine the eligibility of the aircraft and the systems for the navigation specification, and to establish what documentation to provide to the CAA as evidence of the aircraft and the system eligibility. The responsibility for airworthiness approval/certification of the aircraft and systems to these airworthiness requirements in the OEM and State of Design/Manufacture

Airworthiness Requirements

For airworthiness and installation considerations of equipment for RNAV 1 and/or RNAV 2 eligible operations, an acceptable specification is FAA AC20-138D Change 2 or later revision.

Communications environment

RNAV 1 and RNAV 2 operations are expected to be conducted in a communication environment with direct controller pilot communication (DCPC).

Surveillance environment

The RNAV 1 and 2 specification is primarily developed for RNAV operations in a surveillance environment (for SIDs, radar coverage is expected prior to the first RNAV course change). The RNP specifications are intended for similar operations outside surveillance coverage. However, RNAV 1 and RNAV 2 may be used in a non-surveillance environment or below minimum vectoring altitude if appropriate system safety is ensured and lack of on-board performance monitoring and alerting is accounted for by the ANSP.

Navaid infrastructure considerations

The RNAV 1 and RNAV 2 navigation specification is based on the following navigation criteria: GNSS, DME/DME and DME/DME/IRU. Where DME is the only navigation service used for

position updates, gaps in DME coverage can prevent position update. Integration of IRUs can permit extended gaps in coverage[2].

Note: *Most modern RNAV systems prioritize input from GNSS and then DME/DME positioning. Although VOR/DME positioning is usually performed within a flight management computer when DME/DME positioning criteria cannot be met, avionics and infrastructure variability pose serious challenges to standardization. Therefore, the criteria in this document only cover GNSS, DME/DME and DME/DME/IRU. This does not preclude the conduct of operations by systems that also use VOR provided they satisfy the criteria in in this appendix.*

SBAS

RNAV 1 and RNAV 2 are not dependent on the availability of SBAS service.

Navigation systems eligibility

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

1) GNSS in accordance equipment complying with the criteria listed in paragraph 6-3 of FAA AC20-138D Change 2 or later revision;

2) DME/DME RNAV equipment complying with the criteria listed in paragraph 6-4 of FAA AC20-138D Change 2 or later revision;

3) DME/DME/IRU RNAV equipment complying with the criteria listed in paragraph 6-8 of FAA AC20-138D Change 2 or later revision.

Legacy Aircraft

If a statement of compliance with any of the following specifications or standards is found in the acceptable documentation, the aircraft is eligible for RNAV 1/RNAV 2 operations:

1) RNAV 1;
2) P-RNAV;
3) US RNAV type A;
4) FAA AC 20-138 for the appropriate navigation specification;
5) FAA AC 90-100A;

Alternatively, if a statement of compliance with any of the following specifications or standards is found in the acceptable documentation as listed above and position determination is primarily based on GNSS, the aircraft is eligible for RNAV 1/RNAV 2 operations:

1) JAA TEMPORARY GUIDANCE MATERIAL, LEAFLET NO. 10 (TGL 10) (any revision); **AND**
2) FAA AC 90-100 (TSO-C129 equipment must have pseudo-range step detector and health word checking).

If a statement of compliance is found to either one of these two specifications only the following has to be verified:

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[2] If an IRU is not carried, then the aircraft can revert to dead reckoning. In such cases, additional protection, in accordance with PANS-OPS (ICAO Doc 8168, Volume II), will be needed to cater for the increased error. GNSS should be authorized whenever possible and limitations on the use of specific system elements should be avoided.

1) TGL-10
    a. TGL-10 allows for DME/VOR area navigation approvals based on TGL-10 must be based on GNSS, DME/DME or DME/DME/IRU. However, DME/VOR input does not have to be inhibited or deselected. (If position determination is exclusively computed based on VOR-DME, the aircraft is not eligible for RNAV 1/RNAV 2 operations).
    b. The DME/DME and/or DME/DME/IRU performance must meet the associated navigation service criteria as listed under navigation system eligibility of this appendix.
    c. For DME/DME TGL-10 approvals the RNAV guidance on RNAV SID must be available no later than 500ft above field elevation.
2) AC 90-100
    a. GPS pseudo-range step detector and GPS health word checking is required in accordance with ATS route.

Preflight planning

Operators and pilots intending to conduct operations on RNAV1/RNAV2 routes must file the appropriate flight plan suffixes.

The on-board navigation data must be current and include appropriate procedures.

Note: *Navigation databases are expected to be current for the duration of the flight. If the database cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy and suitability of the navigation data. Inflight change of the active database is not recommended and often prohibited by system design.*

The operator must confirm the availability of the NAVAID infrastructure, required for the intended routes, including those for use in a non-GNSS contingency, for the period of intended operations using all available information.

Contingency procedures

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

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

Pilot training

For pilot training requirement refer to section 10 of this AC.

MEL considerations

Any MEL revisions necessary to address RNAV 1 and/or RNAV 2 provisions must be approved. Operators must adjust the MEL, or equivalent, and specify the required dispatch conditions.

Continuing airworthiness

Operators must adhere to continued airworthiness instructions applicable to the aircraft configuration and the qualification for RNAV 1/RNAV 2 operation. The operator must also consider whether any future alterations to the aircraft or its configuration has an effect on the RNAV 1/RNAV 2 qualification.

On-board Performance Monitoring and Alerting

Accuracy

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

Integrity

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

Continuity

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

Signal-In-Space

During operations in airspace or on routes designated as RNAV 1 if using GNSS, the aircraft navigation equipment shall provide an alert if the probability of SIS errors causing a lateral position error greater than 2 NM exceeds 10^{-7} per hour. During operations in airspace or on routes designated as RNAV 2 if using GNSS, the aircraft navigation equipment shall provide an alert if the probability of SIS errors causing a lateral position error greater than 4 NM exceeds 10^{-7} per hour.

Note: *DME signals are considered to meet SIS accuracy tolerances where signals are received, regardless of the published coverage volume. Field strength below the minimum requirement, or where co-channel or adjacent channel interference may exist, are considered receiver errors.*

Functional Requirements

The functional requirements of the RNAV 1/RNAV 2 system as required by the Navigation specification, are met if a statement is provided in the relevant accepted documentation that the system is installed per AC 20-130A, AC 20-138(),or equivalent airworthiness installation advisory material.

If such a statement is not provided the installation has to be assessed to the functional requirements in FAA AC 20-138D change 2 (or later revision).

RNAV Systems Compatibility Compliance Table

The FAA has published AC 90-100 Compliance Tables document, this can be found at:

https://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afx/afs/afs400/afs410/media/AC90-100compliance.pdf

Table 7 - RNAV System Capability Compliance Table below has been derived from the FAA AC 90-100 Compliance Tables document.

Table 7 - RNAV System Capability Compliance Table

Manufacturer	System	Part Number	Software Version	Approval Using GPS	RNAV 2 Routes	RNAV 1 SID/STARS
Gulfstream G100	Universal UNS-1C	1017-3X-XXX and subsequent	600.X and subsequent	YES (TSO-115B and TSO-C129A Class A1/B1/C1). Must use Universal Flight Planning Program P/N K12037-6 to obtain predictive RAIM for route/procedure if one or more satellites is out of service.	YES	NO unless FMS software is 802.X or 803.X or higher
Gulfstream G100	Honeywell (Allied Signal) GNS-XLS	17960-XXXX-XXXX	ALL	See Honeywell GNS-XLS entry stating system ONLY approved for RNAV Q-routes and Obstacle Clearance Departure Procedures. NOT RNAV 1 and RNAV 2 SID/STAR procedures. PreFlight Software version 2.0 for IBM-compatible PCs running Microsoft Windows is available from Honeywell	Yes	No
Garmin	GPS 155, GPS 165, GNC 300	All	All	NO, TSO-C129 Class A1. Unable to automatically execute leg transitions and maintain tracks consistent with Course to Fix (CF) and Direct to Fix (DF) legs. No plans to obtain Type 2	Yes	No

Manufacturer	System	Part Number	Software Version	Approval Using GPS	RNAV 2 Routes	RNAV 1 SID/STARS
				LOA for navigation database.		
Garmin	GPS 155XL, GNC 300XL	All	All	NO, TSO-C129a Class A1. Unable to automatically execute leg transitions and maintain tracks consistent with Course to Fix (CF) and Direct to Fix (DF) legs. No plans to obtain Type 2 LOA for navigation database.	Yes	No
Originally II Morrow / UPSAT now doing business as Garmin AT	Apollo 2001 Apollo 2101System	All	All	NO, TSO-C129a but not compliant due to equipment limitation that prevents selection of named departure and/or arrival procedures. No plans to obtain Type 2 LOA for navigation database.	Yes	No
Originally II Morrow / UPSAT now doing business as Garmin AT	Apollo SL50 Apollo SL60 Apollo SL65	All	All	NO, TSO-C129a but not compliant due to equipment limitation that prevents selection of named departure and/or arrival procedures. No plans to obtain Type 2 LOA for navigation database.	Yes	No
Originally II Morrow / UPSAT now doing business as Garmin AT	Apollo GX50 Apollo GX60	All	All	NO, TSO-C129a but not compliant due to equipment limitation that prevents selection of named departure and/or arrival	Yes	No

Manufacturer	System	Part Number	Software Version	Approval Using GPS	RNAV 2 Routes	RNAV 1 SID/STARS
				procedures. No plans to obtain Type 2 LOA for navigation database.		
Originally II Morrow / UPSAT now doing business as Garmin AT	Apollo GX55 Apollo GX65	All	All	NO, TSO-C129a but not compliant due to equipment limitation that prevents selection of named departure and/or arrival procedures. No plans to obtain Type 2 LOA for navigation database.	Yes	No
Honeywell	GNS-XES	17450-0305-0X0X 17450-0307-0X0X 17450-0406-0X0X	All	Yes	Yes	No
Honeywell	CDU-XLS	CDU-XLS System CDU: 18420-0101-XXXX NMU: 14141-0624-XXXX	All	Yes	Yes	No
Honeywell	GNS-XLS	17960-0102-0XXX 17960-0203-0XXX	All	Yes	Yes	No
Honeywell	GNS-XL	18355-0101-XXXX	All	Yes	Yes	No
Honeywell	KLN-89B	066-01148-010X	All	Yes	Yes	No

Manufacturer	System	Part Number	Software Version	Approval Using GPS	RNAV 2 Routes	RNAV 1 SID/STARS
Honeywell	KLN-90A	066-04031-0X11	All	Yes	Yes	No
Honeywell	KLN-90B	066-04031-XX2X	All	Yes	Yes	No
Honeywell	KLN-94	069-01034-XXXX	All	Yes	Yes	No
Honeywell	KLN-900	066-04034-XXXX	All	Yes	Yes	No
Universal Avionics Systems Corporation	UNS-1C	1017-3X-XXXX	705.X	Yes	Yes	No
Universal Avionics Systems Corporation	UNS-1C	1017-4X-XXXX	600.X	Yes	Yes	No
Universal Avionics Systems Corporation	UNS-1Csp	1019-3X-XXXX	700.x	Yes	Yes	No
Universal Avionics Systems Corporation	UNS-1Csp	1019-4X-XXXX	600.X	Yes	Yes	No
Universal Avionics Systems Corporation	UNS-1D	1192-0X-XXX1XX	600.X	Yes	Yes	No
Universal Avionics Systems Corporation	UNS-1D	1192-3X-XXX1XX	700.X	Yes	Yes	No

Appendix V – RNP 2 Technical and Operational Criteria

Purpose

This appendix may be used for RNP 2 operations for a diverse set of en-route applications with little or no ground NAVAID infrastructure, limited or no ATS surveillance, and low to medium density traffic.

This navigation specification provides guidance to operators seeking RNP 2 approval and is applicable to oceanic, continental and in airspace considered to be remote. RNP 2 operation in oceanic or remote airspace may require additional considerations for aircraft eligibility based on suitable landing airports, continuous communication, or support of reversion to an alternate means of navigation.

RNP 2 can be associated with Fixed Radius Transitions (FRTs).

Implementation In New Zealand

This navigation specification is currently implemented on ATS routes in NZ FIR.

Applicable Specification

The content of this appendix is based on the ICAO PBN Manual, Doc 9613, Volume II, Part C, Chapter 2.

The content of the specification has been split into airworthiness requirements and operational requirements.

The airworthiness requirements may be used the operator to determine the eligibility of the aircraft and the systems for the navigation specification, and to establish what documentation to provide to the CAA as evidence of the aircraft and the system eligibility. The responsibility for airworthiness approval/certification of the aircraft and systems to these airworthiness requirements in the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness and installation considerations of equipment for RNP 2 eligible operations, an acceptable specification is FAA AC20-138D Change 2 or later revision.

Communications environment

Communication performance on RNP 2 routes will commensurate with operational considerations such as route spacing, traffic density, complexity and contingency procedures. To ensure availability of continuous two way communication with ATS the aircraft must have suitable long range communication equipment for oceanic and remote continental operations.

Surveillance environment

This navigation specification is primarily intended for environments where ATS surveillance is either not available or limited.

Navaid infrastructure considerations

The RNP 2 specification is based on GNSS.

Aircraft must have dual, independent LRNS for oceanic and remote area RNP 2 operations.

For continental en-route RNP 2 operations, the operator may revert to an alternate navigation system to navigate to, and safely land at, a suitable airport.

Note: *This consideration does not relief operators from the requirements of Rules 135.353, 125.353, and 121.353.*

SBAS

RNP 2 is not dependent on the availability of SBAS service.

Navigation systems eligibility

The following systems meet the accuracy, integrity and continuity requirements for RNP 2.

1. Aircraft with E/TSO-C129a sensor (Class B or C), E/TSO-C145() and the requirements of E/TSO-C115b FMS, installed for IFR use in accordance with FAA AC 20-130A or AC 20-138C (or later revision);

2. Aircraft with E/TSO-C129aClass A1 or E/TSO-C146() equipment installed for IFR use in accordance with FAA AC 20-138A (or later revision).

Legacy Aircraft

RNP 2 continental:

If a statement of compliance with any of the following specifications or standards is found in the acceptable documentation as listed above, the aircraft is eligible for RNP 2 continental operations:

1. A-RNP;
2. FAA AC 20-138 for the appropriate navigation specification;
3. FAA AC 90-105.

Alternatively, if a statement of compliance with any of the following specifications or standards is found in the acceptable documentation as listed above and position determination is primarily based on GNSS, the aircraft is eligible for RNP 2 continental operations:

1. JAA TEMPORARY GUIDANCE MATERIAL, LEAFLET NO. 10 (TGL 10) (any revision); and
2. FAA AC 90-100.

However, these specifications are RNAV specifications and allows for a DME/DME position determination, if the system with this specification uses both DME/DME and GNSS, loss of GNSS implies loss of RNP 2 capability.

RNP 2 oceanic:

If a statement of compliance with FAA AC 90-105 for the appropriate navigation specification is found in the acceptable documentation as listed above, the aircraft is eligible for RNP 2 oceanic operations.

Operational Requirements

To conduct RNP 2 operations there are operational requirements to be considered.

ABAS RAIM

Operators relying on GNSS are required to have the means to predict the availability of GNSS fault detection (e.g. ABAS RAIM) to support operations along the RNP 2 ATS route.

Preflight planning

Operators and pilots intending to conduct operations on RNP 2 routes must file the appropriate flight plan suffixes.

The on-board navigation data must be current and include appropriate procedures.

Note: *Navigation databases are expected to be current for the duration of the flight. If the database cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy and suitability of the navigation data. Inflight change of the active database is not recommended and often prohibited by system design.*

The operator must confirm the availability of the NAVAID infrastructure, required for the intended routes, including those for use in a non-GNSS contingency, for the period of intended operations using all available information.

Contingency procedures

The pilot must notify ATC of any loss of the RNP 2 capability (integrity alerts or loss of navigation). If unable to comply with the requirements of the RNP 2 route for any reason, the pilot must advice ATC as soon as possible. The loss of RNP 2 capability includes any failure or event causing the aircraft to no longer satisfy the RNP 2 requirements.

Pilot training

For pilot training requirement refer to Section 10 of this AC.

MEL considerations

Operators must have a MEL or equivalent, addressing the provisions for RNP 2 operations, and specify the required dispatch conditions.

Continuing airworthiness

Operators must adhere to continued airworthiness instructions applicable to the aircraft configuration and the qualification for RNP 2 operation. The operator must also consider whether any future alterations to the aircraft or its configuration has an effect on the RNP 2 qualification.

On-board Performance Monitoring and Alerting

On-board performance monitoring and alerting is required for RNP 2

The aircraft navigation system, or aircraft navigation system and the pilot in combination, is required to monitor the TSE, and to provide an alert if the accuracy requirement is not met or if the probability that the lateral TSE exceeds two times the accuracy value is larger than 10^{-5}.

To the extent operational procedures are used to satisfy this requirement, the crew procedure, equipment characteristics, and installation should be evaluated for their effectiveness and equivalence. Examples of information provided to the pilot for awareness of navigation system performance include “EPU”, “ACTUAL”, “ANP” and “EPE”. Examples of indications and alerts provided when the operational requirement is or can be determined as not being met include “UNABLE RNP”, “Nav Accur Downgrad”, GNSS alert limit, loss of GNSS integrity, TSE monitoring (real time monitoring of NSE and FTE combined), etc. The navigation system is not required to provide both performance and sensor-based alerts, e.g. if a TSE based alert is provided, a GNSS alert may not be necessary.

Accuracy

During operations in airspace or on routes designated as RNP 2, the lateral TSE must be within ±2 NM for at least 95 per cent of the total flight time. The along-track error must also be within ±2 NM for at least 95 per cent of the total flight time. To satisfy the accuracy requirement, the 95 per cent FTE should not exceed 1 NM.

Note: *The use of a deviation indicator with 2 NM full-scale deflection is an acceptable means of compliance.*

Integrity

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

Continuity

For RNP 2 oceanic/remote continental airspace applications, loss of function is a major failure condition.

For RNP 2 continental applications, loss of function is a minor failure condition if the operator can revert to a different navigation system and proceed to a suitable airport.

If a single aircraft configuration is to support all potential applications of RNP 2, the more stringent continuity requirement applies.

The AFM limitations section must reflect restrictions in capability to aid in operational approvals.

Signal-In-Space

The aircraft navigation equipment shall provide an alert if the probability of SIS errors causing a lateral position error greater than 4 NM exceeds 1×10^{-7} per hour.

Bounding FTE

During the aircraft certification process, the manufacturer must demonstrate the ability of the pilot to operate the aircraft within the allowable FTE. The demonstration of FTE should account for the aircraft type, the operating envelope, aircraft displays, autopilot performance, and flight guidance characteristics. When this is done, the pilot may use the demonstrated value of FTE to monitor compliance to the RNP requirements. This value must be the cross-track distance to the defined path. For cross-track containment compliance, the demonstration should account for any inaccuracies in the cross-track error computation (e.g. resolution) in the TSE.

PDE is considered negligible because a quality assurance process is applied at the navigation database level.

Functional Requirements

The functional requirements of the RNP 2 system as required by the Navigation specification, are met if a statement is provided in the relevant accepted documentation that the system is installed per AC 20-130A, AC 20-138(), or equivalent airworthiness installation advisory material.

If such a statement is not provided the installation has to be assessed to the functional requirements in FAA AC 20-138D change 2 (or later revision).

Appendix VI – RNP 1 Technical and Operational Criteria

Purpose

This appendix may be used for RNP 1 operations on routes for connectivity between the en-route structure and terminal airspace with no or limited ATS surveillance, with low to medium density traffic.

This navigation specification provides guidance to operators seeking RNP 1 approval and is applicable to arrival and departure procedures. Arrival and departure procedures are referred to as SIDs or STARs, but are intended to also apply to initial and intermediate approach segments.

RNP 1 can be associated with Radius to Fix (RF) path terminators and baro-VNAV.

Implementation in New Zealand

This navigation specification is currently implemented on ATS routes in NZ FIR.

Applicable Specification

The content of this appendix is based on the ICAO PBN Manual, Doc 9613, Volume II, Part C, Chapter 3.

The content of the specification has been split into airworthiness requirements and operational requirements.

The airworthiness requirements may be used the operator to determine the eligibility of the aircraft and the systems for the navigation specification, and to establish what documentation to provide to the CAA as evidence of the aircraft and the system eligibility. The responsibility for airworthiness approval/certification of the aircraft and systems to these airworthiness requirements in the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness and installation considerations of equipment for RNP 1 eligible operations, an acceptable specification is FAA AC20-138D Change 2 or later revision.

Communications environment

There is no specific requirement for ATS communications for RNP 1.

Surveillance environment

This navigation specification is primarily intended for environments where ATS surveillance is either not available or limited.

Navaid infrastructure considerations

This navigation specification is based upon GNSS. While DME/DME-based RNAV systems are capable of RNP 1 accuracy, this navigation specification is primarily intended for environments where the DME infrastructure cannot support DME/DME area navigation to the required performance.

SBAS

RNP 1 is not dependent on the availability of SBAS service.

Navigation systems eligibility

The following systems meet the accuracy, integrity and continuity requirements for RNP 1.

1. aircraft with E/TSO-C129a sensor (Class B or C), E/TSO-C145() and the requirements of E/TSOC115b FMS, installed for IFR use in accordance with FAA AC 20-130A or AC 20-138C (or later revision);

2. aircraft with E/TSO-C129a Class A1 or E/TSO-C146() equipment installed for IFR use in accordance with FAA AC 20-138 (or later revision);

3. aircraft with RNP capability certified or approved to equivalent standards

Legacy Aircraft

If a statement of compliance with any of the following specifications or standards is found in the acceptable documentation as listed above, the aircraft is eligible for RNP 1 operations.

i. A-RNP;
ii. FAA AC 20-138 for the appropriate navigation specification;
iii. FAA AC 90-105.

Alternatively, if a statement of compliance with any of the following specifications or standards is found in the acceptable documentation as listed above and position determination is primarily based on GNSS, the aircraft is eligible for RNP 1.

i. JAA TEMPORARY GUIDANCE MATERIAL, LEAFLET NO. 10 (TGL 10) (any revision); and
ii. FAA AC 90-100.

However, these specifications are RNAV specifications and allows for a DME/DME position determination, if the system with this specification uses both DME/DME and GNSS, loss of GNSS implies loss of RNP 1 capability.

Operational Requirements

To conduct RNP 1 operations there are operational requirements to be considered.

ABAS RAIM

Operators relying on GNSS are required to have the means to predict the availability of GNSS fault detection (e.g. ABAS RAIM) to support operations along the RNP 1 ATS SID, or STAR.

Preflight planning

Operators and pilots intending to conduct operations on RNP 1 SIDs and STARs must file the appropriate flight plan suffixes.

The on-board navigation data must be current and include appropriate procedures.

Note*: Navigation databases are expected to be current for the duration of the flight. If the database cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy and suitability of the navigation data. Inflight change of the active database is not recommended and often prohibited by system design.*

The operator must confirm the availability of the NAVAID infrastructure, required for the intended routes, including those for use in a non-GNSS contingency, for the period of intended operations using all available information.

Contingency procedures

The pilot must notify ATC of any loss of the RNP capability (integrity alerts or loss of navigation), together with the proposed course of action. If unable to comply with the requirements of an RNP 1 SID or STAR for any reason, pilots must advise ATS as soon as possible. The loss of RNP capability includes any failure or event causing the aircraft to no longer satisfy the RNP 1 requirements.

Pilot training

For pilot training requirement refer to Section 10 of this AC.

MEL considerations

Operators must have a MEL or equivalent, addressing the provisions for RNP 1 operations, and specify the required dispatch conditions.

Continuing airworthiness

Operators must adhere to continued airworthiness instructions applicable to the aircraft configuration and the qualification for RNP 1 operation. The operator must also consider whether any future alterations to the aircraft or its configuration has an effect on the RNP 1 qualification.

On-board Performance Monitoring and Alerting

The aircraft navigation system, or aircraft navigation system and the pilot in combination, is required to monitor the TSE, and to provide an alert if the accuracy requirement is not met or if the probability that the lateral TSE exceeds two times the accuracy value is larger than 10^{-5}.

To the extent operational procedures are used to satisfy this requirement, the crew procedure, equipment characteristics, and installation should be evaluated for their effectiveness and equivalence. Examples of information provided to the pilot for awareness of navigation system performance include “EPU”, “ACTUAL”, “ANP” and “EPE”. Examples of indications and alerts provided when the operational requirement is or can be determined as not being met include “UNABLE RNP”, “Nav Accur Downgrad”, GNSS alert limit, loss of GNSS integrity, TSE monitoring (real time monitoring of NSE and FTE combined), etc. The navigation system is not required to provide both performance and sensor-based alerts, e.g. if a TSE based alert is provided, a GNSS alert may not be necessary.

Accuracy

During operations in airspace or on routes designated as RNP 1, the lateral TSE must be within ±1 NM for at least 95 per cent of the total flight time. The along-track error must also be within ±1 NM for at least 95 percent of the total flight time. To satisfy the accuracy requirement, the 95 per cent FTE should not exceed 0.5 NM.

Note: *The use of a deviation indicator with 1 NM full-scale deflection has been found to be an acceptable means of compliance. The use of an autopilot or flight director has been found to be an acceptable means of compliance (roll stabilization systems do not qualify).*

Integrity

Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness regulations (i.e. 1×10^{-5} per hour).

Continuity

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

Signal-In-Space

The aircraft navigation equipment shall provide an alert if the probability of SIS errors causing a lateral position error greater than 2 NM exceeds 1×10^{-7} per hour.

Bounding FTE

During the aircraft certification process, the manufacturer must demonstrate the ability of the pilot to operate the aircraft within the allowable FTE. The demonstration of FTE should account for the aircraft type, the operating envelope, aircraft displays, autopilot performance, and flight guidance characteristics. When this is done, the pilot may use the demonstrated value of FTE to monitor compliance to the RNP requirements. This value must be the cross-track distance to the defined path. For cross-track containment compliance, the demonstration should account for any inaccuracies in the cross-track error computation (e.g. resolution) in the TSE.

PDE is considered negligible because a quality assurance process is applied at the navigation database level.

Functional Requirements

The functional requirements of the RNP 1 system as required by the Navigation specification, are met if a statement is provided in the relevant accepted documentation that the system is installed per AC 20-130A, AC 20-138(),or equivalent airworthiness installation advisory material.

If such a statement is not provided the installation has to be assessed to the functional requirements in FAA AC 20-138D change 2 (or later revision).

Appendix VII – A-RNP (Advanced-RNP) Technical and Operational Criteria

Purpose

This appendix may be used for the implementation of RNP operations predicated on the performance and capabilities included in A-RNP. A-RNP spans oceanic, en-route, terminal area and approach operations, significantly reducing the amount of individual assessments associated with multiple, existing navigation specifications (or new ones that may be added).

This Navigation specifications have mostly been derived from existing guidance material and criteria that are associated with specific types of applications, e.g. departure/arrival, approach, en-route, continental, oceanic, or remote area. The result is that for all stakeholders a separate activity is needed for each navigation specification with regard to aircraft qualification and operational approval. This navigation specification departs from that trend and provides for a single assessment of aircraft eligibility that will apply to more than one navigation accuracy requirement and multiple applications across all phases of flight. With respect to the lateral navigation accuracy and functional requirements that pertain to other navigation applications, those shown in the table below, are considered as being addressed in full by this navigation specification.

Table 8 Navigation specifications addressed by A-RNP

Navigation Specification	AC reference
RNAV 5	Appendix III
RNAV 1	Appendix IV
RNAV 2	Appendix IV
RNP 2	Appendix V
RNP 1	Appendix VI
RNP APCH	Appendix VIII and/or IX

RF Legs functionality capability (Appendix XIII) is required for A-RNP

Implementation in New Zealand

A-RNP is currently not implemented in NZ FIR.

Applicable Specification

The content of this appendix is based on the ICAO PBN Manual, Doc 9613, Volume II, Part C, Chapter 4.

The content of the specification has been split into airworthiness requirements and operational requirements.

The airworthiness requirements may be used the operator to determine the eligibility of the aircraft and the systems for the navigation specification, and to establish what documentation to provide to the CAA as evidence of the aircraft and the system eligibility. The responsibility for airworthiness approval/certification of the aircraft and systems to these airworthiness requirements in the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness and installation considerations of equipment for A-RNP eligible operations, an acceptable specification is FAA AC20-138D Change 2 or later revision.

Communications environment

Communications equipment must be appropriate for the navigation application.

Surveillance environment

ATS surveillance equipment must be appropriate for the navigation application.

Note: *Surveillance by ATS may be used to mitigate the risk of gross navigation errors, provided that the procedure lies within the ATS surveillance and communications service volumes, and the ATS resources are sufficient for the task. For certain A-RNP navigation applications, radar surveillance may be required.*

Navaid infrastructure considerations

A-RNP is based upon GNSS.

SBAS

A-RNP is not dependent on the availability of SBAS service.

Navigation systems eligibility

The aircraft eligibility has to be determined through demonstration of compliance against the relevant airworthiness criteria and the requirements of this appendix. The aircraft OEM or the holder of installation approval for the aircraft, e.g. STC holder, will demonstrate compliance to their NAA (e.g. CAA, EASA, FAA), and the approval can be documented in manufacturer documentation (e.g. service letters). AFM entries are not required provided the State accepts manufacturer documentation.

The aircraft OEM or the holder of installation approval for the aircraft should document demonstration of compliance with the A-RNP capability and highlight any limitations of functionality and performance.

Legacy Aircraft

[Reserved]

Operational Requirements

To conduct A-RNP operations there are operational requirements to be considered.

ABAS RAIM

Operators relying on GNSS are required to have the means to predict the availability of GNSS fault detection (e.g. ABAS RAIM) to support operation.

Preflight planning

Operators and pilots intending to conduct operations on A-RNP must file the appropriate flight plan suffixes.

The on-board navigation data must be current and include appropriate procedures.

Note: *Navigation databases are expected to be current for the duration of the flight. If the database cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy and suitability of the navigation data. Inflight change of the active database is not recommended and often prohibited by system design.*

The operator must confirm the availability of the NAVAID infrastructure, required for the intended routes, including those for use in a non-GNSS contingency, for the period of intended operations using all available information.

Contingency procedures

The pilot must notify ATC of any loss of the RNP capability (integrity alerts or loss of navigation), together with the proposed course of action. If unable to comply with the requirements of an RNP SID or STAR, pilots must advise ATS as soon as possible. The loss of RNP capability includes any failure or event causing the aircraft to no longer satisfy the A-RNP requirements of the route.

In the event of communications failure, the flight crew should continue with the A-RNP SID or STAR in accordance with the published lost communications procedure.

Pilot training

For pilot training requirement refer to Section 10 of this AC.

MEL considerations

Operators must have a MEL or equivalent, addressing the provisions for A-RNP operations, and specify the required dispatch conditions.

Continuing airworthiness

Operators must adhere to continued airworthiness instructions applicable to the aircraft configuration and the qualification for RNP 1 operation. The operator must also consider whether any future alterations to the aircraft or its configuration has an effect on the RNP 1 qualification.

On-board Performance Monitoring and Alerting

On-board performance monitoring and alerting is required. This section provides the criteria for a TSE form of performance monitoring and alerting that will ensure a consistent evaluation and assessment of compliance that can be applied across all of the possible applications.

The aircraft navigation system, or aircraft navigation system and flight crew in combination, is required to monitor the TSE, and to provide an alert if the accuracy requirement is not met or if the probability that the TSE exceeds two times the accuracy value is larger than 10^{-5}. To the extent operational procedures are used to satisfy this requirement, the crew procedure, equipment characteristics, and installation should be evaluated for their effectiveness and equivalence. Examples of information provided to the flight crew for awareness of navigation system performance include “EPU”, “ACTUAL”, “ANP”, and “EPE”. Examples of indications and alerts provided when the operational requirement is or can be determined as not being met include “UNABLE RNP”, “Nav Accur Downgrad”, GNSS alert, loss of GNSS integrity, TSE monitoring (real time monitoring of NSE and FTE combined), etc. The navigation system is not required to provide both performance and sensor-based alerts, e.g. if a TSE-based alert is provided, a GNSS alert may not be necessary.

Accuracy

During operations in airspace or on routes or procedures designated as RNP, the lateral TSE must be within the applicable accuracy (±0.3 NM to ±2.0 NM) for at least 95 per cent of the total flight time. The along track error must also be within ± the applicable accuracy for at least 95 per cent of

the total flight time. To satisfy the accuracy requirement, the 95 per cent FTE should not exceed one half of the applicable accuracy except for a navigation accuracy of 0.3 NM where the FTE is allocated to be 0.25.

Note: *The use of a deviation indicator is an acceptable means of compliance for satisfying the FTE part of the lateral TSE with the scaling commensurate with the navigation application.*

Integrity

Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness guidance material (i.e. 1×10^{-5} per hour).

Continuity

Loss of function is classified as a minor failure condition for applications predicated on this navigation specification.

Signal-In-Space

For GNSS RNP system architectures, the aircraft navigation equipment shall provide an alert if the probability of SIS errors causing a lateral position error greater than two times the applicable accuracy (2 × RNP) exceeds 1×10^{-7} per hour.

Note: *The lateral TSE includes positioning error, FTE, PDE and display error. For procedures extracted from the on-board navigation database, PDE is considered negligible due to the navigation database requirements, and pilot knowledge and training.*

Note: *For RNP systems where the architecture is an integrated, multi-sensor capability and where GNSS integrity is incorporated into a 2 × RNP integrity alert consistent with RTCA/EUROCAE DO-236/ED-75 when performance cannot be met, a separate GNSS integrity alert is not required.*

Criteria for specific navigation services

GNSS

The sensor must comply with the guidelines in FAA AC 20-138() or FAA AC 20-130A. For systems that comply with FAA AC 20-138(), the following sensor accuracies can be used in the total system accuracy analysis without additional substantiation: GNSS sensor accuracy is better than 36 metres (95 per cent), and augmented GNSS (GBAS or SBAS) sensor accuracy is better than 2 metres (95 per cent). In the event of a latent GNSS satellite failure and marginal GNSS satellite geometry, the probability the TSE remains within the procedure design obstacle clearance volume must be greater than 95 per cent.

Note: *GNSS-based sensors output a HIL, also known as a HPL (see FAA AC 20-138() and RTCA/DO-229D for an explanation of these terms). The HIL is a measure of the position estimation error assuming a latent failure is present. In lieu of a detailed analysis of the effects of latent failures on the TSE, an acceptable means of compliance for GNSS-based systems is to ensure the HIL remains less than twice the navigation accuracy, minus the 95 per cent of FTE, during the RNP operation.*

IRS

IRS. An IRS must satisfy the criteria of US 14 CFR Part 121, Appendix G, or equivalent. While Appendix G defines the requirement for a 2 NM per hour drift rate (95 per cent) for flights up to 10 hours, this rate may not apply to an RNP system after loss of position updating. Systems that have demonstrated compliance with Part 121, Appendix G, can be assumed to have an initial drift rate of 8 NM/hour for the first 30 minutes (95 minutes) without further substantiation. Aircraft manufacturers and applicants can demonstrate improved inertial performance in accordance with the methods described in Appendix 1 or 2 of FAA Order 8400.12A.

Note: *Integrated GPS/INS position solutions reduce the rate of degradation after loss of position updating. For "tightly coupled" GPS/IRUs, RTCA/DO-229C, Appendix R, provides additional guidance.*

DME

For RNP procedures and routes, the RNP system may only use DME updating when authorized by the State. The manufacturer should identify any operating constraints (e.g. manual inhibit of DME) in order for a given aircraft to comply with this requirement.

Note: *This does not imply an equipment capability must exist providing a direct means of inhibiting DME updating. A procedural means for the flight crew to inhibit DME updating or executing a missed approach if reverting to DME updating may meet this requirement.*

VOR station

For RNP procedures, the RNAV system must not use VOR updating. The manufacturer should identify any operating constraints (e.g. manual inhibit of VOR) in order for a given aircraft to comply with this requirement.

Note: *This does not imply an equipment capability must exist providing a direct means of inhibiting VOR updating. A procedural means for the flight crew to inhibit VOR updating or executing a missed approach if reverting to VOR updating may meet this requirement.*

Multi-senor systems

There must be automatic reversion to an alternate RNAV sensor if the primary RNAV sensor fails. Automatic reversion from one multi-sensor system to another multi-sensor system is not required.

Functional Requirements

The functional requirements of the A-RNP system as required by the Navigation specification, are met if a statement is provided in the relevant accepted documentation that the system is installed per AC 20-130A, AC 20-138(),or equivalent airworthiness installation advisory material.

If such a statement is not provided the installation has to be assessed to the functional requirements in FAA AC 20-138D change 2 (or later revision).

Appendix VIII - RNP APCH (LNAV and LNAV/VNAV) Technical and Operational Criteria

Purpose

This appendix may be used for approach applications based on GNSS which are classified RNP APCH in accordance with the PBN concept and give access to minima designated as LNAV or LNAV/VNAV.

This navigation specification provides guidance to operators seeking RNP APCH approval and is applicable to operations down to LNAV or LNAV/VNAV minima (excluding RNP AR APCH). RNP APCH procedures include existing RNAV (GNSS) approach procedures designed with a straight segment.

This appendix addresses only the lateral part of the navigation system. If the system is approved for an APV-baro-VNAV operation, the installation must be compliant with the requirements in *Appendix XII – Baro-VNAV Technical and Operational Criteria*. If the system is approved for APV with augmented GNSS, the installation must be compliant with the requirements in *Appendix IX – RNP APCH (LP and LPV minima) Technical* and Operational Criteria, or must have demonstrated to an airworthiness authority performances at least equivalent to those described in *Appendix XII – Baro-VNAV Technical and Operational Criteria*.

Implementation in New Zealand

This navigation specification is currently implemented on ATS routes in NZ FIR.

Applicable Specification

The content of this appendix is based on the ICAO PBN Manual, Doc 9613, Volume II, Part C, Chapter 5, section A.

The content of the specification has been split into airworthiness requirements and operational requirements.

The airworthiness requirements may ne used the operator to determine the eligibility of the aircraft and the systems for the navigation specification, and to establish what documentation to provide to the CAA as evidence of the aircraft and the system eligibility. The responsibility for airworthiness approval/certification of the aircraft and systems to these airworthiness requirements in the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness and installation considerations of equipment for RNP APCH eligible operations, an acceptable specification is FAA AC20-138D Change 2 or later revision.

Communications environment

RNP APCH does not include specific requirements for communications.

Surveillance environment

RNP APCH does not include specific requirements for ATS surveillance. Adequate obstacle clearance is achieved through aircraft performance and operating procedures.

Navaid infrastructure considerations

The RNP APCH specification is based on GNSS to support RNP APCH operations down to LNAV or LNAV/VNAV minima.

The missed approach segment may be based upon the conventional NAVAID (e.g. VOR, DME, NDB).

SBAS

RNP APCH is not dependent on SBAS however SBAS is required for vertical guidance down to LNAV/VNAV minima in absence of a Baro-VNAV capability.

Navigation systems eligibility

The following systems meet the accuracy, integrity and continuity requirements of these criteria:

1. GNSS stand-alone systems, equipment should be approved in accordance with TSO-C129a/ ETSO-C129a Class A, E/TSO-C146() Class Gamma and operational class 1, 2 or 3, or TSO C-196();

2. GNSS sensors used in multi-sensor system (e.g. FMS) equipment should be approved in accordance with TSO C129 ( )/ ETSO-C129 ( ) Class B1, C1, B3, C3 or E/TSO C145() class 1, 2 or 3, or TSO C-196(). For GNSS receiver approved in accordance with E/TSO-C129(), capability for satellite FDE is recommended to improve continuity of function;

3. multi-sensor systems using GNSS should be approved in accordance with AC20-130A, AC 20-138C (or later revision), or TSO-C115b (or subsequent version), as well as having been demonstrated for RNP APCH capability.

Legacy Aircraft

RNP APCH (LNAV minima)

If a statement of compliance with any of the following specifications or standards is found in the acceptable documentation as listed above, the aircraft is eligible for RNP APCH — LNAV operations:

i. A-RNP;
ii. EASA AMC 20-27;
iii. EASA AMC 20-28;
iv. FAA AC 20-138 for the appropriate navigation specification;
v. FAA AC 90-105 for the appropriate navigation specification.

Alternatively, if a statement of compliance with RNP 0.3 GNSS approaches in accordance with any of the following specifications or standards is found in the acceptable documentation as listed above, the aircraft is eligible for RNP APCH — LNAV operations:

i. JAA TEMPORARY GUIDANCE MATERIAL, LEAFLET NO. 3 (TGL 3);
ii. EASA AMC 20-4;
iii. FAA AC 20-130**A**;
iv. FAA AC 20-138.

Any limitation such as ‘within the US National Airspace’ may be ignored since RNP APCH procedures are assumed to meet the same ICAO criteria around the world.

RNP APCH (LNAV/VNAV minima)

If a statement of compliance with any of the following specifications or standards is found in the acceptable documentation as listed above, the aircraft is eligible for RNP APCH — LNAV/VNAV operations:

i. A-RNP;
ii. EASA AMC 20-27 with Baro VNAV;
iii. EASA AMC 20-28;
iv. FAA AC 20-138;
v. FAA AC 90-105 for the appropriate navigation specification.

Alternatively, if a statement of compliance with FAA AC 20-129 is found in the acceptable documentation as listed above, and the aircraft complies with the requirements and limitations of EASA SIB 2014-04, the aircraft is eligible for RNP APCH — LNAV/VNAV operations.

Any limitation such as 'within the US National Airspace' may be ignored since RNP APCH procedures are assumed to meet the same ICAO criteria around the world.

Operational Requirements

To conduct RNP APCH operations there are operational requirements to be considered.

ABAS RAIM

Operators relying on GNSS are required to have the means to predict the availability of GNSS fault detection (e.g. ABAS RAIM) to support RNP APCH operations.

Preflight planning

Operators and pilots intending to conduct operations using an RNP APCH procedure must file the appropriate flight plan suffixes.

The on-board navigation data must be current and include appropriate procedures.

Note: *Navigation databases are expected to be current for the duration of the flight. If the database cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy and suitability of the navigation data. Inflight change of the active database is not recommended and often prohibited by system design.*

The operator must confirm the availability of the NAVAID infrastructure, required for the intended routes, including those for use in a non-GNSS contingency, for the period of intended operations using all available information.

Contingency procedures

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

Pilot training

For pilot training requirement refer to Section 10 of this AC.

MEL considerations

Operators must have a MEL or equivalent, addressing the provisions for RNP APCH operations to LNAV and/or LNAV/VNAV minima, and specify the required dispatch conditions.

Continuing airworthiness

Operators must adhere to continued airworthiness instructions applicable to the aircraft configuration and the qualification for RNP APCH down to LNAV or LNAV/VNAV minima operation. The operator must also consider whether any future alterations to the aircraft or its configuration has an effect on the RNP APCH down to LNAV or LNAV/VNAV minima qualification.

On-board Performance Monitoring and Alerting

During operations on the initial and intermediate segments and for the RNAV missed approach of an RNP APCH, the RNP system, or the RNP system and pilot in combination, shall provide an alert if the accuracy requirement is not met, or if the probability that the lateral TSE exceeds 2 NM is greater than 10^{-5}. During operations on the final approach segment (FAS) of an RNP APCH down to LNAV or LNAV/VNAV minima, the RNP system, or the RNP system and pilot in combination, shall provide an alert if the accuracy requirement is not met, or if the probability that the lateral TSE exceeds 0.6 NM is greater than 10^{-5}.

Accuracy

During operations on the initial and intermediate segments and for the RNAV missed approach, of an RNP APCH, the lateral TSE must be within ±1 NM for at least 95 per cent of the total flight time. The along-track error must also be within ±1 NM for at least 95 per cent of the total flight time.

During operations on the FAS of an RNP APCH down to LNAV or LNAV/VNAV minima, the lateral TSE must be within ±0.3 NM for at least 95 per cent of the total flight time. The along-track error must also be within ±0.3 NM for at least 95 per cent of the total flight time.

To satisfy the accuracy requirement, the 95 per cent FTE should not exceed 0.5 NM on the initial and intermediate segments, and for the RNAV missed approach, of an RNP APCH. The 95 per cent FTE should not exceed 0.25 NM on the FAS of an RNP APCH.

Note: *The use of a deviation indicator with 1 NM full-scale deflection on the initial and intermediate segments, and for the RNAV missed approach and 0.3 NM full-scale deflection on the FAS, has been found to be an acceptable means of compliance. The use of an autopilot or flight director has been found to be an acceptable means of compliance (roll stabilization systems do not qualify).*

Integrity

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

Continuity

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

Signal-In-Space

During operations on the initial and intermediate segments and for the RNAV missed approach of an RNP APCH, the aircraft navigation equipment shall provide an alert if the probability of SIS errors causing a lateral position error greater than 2 NM exceeds 10^{-7} per hour. During operations on the FAS of an RNP APCH down to LNAV or LNAV/VNAV minima, the aircraft navigation equipment shall provide an alert if the probability of SIS errors causing a lateral position error greater than 0.6 NM exceeds 10^{-7} per hour.

Bounding FTE

Compliance with the on-board performance monitoring and alerting requirement does not imply automatic monitoring of an FTE. The on-board monitoring and alerting function should consist at least of a NSE monitoring and alerting algorithm and a lateral deviation display enabling the crew to monitor the FTE. To the extent operational procedures are used to monitor FTE, the crew procedure, equipment characteristics, and installation are evaluated for their effectiveness and equivalence as described in the functional requirements and operating procedures. PDE is considered negligible due to the navigation database quality assurance process and the operating procedures.

Functional Requirements

The functional requirements of the RNP APCH system for operation down to LNAV and/or LNAV/VNAV minima as required by the Navigation specification, are met if a statement is provided in the relevant accepted documentation that the system is installed per AC 20-130A, AC 20-138(),or equivalent airworthiness installation advisory material.

If such a statement is not provided the installation has to be assessed to the functional requirements in FAA AC 20-138D change 2 (or later revision).

Appendix IX – RNP APCH (LP and LPV minima) Technical and Operational Criteria

Purpose

This appendix may be used for approach applications based on augmented GNSS which are classified RNP APCH in accordance with the PBN concept and give access to minima designated LP and LPV.

This Navigation specification provides guidance to operators seeking RNP APCH approval and is applicable to operations down to LP or LPV minima. RNP APAV procedures include existing RNAV(GNSS) approach procedures conducted down to LP or LPV minima.

This appendix addresses only the requirement for the navigation aspect along a final approach straight segment and the straight continuation of the final approach in the missed approach. The navigation requirements for the initial and intermediate segments, and other segments of the missed approach are addressed in *Appendix IX - RNP APCH (LNAV and LNAV/VNAV) Technical and Operational Criteria* of this chapter. Curved approaches are addressed in *Appendix X – RNP AR APCH Technical and Operational Criteria*.

Note: *While SBAS is one means of compliance, other GNSS systems providing either lateral and/or vertical guidance performance in accordance with Annex 10, Volume I, requirements (Table 3.7.2.4-1, APV I, APV II or Cat 1), may also be used to support RNP APCH down to LP or LPV minima, when employed in accordance with the provisions in this navigation specification.*

Implementation in New Zealand

This navigation specification is not currently implemented on ATS routes in the NZ FIR. There is currently no SBAS service volume covering the NZ FIR.

Applicable Specification

The content of this appendix is based on the ICAO PBN Manual, Doc 9613, Volume II, Part C, Chapter 5, section B.

The content of the specification has been split into airworthiness requirements and operational requirements.

The airworthiness requirements may ne used the operator to determine the eligibility of the aircraft and the systems for the navigation specification, and to establish what documentation to provide to the CAA as evidence of the aircraft and the system eligibility. The responsibility for airworthiness approval/certification of the aircraft and systems to these airworthiness requirements in the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness and installation considerations of equipment for RNP APCH eligible operations, an acceptable specification is FAA AC20-138D Change 2 or later revision.

Communications environment

RNP APCH does not include specific requirements for communications.

Surveillance environment

RNP APCH does not include specific requirements for ATS surveillance. Adequate obstacle clearance is achieved through aircraft performance and operating procedures.

Navaid infrastructure considerations

The RNP APCH specification is based on augmented GNSS to support RNP APCH operations down to LP or LPV minima.

The missed approach segment may be based upon GNSS or conventional NAVAID (e.g. VOR, DME,NDB).

SBAS

As RNP APCH down to LP or LPV minima is based on augmented GNSS, SBAS is a requirement for these operations.

Navigation systems eligibility

The following systems meet the accuracy, integrity and continuity requirements of these criteria:

1) GNSS SBAS stand-alone equipment approved in accordance with E/TSO C146a (or subsequent version). Application of this standard guarantees that the equipment is at least compliant with RTCA DO 229C. The equipment should be a class gamma, operational class 3;

2) For an integrated navigation system (e.g. FMS) incorporating a GNSS SBAS sensor, E/TSO C115b (or subsequent version) and AC 20-130A, or AC 20-138C (or later revision) provide an acceptable means of compliance for the approval of this navigation system when augmented by the following guidelines:

    a. The performance requirements of E/TSO-C146a (or subsequent version) that apply to the functional class gamma, operational class 3 or delta 4 is demonstrated; and
    b. The GNSS SBAS sensor is approved in accordance with E/TSO C145a class beta, operational class 3;

3) Approach system incorporating a class delta GNSS SBAS equipment approved in accordance with E/TSO C146a (or subsequent version). This standard guarantees that the equipment is at least compliant with RTCA DO 229C. The equipment should be a class delta 4;

4) Future augmented GNSS systems are also expected to meet these requirements.

Legacy Aircraft

If a statement of compliance with any of the following specifications or standards is found in the acceptable documentation as listed above, the aircraft is eligible for RNP APCH — LPV operations:

i. EASA AMC 20-28;
ii. FAA AC 20-138 for the appropriate navigation specification;
iii. FAA AC 90-107.

For aircraft that have a TAWS Class A installed and do not provide Mode-5 protection on an LPV approach, the DH is limited to 250 ft.

Operational Requirements

To conduct RNP APCH operations there are operational requirements to be considered.

ABAS RAIM

Operators relying on GNSS are required to have the means to predict the availability of GNSS fault detection (e.g. ABAS RAIM) to support RNP APCH operations.

Preflight planning

Operators and pilots intending to conduct operations using an RNP APCH procedure down to LP or LPV minima must file the appropriate flight plan suffixes.

The on-board navigation data must be current and include appropriate procedures.

Note: *Navigation databases are expected to be current for the duration of the flight. If the database cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy and suitability of the navigation data. Inflight change of the active database is not recommended and often prohibited by system design.*

The operator must confirm the availability of the NAVAID infrastructure, required for the intended routes, including those for use in a non-GNSS contingency, for the period of intended operations using all available information.

Contingency procedures

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

Pilot training

For pilot training requirement refer to Section 10 of this AC.

MEL considerations

Operators must have a MEL or equivalent, addressing the provisions for RNP APCH operations to LP or LPV minima, and specify the required dispatch conditions.

Continuing airworthiness

Operators must adhere to continued airworthiness instructions applicable to the aircraft configuration and the qualification for RNP APCH down to LP or LPV minima operation. The operator must also consider whether any future alterations to the aircraft or its configuration has an effect on the RNP APCH down to LP or LPV minima qualification.

On-board Performance Monitoring and Alerting

Operations on the FAS of an RNP APCH operation down to LP and LPV minima, the on-board performance monitoring and alerting function is fulfilled by:

1) NSE monitoring and alerting (see the Signal-In-Space section below);

2) FTE monitoring and alerting: LPV approach guidance must be displayed on a lateral and vertical deviation display (HSI, EHSI, CDI/VDI) including a failure indicator. The deviation display must have a suitable full-scale deflection based on the required track-keeping accuracy. The lateral and vertical full scale deflection are angular and associated to the lateral and vertical definitions of the FAS contained in the FAS DB; and

3) Navigation database: once the FAS DB has been decoded, the equipment shall apply the cyclic redundancy check (CRC) to the DB to determine whether the data is valid. If the FAS DB does not pass the CRC test, the equipment shall not allow activation of the LP or LPV approach operation.

Accuracy

Along the FAS and the straight continuation of the final approach in the missed approach, the lateral and vertical TSE is dependent on the NSE, PDE and FTE:

1) NSE: the accuracy itself (the error bound with 95 per cent probability) changes due to different satellite geometries. Assessment based on measurements within a sliding time window is not suitable for GNSS. Therefore, GNSS accuracy is specified as a probability for each and every sample. NSE requirements are fulfilled without any demonstration if the equipment computes three dimensional positions using linearized, weighted least square solution in accordance with RTCA DO 229C (or subsequent version) Appendix J.

2) FTE: FTE performance is considered acceptable if the lateral and vertical display full-scale deflection is compliant with the non-numeric lateral cross-track and vertical deviation requirements of RTCA DO 229 C (or subsequent version) and if the crew maintains the aircraft within one-third the full scale deflection for the lateral deviation and within one-half the full scale deflection for the vertical deviation.

3) PDE: PDE is considered negligible based upon the process of path specification to data specification and associated quality assurance that is included in the FAS data-block generation process which is a standardized process. The responsibilities for FAS DB generation lies with the ANSP.

Note: *FTE performance is considered acceptable if the approach mode of the FGS is used during such approach.*

Integrity

Simultaneously presenting misleading lateral and vertical guidance with misleading distance data during an RNP APCH operation down to LPV minima is considered a hazardous failure condition (extremely remote).

Simultaneously presenting misleading lateral guidance with misleading distance data during an RNP APCH operation down to LP minima is considered a hazardous failure condition (extremely remote).

Continuity

Loss of approach capability is considered a minor failure condition if the operator can revert to a different navigation system and proceed to a suitable airport. For RNP APCH operations down to LP or LPV minima at least one system is required.

Signal-In-Space

At a position between 2 NM from the FAP and the FAP, the aircraft navigation equipment shall provide an alert within 10 seconds if the SIS errors causing a lateral position error are greater than 0.6 NM, with a probability of 1×10^{-7} per hour.

After sequencing the FAP and during operations on the FAS of an RNP APCH operation down to LP or LPV minima:

1) the aircraft navigation equipment shall provide an alert within 6 seconds if the SIS errors causing a lateral position error are greater than 40 m, with a probability of 1-2 $\times 10^{-7}$ in any approach (ICAO Annex 10, Volume I, Table 3.7.2.4-1); and

2) the aircraft navigation equipment shall provide an alert within 6 seconds if the SIS errors causing a vertical position error is greater than 50 m (or 35 m for LPV minima down to 200 ft), with a probability of 1-2 × 10^{-7} in any approach (ICAO Annex 10, Volume I, Table 3.7.2.4-1).

Bounding FTE

Compliance with the performance monitoring and alerting requirement does not imply an automatic monitor of FTE. The on-board monitoring and alerting function should consist at least of a NSE monitoring and alerting algorithm and a lateral and vertical deviation display enabling the crew to monitor the FTE. To the extent operational procedures are used to monitor FTE, the crew procedure, equipment characteristics, and installation are evaluated for their effectiveness and equivalence as described in the functional requirements and operating procedures.

PDE is considered negligible due to the navigation database quality assurance process.

Functional Requirements

The functional requirements of the RNP APCH system for operation down to LP and/or LPV minima as required by the Navigation specification, are met fs a statement is provided in the relevant accepted documentation that the system is installed per AC 20-130A, AC 20-138(), or equivalent airworthiness installation advisory material.

If such a statement is not provided the installation has to be assessed to the functional requirements in FAA AC 20-138D change 2 (or later revision).

Appendix X – RNP AR APCH Technical and Operational Criteria

Purpose

This appendix may be used for aircraft RNP AR APCH operations to airports where limiting obstacles exist and/or where significant operational efficiencies can be gained.

This navigation specification provides guidance to operators seeking an RNP AR APCH approval.

RNP AR APCH procedures require additional levels of scrutiny, control and authorization. The increased risks and complexities associated with these procedures are mitigated through more stringent RNP criteria, advanced aircraft capabilities and increased aircrew training.

Implementation in New Zealand

The RNP AR APCH navigation specification is currently in use within NZ FIR.

Applicable Specification

The content of this appendix is based on the ICAO PBN Manual, Doc 9613, Volume II, Part C, Chapter 6.

The content of the specification has been split into airworthiness requirements and operational requirements.

The airworthiness requirements may be used by the operator to determine the eligibility of the aircraft and systems for the navigation specification, and to establish what documentation to provide to the CAA as evidence of aircraft and system eligibility. The responsibility for airworthiness approval/certification of the aircraft and systems to these airworthiness requirements is the OEM and State of Design/Manufacture.

The applicant has the responsibility of providing to the CAA the evidence of the aircraft eligibility and demonstrating compliance to the operating requirements of the navigation specification sought.

Airworthiness Requirements

For airworthiness and installation considerations of equipment for RNP AR APCH eligible operations, an acceptable specification is FAA AC20-138D Change 2 or later revision.

Communications environment

RNP AR APCH implementations do not require any specific communications considerations.

Surveillance environment

RNP AR APCH implementations do not require any specific ATS surveillance considerations.

Navaid infrastructure considerations

RNP AR APCH specification is based on GNSS as the primary NAVAID infrastructure.

SBAS

SBAS is not a requirement for RNP AR APCH.

Navigation systems eligibility

To qualify for RNP AR APCH. In addition to the specific guidance in this chapter, the aircraft must comply with:

1) FAA AC 20-129 and either FAA AC 20-130() or AC 20-138 (revisions prior to rev C): or

2) FAA AC 20-138C (or later revision)

Additional to these requirements to qualify to RNP AR APCH the aircraft must be equipped with the following systems:

1) Class A TAWS for all RNP AR APCH procedures

2) Autopilot and flight director (driven by the RNP system) for RNP AR APCH procedures with an accuracy of less than RNP 0.3 or procedures including RF Legs

To comply with the functional requirements of RNP approaches with missed approaches less than RNP 1.0, typically, the aircraft must have at least the following equipment to mitigate single point failure during the procedure.

1) dual GNSS sensors, and;

2) dual FMS, and;

3) dual air data systems, and;

4) dual autopilots, and;

5) a single IRU.

Legacy Aircraft

[Reserved]

Operational Requirements

To conduct RNP APCH operations there are operational requirements to be considered.

ABAS RAIM

Operators relying on GNSS are required to have the means to predict the availability of GNSS fault detection (e.g. ABAS RAIM) to support RNP APCH operations.

RNP AR APCH operations must have GNSS updating available prior to the commencement of the procedure.

Preflight planning

Operators and pilots intending to conduct operations on RNP AR APCH ATS procedures, should file the appropriate flight plan suffixes.

RNP AR APCH operations must have GNSS updating available prior to the commencement of the procedure.

The on-board navigation data must be current and include appropriate procedures.

Note: *Navigation databases are expected to be current for the duration of the flight. If the database cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy and suitability of the navigation data. Inflight change of the active database is not recommended and often prohibited by system design.*

The operator must confirm the availability of the NAVAID infrastructure, required for the intended routes, including those for use in a non-GNSS contingency, for the period of intended operations using all available information.

Contingency procedures

The pilots must advise ATC immediately when the performance of the aircraft's navigation system is no longer suitable to support continuation of an RNP AR APCH procedure. Pilots must also know what navigation sensors form the basis for their RNP AR APCH compliance, and they must be able to assess the impact of a failure of any avionics or a known loss of ground systems on the remainder of the flight plan.

Pilot training

For pilot training requirement refer to Section 10 of this AC.

MEL considerations

The operator's MEL should be developed/revised to address the equipment requirements for RNP AR instrument procedures. The required equipment may depend on the intended navigation accuracy and whether the missed approach requires an RNP less than 1.0. For example, GNSS and autopilot are typically required for high navigation accuracy. Dual equipment is typically required for approaches when using a line of minima less than RNP 0.3 and/or where the missed approach has an RNP less than 1.0. An operable Class A TAWS is required for all RNP AR APCH procedures. It is recommended that the TAWS use an altitude that compensates for local pressure and temperature effects (e.g. corrected barometric and GNSS altitude), and includes significant terrain and obstacle data. The TAWS must not utilize the captain's altimeter subscale setting as the sole reference to help militate against a dual QNH setting error by the pilot. The pilot must be cognizant of the required equipment.

Continuing airworthiness

Operators must adhere to continued airworthiness instructions applicable to the aircraft configuration and the qualification for RNP APCH down to LP or LPV minima operation. The operator must also consider whether any future alterations to the aircraft or its configuration has an effect on the RNP APCH down to LP or LPV minima qualification.

On-board Performance Monitoring and Alerting

A critical component of RNP is the ability of the aircraft navigation system to monitor its achieved navigation performance, and to identify, for the pilot, whether the operational requirement is or is not being met during an operation (e.g. "Unable RNP", "Nav Accur Downgrad"). It should be noted that the monitoring system may not provide warnings of FTE. The management of FTE must be addressed as a pilot procedure.

A crew alert is required when GNSS updating is lost unless the navigation system provides an alert when the selected RNP no longer meets the requirements for continued navigation.

This section defines the general performance requirements for aircraft qualification. The requirements for RNP AR APCH are unique due to the reduced obstacle clearance and advanced functionality, therefore the requirements in this section do not use the same structure as for other navigation specifications, e.g. RNP 4, RNP 1 and RNP APCH.

Path definition

Aircraft performance is evaluated around the path defined by the published procedure and RTCA/DO-236B Section 3.2; EUROCAE ED-75B. All vertical paths used in conjunction with the FAS will be defined by a flight path angle as a straight line emanating to a fix and altitude.

Lateral accuracy

All aircraft operating on RNP AR APCH procedures must have a cross-track navigation error no greater than the applicable accuracy value (0.1 NM to 0.3 NM) for 95 per cent of the flight time.

This includes positioning error, FTE, PDE and display error. Also, the aircraft along-track positioning error must be no greater than the applicable accuracy value for 95 per cent of the flight time.

Vertical accuracy

The vertical system error includes altimetry error (assuming the temperature and lapse rates of the International Standard Atmosphere), the effect of along-track error, system computation error, data resolution error, and FTE. The 99.7 per cent of system error in the vertical direction must be less than the following (in feet):

$$\sqrt{\left((6076.115)(1.225)RNP \cdot \tan\theta\right)^2 + (60\tan\theta)^2 + 75^2 + \left((-8.8 \cdot 10^{-8})(h+\Delta h)^2 + (6.5 \cdot 10^{-3})(h+\Delta h) + 50\right)^2}$$

Where θ is the VNAV path angle, h is the height of the local altimetry reporting station and Δh is the height of the aircraft above the reporting station.

Note: *VNAV systems compliant with the performance specification for RNP APCH operations down to LPV minima (see Appendix IX) meet or exceed this vertical accuracy performance criteria.*

Airspace containment

RNP and baro-VNAV aircraft.

This appendix provides a detailed acceptable means of compliance for aircraft that use an RNP system based primarily on GNSS, and a VNAV system based on barometric altimetry. Aircraft and operations complying with this navigation specification provide the requisite airspace protection through a variety of monitoring and alerting systems and pilot procedures. Aircraft and operations complying with this navigation specification provide the requisite performance and assurance to satisfy the airspace requirements and safety margins through a variety of monitoring and alerting (e.g. “Unable RNP”, GNSS alert limit, and path deviation monitoring).

Other systems or alternate means of compliance.

For other systems or alternate means of compliance the probability of the aircraft exiting the lateral and vertical extent of the obstacle clearance volume of the procedure must not exceed 10^{-7} per approach (including the missed approach). This requirement may be satisfied by an operational safety assessment applying:

1) appropriate quantitative numerical methods;

2) qualitative operational and procedural considerations and mitigations; or

3) an appropriate combination of both quantitative and qualitative methods.

Note: *This requirement applies to the total probability of excursion outside the obstacle clearance volume, including events caused by latent conditions (integrity) and by detected conditions (continuity) if the aircraft does not remain within the obstacle clearance volume after the failure is annunciated (considering the aircraft wingspan). The monitor limit of the alert, the latency of the alert, the crew reaction time, and the aircraft response should all be considered when ensuring that the aircraft does not exit the obstacle clearance volume. The requirement applies to a single approach, considering the exposure time of the operation and the NAVAID geometry and navigation performance available for each published approach.*

Note: *This containment requirement is derived from the operational requirement which is notably different than the containment requirement specified in RTCA/DO 236B (EUROCAE ED-75B). The requirement in RTCA/DO-236B (EUROCAE ED-75B) was developed to facilitate airspace design and does not directly equate to obstacle clearance.*

Criteria for specific navigation services

This section identifies unique issues for the navigation sensors within the context of RNP AR APCH operations.

ABAS and other GNSS augmentations based on GPS

1) The sensor must comply with the guidelines in AC 20-138() or AC 20-130A. For systems that comply with AC 20-138(), the following sensor accuracies can be used in the total system accuracy analysis without additional substantiation: GPS (ABAS) sensor lateral accuracy is better than 36 m (119 ft) (95 per cent), and augmented GPS (GBAS or SBAS) sensor lateral accuracy is better than 2 m (7 ft) (95 per cent).

2) In the event of a latent GPS satellite failure and marginal GPS satellite geometry (e.g. HIL) equal to the horizontal alert limit), the probability that the aircraft remains within the obstacle clearance volume used to evaluate the procedure must be greater than 95 per cent (both laterally and vertically).

Note1*: Other GNSS systems meeting or exceeding the accuracy of GPS can use the criteria in 1) and 2) above.*

Note2: *GNSS-based sensors output a HIL, also known as a HPL (see AC 20-138A, Appendix 1 and RTCA/DO-229C for an explanation of these terms). The HIL is a measure of the position estimation error assuming a latent failure is present. In lieu of a detailed analysis of the effects of latent failures on the TSE, an acceptable means of compliance for GNSS-based systems is to ensure the HIL remains less than twice the navigation accuracy, minus the 95 per cent of FTE, during the RNP AR APCH operation.*

IRS

An IRS must satisfy the criteria of US 14 CFR part 121, Appendix G, or equivalent. While Appendix G defines the requirement for a 2 NM per hour drift rate (95 per cent) for flights up to 10 hours, this rate may not apply to an RNP system after loss of position updating. Systems that have demonstrated compliance with Part 121, Appendix G, can be assumed to have an initial drift rate of 8 NM/hour for the first 30 minutes (95 per cent) without further substantiation. Aircraft manufacturers and applicants can demonstrate improved inertial performance in accordance with the methods described in Appendix 1 or 2 of FAA Order 8400.12A.

Note: *Integrated GPS/INS position solutions reduce the rate of degradation after loss of position updating. For "tightly coupled" GPS/IRUs, RTCA/DO-229C, Appendix R, provides additional guidance.*

VOR

The aircraft's RNP system may not use VOR-updating when conducting RNP AR APCH procedures. The aircraft manufacturer should identify any pilot procedures or techniques for an aircraft to comply with this requirement.

Note: *This does not imply a requirement for a direct means of inhibiting VOR updating. An operational procedure requiring the pilot to inhibit VOR updating or a procedure requiring the pilot to execute a missed approach when the navigation system reverts to VOR-updating may satisfy this requirement.*

Multi-sensor systems

There must be automatic reversion to an alternate area navigation sensor if the primary area navigation sensor fails. Automatic reversion from one multi-sensor system to another multi-sensor system is not required.

Altimetry System Error (ASE)

The 99.7 per cent aircraft ASE for each aircraft (assuming the temperature and lapse rates of the International Standard Atmosphere) must be less than or equal to the following with the aircraft in the approach configuration:

$$ASE = -8.8 \cdot 10^{-8} \cdot H^2 + 6.5 \cdot 10^{-2} \cdot H + 50(\text{ft})$$

Where H is the true altitude of the aircraft.

Temperature compensation systems

Systems that provide temperature-based corrections to the barometric VNAV guidance must comply with RTCA/DO-236B, Appendix H.2. This applies to the FAS. Manufacturers should document compliance to this standard to allow the operator to conduct RNP approaches when the actual temperature is below or above the published procedure design limit. Appendix H also provides guidance on operational issues associated with temperature compensated systems, such as intercepting the compensated path from uncompensated procedure altitudes.

Functional Requirements

The functional requirements of the RNP AR APCH system as required by the Navigation specification, are met fs a statement is provided in the relevant accepted documentation that the system is installed per AC 20-130A, AC 20-138(),or equivalent airworthiness installation advisory material.

If such a statement is not provided the installation has to be assessed to the functional requirements in FAA AC 20-138D change 2 (or later revision).

Appendix XI – RNP 0.3(H) Technical and Operational Criteria

Purpose

This Appendix may be used for helicopter RNP 0.3(H) operations en-route and in the terminal airspace of airports as well as operations to and from heliports and for servicing offshore rigs. RNP 0.3(H) accuracy may also be needed en-route to support operations at low level in mountainous remote areas and, for airspace capacity reasons, in high density airspace.

This navigation specification provides guidance to operators seeking RNP 0.3(H) approval and is applicable to departure, en-route, arrival (including the initial and intermediate approach segments), and to the final phase of the missed approach. This navigation specification addresses continental, remote continental and offshore operations. Route length restrictions may be applicable for en-route operations meeting RNP 0.3(H).

Fulfilling the accuracy requirements of this navigation specification may be achieved by applying operational limitations, which could include but are not necessarily limited to the maximum permitted airspeed and requirements for autopilot coupling. The large majority of IFR helicopters are already equipped with TSO C145/146 systems and moving map displays, and require autopilot including stability augmentation for IFR certification.

Implementation in New Zealand

This navigation specification is **NOT** currently implemented on ATS routes in the NZ FIR. There is currently no SBAS service volume covering the NZ FIR and in addition, concerns of terrain and obstacle masking of low-level routes will need to be addressed as part of the procedure design of RNP 0.3(H) routes in the NZ FIR, including potential amendments to masking angle of the RAIM prediction tool(s).

Applicable Specification

The content of this appendix is based on the ICAO PBN Manual, Doc 9613, Volume II, Part C, Chapter 7.

The content of the specification has been split into airworthiness requirements and operational requirements.

The airworthiness requirements may be used by the operator to determine the eligibility of the aircraft and systems for the navigation specification, and to establish what documentation to provide to the CAA as evidence of aircraft and system eligibility. The responsibility for airworthiness approval/certification of the aircraft and systems to these airworthiness requirements is the OEM and State of Design/Manufacture.

The applicant has the responsibility of providing to the CAA the evidence of the aircraft eligibility and demonstrating compliance to the operating requirements of the navigation specification sought.

Airworthiness Requirements

For airworthiness and installation considerations of equipment for RNP 0.3(H) eligible operations, an acceptable specification is FAA AC20-138D Change 2 or later revision.

Communications environment

There is no specific requirement for ATS communications for RNP 0.3(H).

Surveillance environment

There is no specific requirement for ATS surveillance for RNP 0.3(H).

Navaid infrastructure considerations

The RNP 0.3(H) specification is based upon GNSS. DME/DME based RNAV systems are not capable of consistently providing RNP 0.3 performance.

If RF legs are part of the operation then the rotorcraft will have to have evidence of compliance to RF Legs functionality and performance per Appendix XIII – RF Legs Technical and Operational Criteria.

Rotorcraft must have dual, independent LRNS for offshore and remote area RNP 0.3(H) operations.

For en-route RNP 0.3(H) operations, the operator may revert to an alternate navigation system to navigate to, and safely land at, a suitable airport.

Note: *This consideration does not relieve operators from the requirements of Rules 135.353, 125.353, and 121.353.*

SBAS

RNP 0.3(H) in not dependent on the availability of SBAS service.

Navigation systems eligibility

The following systems meet the accuracy, integrity and continuity requirements for RNP 0.3(H):

1. Rotorcraft with E/TSO-C145a and the requirements of E/TSO-C115b FMS, installed for IFR use in accordance with FAA AC 20-130A, or AC 20-138 (or later revision);
2. Rotorcraft with E/TSO-C146a equipment installed for IFR use in accordance with FAA AC 20-138 (or later revision);
3. Rotorcraft with RNP 0.3 capability certified or approved to equivalent standards (e.g. TSO-C193).

Legacy aircraft

[Reserved]

Operational Requirements

To conduct RNP 0.3(H) operations there are operational requirements to be considered

ABAS RAIM

Operators relying on GNSS are required to have the means to predict the availability of GNSS fault detection (e.g. ABAS RAIM) to support operations along the RNP 0.3(H) ATS route.

Note: *RAIM prediction may not be required where the navigation system can make use of SBAS augmentation and the planned operation will be contained within the SBAS signal service volume, but the operator should check SBAS NOTAMS before flight to ensure the availability of the SBAS SIS.*

Preflight planning

Operators and pilots intending to conduct operations on RNP 0.3(H) routes, including SIDs and STARs, initial and intermediate approach, should file the appropriate flight plan suffixes.

The on-board navigation data must be current and include appropriate procedures.

Note: *Navigation databases are expected to be current for the duration of the flight. If the database cycle is due to change during flight, operators and pilots should establish procedures to ensure the accuracy and suitability of the navigation data. Inflight change of the active database is not recommended and often prohibited by system design.*

Contingency procedures

The pilot must notify ATC of any loss of the RNP 0.3(H) capability (integrity alerts or loss of navigation) together with the proposed course of action. If unable to comply with the requirements of the RNP 0.3(H) route for any reason, the pilot must advice ATC as soon as possible. The loss of RNP 0.3(H) capability includes any failure or event causing the aircraft to no longer satisfy the RNP 0.3(H) requirements.

Pilot training

For pilot training requirement refer to Section 10 of this AC.

MEL considerations

Operators must have a MEL or equivalent, addressing the provisions for RNP 0.3(H) operations, and specify the required dispatch conditions.

Continuing airworthiness

Operators must adhere to continued airworthiness instructions applicable to the aircraft configuration and the qualification for RNP 0.3(H) operation. The operator must also consider whether any future alterations to the aircraft or its configuration has an effect on the RNP 0.3(H) qualification.

On-board Performance Monitoring and Alerting

On-board performance monitoring and alerting is required for RNP 0.3(H).

The rotorcraft navigation system, or rotorcraft navigation system and the pilot in combination, is required to monitor the TSE, and to provide an alert if the accuracy requirement is not met or if the probability that the lateral TSE exceeds two times the accuracy value is larger than 10^{-5}.

To the extent operational procedures are used to satisfy this requirement, the crew procedure, equipment characteristics, and installation should be evaluated for their effectiveness and equivalence. Examples of information provided to the pilot for awareness of navigation system performance include “EPU”, “ACTUAL”, “ANP” and “EPE”. Examples of indications and alerts provided when the operational requirement is or can be determined as not being met include “UNABLE RNP”, “Nav Accur Downgrad”, GNSS alert limit, loss of GNSS integrity, TSE monitoring (real time monitoring of NSE and FTE combined), etc. The navigation system is not required to provide both performance and sensor-based alerts, e.g. if a TSE based alert is provided, a GNSS alert may not be necessary.

Accuracy

During operations in airspace or on ATS routes designated as RNP 0.3(H), the lateral TSE must be within ±0.3 NM for at least 95 per cent of the total flight time. The along-track error must also be within ±0.3 NM for at least 95 per cent of the total flight time. To meet this performance requirement, an FTE of 0.25 NM (95 per cent) may be assumed.

Note: *For all RNP 0.3(H) operations, the use of a coupled FGS is an acceptable means of complying with this FTE assumption (see RTCA DO-208, Appendix E, Table 1). Any alternative means of FTE bounding, other than coupled FGS, may require FTE substantiation through an airworthiness demonstration and approval, which may include, but not necessarily limited to, the application of operational limitations such as maximum speed permitted.*

Integrity

Malfunction of the rotorcraft navigation equipment is classified as a Major failure condition under airworthiness regulations (i.e. 1×10^{-5} per hour).

Continuity

For the purpose of this specification, loss of function is a major failure condition for remote continental and offshore operations.

The carriage of dual independent long-range navigation systems may satisfy the continuity requirement.

Loss of function is classified as a minor failure condition for other RNP 0.3(H) operations if the operator can revert to a different available navigation system and proceed to a suitable airport.

Signal-In-Space

The rotorcraft navigation equipment shall provide an alert if the probability of SIS errors causing a lateral position error greater than 0.6 NM exceeds 1×10^{-7} per hour.

Bounding FTE for Equipment not Monitoring TSE Performance

RNP 0.3(H) operations require coupled FGS to meet the allowable FTE bound unless the manufacturer demonstrates and obtains airworthiness approval for an alternate means of meeting the FTE bound. The following may be considered as one operational means to monitor the FGS FTE.

a) FTE should remain within half-scale deflection (unless there is other substantiated FTE data);

b) Pilots must manually set systems without automatic CDI scaling to not greater than 0.3 NM full-scale prior to commencing RNP 0.3(H) operations; and

c) Rotorcraft with electronic map display, or another alternate means of flight path deviation display, must select appropriate scaling for monitoring FTE.

Automatic monitoring of FTE is not required if the necessary monitoring can be achieved by the pilot using available displays without excessive workload in all phases of flight. To the extent that compliance with this specification is achieved through operational procedures to monitor FTE, an evaluation of the pilot procedures, equipment characteristics, and installation must ensure their effectiveness and equivalence, as described in the functional requirements and operating procedures.

PDE is considered negligible if the quality assurance process is applied at the navigation database level and if operating procedures are applied.

Functional Requirements

The functional requirements of the RNP 0.3(H) system as required by the Navigation specification, are met fs a statement is provided in the relevant accepted documentation that the system is installed per AC 20-130A, AC 20-138(),or equivalent airworthiness installation advisory material.

If such a statement is not provided the installation has to be assessed to the functional requirements in FAA AC 20-138D change 2 (or later revision).

Appendix XII – Baro-VNAV Technical and Operational Criteria

Purpose

This appendix may be used for those systems based upon the use of barometric altitude and RNAV information in the definition of vertical flight paths, and vertical tracking to a path. The FAS of VNAV IFPs can be performed using vertical guidance to a glide path computed by the on-board RNP system.

This navigation specification provides guidance to operators seeking Baro-VNAV approval for RNP APCH and RNP AR APCH procedures.

Implementation in New Zealand

Baro-VNAV is intended to be applied where vertical guidance and information are provided to the pilot on IAPs containing a vertical flight path defined by a vertical path angle.

Applicable Specification

The content of this appendix is based on the ICAO PBN Manual, Doc 9613, Volume II, Attachment A.

The content of the specification has been split into airworthiness requirements and operational requirements.

The airworthiness requirements may be used by the operator to determine the eligibility of the aircraft and systems for the navigation specification, and to establish what documentation to provide to the CAA as evidence of aircraft and system eligibility. The responsibility for airworthiness approval/certification of the aircraft and systems to these airworthiness requirements is the OEM and State of Design/Manufacture.

The applicant has the responsibility of providing to the CAA the evidence of the aircraft eligibility and demonstrating compliance to the operating requirements of the navigation specification sought.

Airworthiness Requirements

For airworthiness and installation considerations of equipment for Baro-VNAV eligible operations, an acceptable specification is FAA AC20-138D Change 2 or later revision.

Communications environment

The procedure design does not have unique communications requirements.

Surveillance environment

The procedure design does not have unique surveillance requirements.

Navaid infrastructure considerations

The procedure design does not have unique infrastructure requirements. These criteria are based upon the use of barometric altimetry by an airborne RNP system whose performance capability supports the required operation.

SBAS

Baro-VNAV is based on the use of barometric altimetry, GNSS and SBAS are not used

Navigation systems eligibility

Baro-VNAV approach operations are based upon the use of RNAV equipment that automatically determines aircraft position in the vertical plane using inputs from equipment that can include:

1) FAA TSO-C106, Air Data Computer;

2) air data system, ARINC 706, Mark 5 Air Data System;

3) barometric altimeter system, DO-88 Altimetry, ED-26 MPS for Airborne Altitude Measurements and Coding Systems, ARP-942 Pressure Altimeter Systems, ARP-920 Design and Installation of Pitot Static Systems for Transport Aircraft;

4) type certified integrated systems providing an air data system capability comparable to item 2).

Note: *Positioning data from other sources may be integrated with the barometric altitude information provided it does not cause position errors exceeding the track keeping accuracy requirements.*

Note: *Altimetry system performance is demonstrated separately through the static pressure systems certification (e.g. FAR or CS 25.1325), where performance must be 30 ft per 100 KIAS. Altimetry systems meeting such a requirement will satisfy the ASE requirements for baro-VNAV. No further demonstration or compliance is necessary.*

The 99.7 per cent aircraft ASE for each aircraft (assuming the temperature and lapse rates of the International Standard Atmosphere) must be less than or equal to the following:

$$ASE = -8.8 \cdot 10^{-8} \cdot H^2 + 6.5 \cdot 10^{-2} \cdot H + 50(\text{ft})$$

Where H is the true altitude of the aircraft.

Legacy Aircraft

[Reserved]

Operational Requirements

To conduct Baro-VNAV operations there are operational requirements to be considered:

ABAS RAIM

Baro-VNAV is based on the use of barometric altimetry, ABAS RAIM is not applicable.

Preflight planning

Refer to the RNP approach procedure which utilizes the Baro-VNAV capability for flight plan suffixes to be used.

When cold weather temperatures exist, the pilot should check the chart for the IAP to determine the limiting temperature for the use of baro-VNAV capability. If the airborne system contains a temperature compensation capability, the manufacturer's instructions should be followed for the use of the baro-VNAV function.

Contingency procedures

Where the contingency procedure requires reversion to a conventional procedure, necessary preparations should be completed before commencing the RNAV procedure, consistent with operator practices.

Pilot training

For pilot training requirement refer to Section 10 of this AC.

MEL considerations

Operators must have a MEL or equivalent addressing baro-VNAV for approach and specify the required dispatch conditions.

Note: *Barometric altimetry and related systems are minimum equipment for all operations. Any unique dispatch or operational assumptions should be documented.*

Continuing airworthiness

Operators must adhere to continued airworthiness instructions applicable to the aircraft configuration and the qualification for Baro-VNAV operation. The operator must also consider whether any future alterations to the aircraft or its configuration has an effect on the Baro-VNAV qualification.

System requirements

Accuracy

For instrument approach operations, the error of the airborne baro-VNAV equipment, excluding altimetry, should have been demonstrated to be less than that shown below on a 99.7 per cent probability basis:

Table 9 Baro-VNAV equipment error

	Level flight segments and climb/descent intercept altitude region of specified altitudes	Climb/descent along specified vertical profile (angle)
At or below 5,000 ft (1,500 m)	50 ft (15 m)	100 ft (30 m)
5,000 ft to 10,000 ft (1,500 m to 3,000 m)	50 ft (15 m)	150 Ft (45 m)
Above 10,000 ft (3,000 m)	50 ft (15 m)	220 ft (67 m)

Note: *Altimetry error refers to the electrical output and includes all errors attributable to the aircraft altimetry installation including position effects resulting from normal aircraft flight attitudes. In high performance aircraft, it is expected that altimetry correction will be provided. Such a correction should be done automatically. In lower performance aircraft, upgrading of the altimetry system may be necessary.*

Note: *Baro-VNAV equipment error includes all errors resulting from the vertical guidance equipment installation. It does not include errors of the altimeter system, but does include any additional errors resulting from the addition of the baro-VNAV equipment. This error component may be zero in level en-route flight if the operation is limited to guidance by means of the altimeter only. It should not be disregarded in terminal and approach operations where the pilot is expected to follow the baro-VNAV indications.*

Flight technical (pilotage) errors. With satisfactory displays of vertical guidance information, FTEs should have been demonstrated to be less than the values shown below on a three-sigma basis.

Table 10 Flight Technical Error

	Level flight segments and climb/descent intercept altitude region of specified altitudes	Climb/descent along specified vertical profile (angle)
At or below 5,000 ft (1,500 m)	150 ft (45 m)	200 ft (60 m)
5,000 ft to 10,000 ft (1,500 m to 3,000 m)	240 ft (73 m)	300 Ft (91 m)
Above 10,000 ft (3,000 m)	240 ft (73 m)	300 ft (91 m)

Note: *Some applications (e.g. RNP APCH and RNP AR APCH operations) require truncation of the FTE error distribution through operational procedures.*

Sufficient flight tests of the installation should have been conducted to verify that these values can be maintained. Smaller values for FTEs may be achieved especially in the cases where the baro-VNAV system is to be used only when coupled to an autopilot or flight director. However, at least the total system vertical accuracy shown below should be maintained.

If an installation results in larger FTEs, the total vertical error of the system (excluding altimetry) may be determined by combining equipment and FTEs using the root sum square (RSS) method. The result should be less than the values listed below.

Table 11 System total vertical error

	Level flight segments and climb/descent intercept altitude region of specified altitudes	Climb/descent along specified vertical profile (angle)
At or below 5,000 ft (1,500 m)	158 ft (48 m)	224 ft (68 m)
5,000 ft to 10,000 ft (1,500 m to 3,000 m)	245 ft (74 m)	335 Ft (102 m)
Above 10,000 ft (3,000 m)	245 ft (74 m)	372 ft (113 m)

An acceptable means of complying with these accuracy requirements is to have an RNP system approved for baro-VNAV approaches in accordance with the criteria of FAA AC20-129() or AC20-138C (or later) and an altimetry system approved in accordance with FAR/CS 25.1325 or equivalent.

Functional Requirements

The functional requirements of the Baro-VNAV capable system as required by the Navigation specification, are met fs a statement is provided in the relevant accepted documentation that the system is installed per AC 20-130A, AC 20-138(),or equivalent airworthiness installation advisory material.

If such a statement is not provided the installation has to be assessed to the functional requirements in FAA AC 20-138D change 2 (or later revision).

Appendix XIII – RF Legs Technical and Operational Criteria

Purpose

This appendix may be used for applications using the ARINC 424 RF path terminator functionality when used in association with RNP 1, RNP 0.3(H), RNP APCH, and A-RNP specifications.

RF legs are an optional capability for use with RNP 1 RNP 0.3(H) and RNP APCH rather than a minimum requirement. This functionality can be used in the initial and intermediate approach segments, the final phase of the missed approach, SIDs and STARs.

The application of this appendix in the final approach or the initial or intermediate phases of the missed approach is prohibited. Such procedure segments wishing to apply RF would have to use the RNP AR specification.

This appendix also provides guidance to operators seeking the approval of an RNP system incorporating an RF leg capability.

Note: *Although the ARINC 424 RF leg functionality in this appendix is identical to that found in the RNP AR specification, the approval requirements when applied in association with RNP 1, RNP 0.3(H), RNP APCH and A-RNP are not as constraining as those applied to RNP AR. This is taken into account in the related obstacle protection and route spacing criteria.*

Implementation in New Zealand

NZ FIR does not currently have RF Legs in RNP 1, RNP 0.3(H), RNP APCH, and A-RNP specifications. They are included in RNP AR APCH procedures, refer to *Appendix X – RNP AR APCH Technical and Operational Criteria* of this AC for RNP AR APCH.

Applicable Specification

The content of this appendix is based on the ICAO PBN Manual, Doc 9613, Volume II, Appendix 1 to Part C.

The content of the specification has been split into airworthiness requirements and operational requirements.

The airworthiness requirements may be used by the operator to determine the eligibility of the aircraft and systems for the navigation specification, and to establish what documentation to provide to the CAA as evidence of aircraft and system eligibility. The responsibility for airworthiness approval/certification of the aircraft and systems to these airworthiness requirements is the OEM and State of Design/Manufacture.

The applicant has the responsibility of providing to the CAA the evidence of the aircraft eligibility and demonstrating compliance to the operating requirements of the navigation specification sought.

Airworthiness Requirements

For airworthiness and installation considerations of equipment for Baro-VNAV eligible operations, an acceptable specification is FAA AC20-138D Change 2 or later revision.

Communications environment

RF legs is an optional addition to RNP procedures, communications considerations of the parent RNP specification are applicable if present.

Surveillance environment

RF legs is an optional addition to RNP procedures, surveillance considerations of the parent RNP specification are applicable if present.

Navaid infrastructure considerations

RF legs is an optional addition to RNP procedures, navigation infrastructure considerations of the parent RNP specification are applicable if present.

SBAS

RF Legs are not dependent on SBAS coverage.

Navigation systems eligibility

RF legs is an optional addition to an RNP procedure, to perform RF legs the system must meet the requirements for the parent specification added with an RF leg capability.

Relevant documentation acceptable to CAA must be available to establish that the aircraft is equipped with an RNP system with a demonstrated RF leg capability. Eligibility may be established in two steps: first, recognizing the qualities and qualifications of the aircraft and equipment; and second, determining the acceptability for operations. The determination of eligibility for existing systems should consider acceptance of manufacturer documentation of compliance, e.g. FAA ACs 90-105(), 90-101A, 20-138B (or later), EASA AMC 20-26.

Note: *RNP systems demonstrated and qualified for RNP AR operations using RF leg functionality are considered qualified with recognition that the RNP operations are expected to be performed consistent with the operators RNP AR approval. No further examination of aircraft capability, operator training, maintenance, operating procedures, databases, etc. is necessary.*

The flight manual or referenced document should contain the following information:

a. A statement indicating that the aircraft meets the requirements for RNP operations with RF legs and has demonstrated the established minimum capabilities for these operations. This documentation should include the phase of flight, mode of flight (e.g. FD on or off, and/or AP on or off, and applicable lateral and vertical modes), minimum demonstrated lateral navigation accuracy, and sensor limitations, if any;

b. Any conditions or constraints on path steering performance (e.g. AP engaged, FD with map display, including lateral and vertical modes, and/or CDI/map scaling requirements) should be identified. Use of manual control with CDI only is not allowed on RF legs; and

c. The criteria used for the demonstration of the system, acceptable normal and non-normal configurations and procedures, the demonstrated configurations and any constraints or limitations necessary for safe operation should be identified.

Compliance demonstration

In seeking an airworthiness approval for a navigation system implementing the RF path terminator, the compliance demonstration supporting such an approval should be scoped to the airspace operational concept and the boundaries to which the RF leg is likely to be applied.

Consideration should be given to evaluation of the navigation system on a representative set of procedure designs under all foreseen operating conditions. The evaluation should address maximum assumed crosswind and maximum altitude with the aircraft operating in the range of expected airspeeds for the manoeuvre and operating gross weights. Procedure design constraints should include sequencing multiple, consecutive RF leg segments of varying turn radii, including consecutive RF leg segments reversing the direction of turn (i.e. reversing from a left-hand RF turn to a right-hand RF turn). Within the demonstration, the applicant should be seeking to confirm the FTE commensurate with the identified RNP navigation accuracy and that the RF turn entry and exit criteria are satisfied. Any limitations identified during the compliance demonstration should be

documented. Flight crew procedures should be assessed, including identification of any limitations which surround the use of pilot selectable or automatic bank angle limiting functions and confirmation of those related to go-around or missed approach from an RF leg segment.

Legacy Aircraft

[reserved]

Operational Requirements

The pilot must use either a flight director or autopilot when flying an RF leg. The pilot should comply with any instructions or procedures identified by the manufacturer as necessary to comply with the performance requirements in this appendix.

ABAS RAIM

As required by the RNP parent specification the RF Leg is contained in.

Preflight planning

When the dispatch of a flight is predicated on flying an RNP procedure with an RF leg, the dispatcher/pilot must determine that the installed autopilot/flight director is operational.

Contingency procedures

If an aircraft system failure results in the loss of capability to follow an RF turn, the pilot should maintain the current bank and roll out on the charted RF exit course. The pilot should advise ATC as soon as possible of the system failure.

Pilot training

For pilot training requirement refer to Section 10 of this AC.

MEL considerations

Operators must have a MEL or equivalent addressing RF legs capability in relation to required equipment.

Continuing airworthiness

Operators must adhere to continued airworthiness instructions applicable to the aircraft configuration and the qualification for RF legs operation. The operator must also consider whether any future alterations to the aircraft or its configuration has an effect on the RF legs qualification.

On-board Performance Monitoring and Alerting

The navigation system must have the capability to execute leg transitions and maintain a track consistent with an RF leg between two fixes. The lateral TSE must be within ±1 × RNP of the path defined by the published procedure for at least 95 per cent of the total flight time for each phase of flight and each autopilot and/or flight director mode requested.

Aircraft Functional Requirements

The functional requirements of the RF Legs capable system as required by the Navigation specification, are met fs a statement is provided in the relevant accepted documentation that the system is installed per AC 20-130A, AC 20-138(),or equivalent airworthiness installation advisory material.

If such a statement is not provided the installation has to be assessed to the functional requirements in FAA AC 20-138D change 2 (or later revision).

Attachment A: PBN Implementation in New Zealand

In 2013 New Zealand began the transition from Part 19D GNSS IFR operations to ICAO-based PBN operations in the domestic flight information region. The transition to a complete PBN operating environment is expected by 2023. The CAA has published the following document: "Performance Based Navigation Operational End State 2023 – A Regulatory View" available on the CAA and New Southern Sky websites. The document will provide the reader with an understanding of PBN operations, navigation specification deployment, technology requirements and infrastructure anticipated to be in service by 2023.

Currently the CAA are delivering the necessary rule change to support the 2023 environment through a PBN regulatory project. Anticipated delivery of the complete PBN rules and associated notices and advisory circulars is 2021. Once the PBN regulatory framework project delivers the required change, rule Part 19D and exemption 11/EXE/7 will be revoked.

New Zealand PBN key operational decisions and requirements are summarised below:

- All PBN in New Zealand will be based upon GNSS, the constellation selected is the US Department of Defence Global Positioning System (GPS).
- PBN procedures based upon ground based navigation aids (e.g. DME/DME) will not be implemented.
- PBN implementation is based upon ICAO PBN Manual Doc 9613 and associated Standards and Recommended Practices (SARPS)
- Currently PBN has been deployed using RNAV and RNP specifications, both specification types in New Zealand are reliant on use of GPS.
- It is the intent for New Zealand to have an end state PBN environment based upon RNP specifications only, this aligns with the ICAO concept of PBN delivering optimum safety by use of RNP operations. GNSS legacy procedures supporting Part 19D GNSS IFR operations will be removed.
- New Zealand does not currently have an SBAS system that supports GNSS vertical navigation. However the New Zealand government are looking at a joint venture with Australia for SBAS capability, keep this in mind from a technology future proof perspective if purchasing PBN systems, the vertical navigation provided by SBAS provides a significant safety benefit.
- An aircraft will require GPS TSO (or equivalent) equipment and associated displays and systems to operate safely within the PBN environment. The system must be installed and certified to acceptable technical data, or require an airworthiness approval by the Director of the CAA.
- As PBN is solely reliant on GPS, the aircraft will require an alternate navigation system reliant on ground based navigation aids, using conventional navigation principles.
    - An IFR PBN flight must be able to be recovered safely using the alternate navigation system, this will require extraction and recovery planning by the operator for IFR – IMC conditions. Note, recovery based upon VFR operations is plausible, the operator should consider the risk and training requirements of such recovery means. An AC is being developed to provide guidance material for extraction and recovery requirements.
- It is the intention to have ground infrastructure providing a Minimum Operational Network and supporting instrument flight procedures based upon VOR and VOR/DME, enabling safe recovery of aircraft upon loss of PBN capability.

- At the time of publishing this AC, PBN deployment is complete at all international aerodromes, deployment to controlled aerodromes is at a mature state, expected to be 100% complete by end of 2021. The Legacy GNSS procedures supporting Part 19D GNSS IFR operations will likely cease by 2023, replacement with PBN procedures will be based upon operator, aerodrome or national demand.

Attachment B: Part 19D GNSS IFR Transition to PBN Specifications

CAR Part 19D IFR Operations GNSS, was published in 1997. This transition rule enabled GNSS navigation based upon the GPS constellation and FAA TSO-C129 equipment.

The instrument flight procedures developed to support Part 19D enable GPS en-route, terminal and approach operations. These procedures are known as legacy GNSS (GPS) procedures, they are not PBN specification procedures.

Part 19D approvals generally approved aircraft (on the Form CAA 2129) and operators (on the operations specification - Ops Spec) for GPS oceanic/remote, en-route, terminal and approach operations without reference to the PBN specifications (e.g. RNP 1, RNAV 2, RNP APCH, etc.).

Since Part 19D publication, GNSS technology has advanced and new technical standard orders have been developed by the FAA and EASA. Multiple satellite constellations are in service. ICAO PBN Manual Doc 9613 evolved and an international standard for Performance Based Navigation published and has been in use for a number of years.

As New Zealand implements PBN specifications, the Legacy GNSS (GPS) procedures are being removed from service. Aircraft with Part 19D approval can continue to operate to these legacy procedures. However, it is expected by 2023 that the Legacy GNSS (GPS) procedures will have been entirely removed from service and PBN specifications will be the only means of GNSS-based navigation under IFR.

The introduction of the RNAV and RNP operations above affects the Part 19D GNSS IFR approvals issued to date; aircraft systems will need to be reviewed for compliance for PBN operations eligibility. The PBN approvals are specific to the route/procedure classification; they do not affect existing equipment approvals for routes not defined as RNAV 1 or 2, RNP 1, RNP 2 or RNPS APCH (BARO VNAV).

Operators with aircraft and crew approved for PBN specifications based upon GNSS (GPS) can conduct the legacy GNSS (GPS) procedures through to their in-service removal.

Operators are encouraged to apply for PBN operational approvals well in advance of the full implementation of PBN in NZ to allow a reasonable period for CAA assessment and to avoid a period of ineligibility to use GNSS en-route navigation. New operators entering the system can no longer apply for a standalone Part 19D approval, they are required to apply for a PBN Operational Approval. The CAA assesses Part 19D compliance as part of the PBN Operational approval assessment.

Once the full set of PBN rules, notices and ACs have been delivered (expected 2021) Part 19D will be revoked.

During the transition to full PBN implementation in the NZ FIR, the following transitional arrangements for Part 19D approved aircraft operating in a PBN environment are in place, until Part 19D is revoked:

En-route Operations

- **RNAV 2:** Aircraft with existing GPS-IFR en-route approvals are approved to operate on RNAV 2 ATS routes.
- **RNP 2**: RNP 2 operations require a RNP 2 approval.

Terminal Operations

- **RNAV 1**: Except those fitted with equipment listed in Table 8 of Appendix IV – RNAV 1 and RNAV 2 Technical and Operational Criteria, all aircraft with existing GPS-IFR Terminal approvals are

approved to conduct RNAV 1 SID/STAR procedures. Owners/Operators of aircraft with equipment listed in Table 8 of Appendix IV – RNAV 1 and RNAV 2 Technical and Operational Criteria, are not authorised to conduct RNAV 1 SID/STAR procedures unless specifically approved to do so by the CAA.

- **RNP 1**: RNP 1 operations require a RNP 1 approval.

Approach Operations

- **RNP APCH (LNAV):** Aircraft with existing GPS-IFR non-precision approach approvals, or RNAV (GNSS) approach approvals, are approved to operate RNP APCH (LNAV), to LNAV minima, straight-in approaches (without RF legs) only.
- **RNP APCH (LNAV/VNAV)**: RNP APCH (LNAV/VNAV) operations require an RNP APCH LNAV/VNAV approval. Aircraft with existing Baro-VNAV approvals are approved to operate to LNAV/VNAV minima, straight-in approaches (without RF legs) only.

Pilot Training and Knowledge

Pilots currently authorised for:

- **RNAV (GNSS) approaches** may conduct RNP APCH operations but not RNP AR APCH unless specifically authorised.
- **GNSS (GPS) IFR en-route** operations may conduct RNAV 2 operations.
- **GNSS (GPS) Terminal** operations may conduct RNAV (GNSS) Arrival, RNAV1 SIDs and STARs.