

Advisory Circular

AC91-21

Revision 1

1 December 2021

Operational Approvals — Performance-Based Navigation

General

Civil Aviation Authority (CAA) advisory circulars (ACs) 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.

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 AC.

Purpose

This AC describes 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, as per rule 91.261. Approval by the Director may be granted when the operator has demonstrated compliance with the relevant airworthiness, continued airworthiness, and flight operations requirements.

Related Rules

This AC relates specifically to the applicable provisions of New Zealand Civil Aviation Rules, in particular rules 91.261, 91.263, and 91.519.

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

Change Notice

Revision 1 updates the AC completely to align with the PBN regulatory framework, by:

- updating the rule references
- including related CAA Notices
- adding a new Appendix I, Contingency Procedures in the Event of loss of Primary Means of Navigation (PMoN)
- renumbering all subsequent appendices as a result (with Appendix I in the last Revision now being Appendix II, and so on)

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- providing clarification and simplification of the PBN operation application and approval process, with reference to rules 91.261 and 91.263, and the new 91.519, due to come into force on 1 December 2021
- moving detailed technical and operational content to the Appendices, and
- including all RNP capabilities covered in the ICAO PBN Manual (DOC 9613 fourth edition).

It also introduces standard revision numbers and changes the order of some sections.

Version History

This revision history log contains a record of revisions made to this AC.

AC Revision No.	Effective Date	Summary of Changes
AC91-21, Rev 0	12 October 2012	Initial issue of this AC
AC91-21, Rev 0.1	18 November 2014	An interim change that introduced an additional subheading, under Part 1- 'transition clarification'.
AC91-21, Rev 0.2	19 December 2014	Clarified the interim paragraph introduced in Revision 0.1.
AC91-21, Rev.0.3	5 September 2016	Developed the equipment requirements for operational approvals.
AC91-21, Rev 1	1 December 2021	Complete update to to align with the PBN regulatory framework, by: • updating rule references • including related CAA Notices • adding definitions of 'RNP 0.3(H)' and 'Part 91 operators' specific to this AC • adding a new Appendix I, <i>Contingency Procedures in the Event of loss of Primary Means of Navigation (PMoN)</i> • renumbering all subsequent appendices as a result (with Appendix I in the last Revision now Appendix II, and so on) • providing clarification and simplification of the PBN operation application and approval process, with reference to rules 91.261 and 91.263, and new 91.519, due to come into force on 1 December 2021

		• moving detailed technical and operational content to the Appendices • including all RNP capabilities covered in the ICAO PBN Manual (DOC 9613 fourth edition), and • introducing standard revision numbers and changing the order of some sections. Note 1: On 16 December 2021, an incorrect rule reference at Section 9, page 35, was changed to 91.261(2)(iii). Formerly, the reference was listed as 91.263. We also corrected rule references at Appendix I, on page 34, from 91.261(a)(2)(iii) to rule 91.261(2)(iii). Lastly, we took the opportunity to correct some formatting errors in the Table of Contents and Section 5 - Navigation Specifications. Note 2: On 18 June 2025, we amended this AC as there was a numbering error and section 6 was inadvertently omitted. We have now adjusted the numbering by adding section 4, <i>Related Reading Material</i>. CAA would like to thank the participant who pointed out this error.
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Table of Contents

1. Introduction	8
2. Abbreviations	10
3. Definitions	13
4. Related Reading Material	13
5. Background	15
PBN Specifications used in the NZ FIR	15
En route Operations	16
Terminal Operations	17
Approach Operations	18
6. Operational approval process	20
Operational Approval Process overview	20
Pre-application	20
Application	21
Aircraft Eligibility	21
Continued Airworthiness	21
Operator Procedures:	22
Training and Qualification	22
Assessment	23
Aircraft Eligibility:	23
Continued Airworthiness:	23
Operational Considerations:	23
Pilot Knowledge and Training:	23
Human Factors:	23
Navigation Specifications:	24
Demonstration	24
Issue of Operational Approval	24
7. Aircraft Eligibility	25
Aircraft-level airworthiness compliance	25
System-level airworthiness compliance	25
8. Continued Airworthiness Considerations	28
MEL	28
9. Operational Considerations	30
Contingency Procedures in the event of loss of Primary Means of Navigation (PMoN)	30
Navigation database	31
Oversight of operators	31
10. Pilot Knowledge and Training	31
Appendix I – Contingency Procedures in the Event of loss of Primary Means of Navigation (PMoN)	34
Appendix II – RNAV 10 (RNP 10) Technical and Operational Criteria	37
Purpose	37
Implementation in New Zealand	37
Applicable Specification	37
Airworthiness Requirements	37
Communications environment	37
Surveillance environment	37
Navaid infrastructure considerations	38
SBAS	38
Navigation systems eligibility	38

Appendix III – RNP 4 Technical and Operational Criteria	40
Purpose	40
Implementation in New Zealand	40
Applicable Specification.....	40
Airworthiness Requirements.....	40
Communications environment.....	40
Surveillance environment.....	40
Navaid infrastructure considerations.....	41
SBAS	41
Navigation systems eligibility	41
Appendix IV – RNAV 5 (BRNAV) Technical and Operational Criteria.....	42
Purpose	42
Implementation in New Zealand	42
Applicable Specification.....	42
Airworthiness Requirements.....	42
Communications environment.....	42
Surveillance environment.....	42
Navaid infrastructure considerations.....	42
SBAS	42
Navigation systems eligibility	43
Appendix V – RNAV 1 and RNAV 2 Technical and Operational Criteria	44
Purpose	44
Implementation in New Zealand	44
Applicable Specification.....	44
Airworthiness Requirements.....	44
Communications environment.....	44
Surveillance environment.....	44
Navaid infrastructure considerations.....	44
SBAS	45
Navigation systems eligibility	45
Legacy Aircraft.....	45
RNAV Systems Compatibility Compliance Table	46
Appendix VI – RNP 2 Technical and Operational Criteria.....	51
Purpose	51
Implementation in New Zealand	51
Applicable Specification.....	51
Airworthiness Requirements.....	51
Communications environment.....	51
Surveillance environment.....	51
Navaid infrastructure considerations.....	51
ABAS RAIM	52
Navigation systems eligibility	52
Legacy Aircraft.....	52
Appendix VII – RNP 1 Technical and Operational Criteria.....	53
Purpose	53
Implementation in New Zealand	53
Applicable Specification.....	53
Airworthiness Requirements.....	53
Communications environment.....	53
Surveillance environment.....	53
Navaid infrastructure considerations.....	53
SBAS	53
ABAS RAIM	54
Navigation systems eligibility	54
Legacy Aircraft.....	54
Appendix VIII – A-RNP (Advanced-RNP) Technical and Operational Criteria	55
Purpose	55
Implementation in New Zealand	56
Applicable Specification.....	56
Airworthiness Requirements.....	56
Communications environment.....	56
Surveillance environment.....	56

Navaid infrastructure considerations.....	56
SBAS	56
ABAS RAIM	56
Navigation systems eligibility	56

Appendix IX - RNP APCH (LNAV and LNAV/VNAV) Technical and

Operational Criteria	58
Purpose	58
Implementation in New Zealand	58
Applicable Specification.....	58
Airworthiness Requirements.....	58
Communications environment.....	58
Surveillance environment.....	58
Navaid infrastructure considerations.....	58
SBAS	59
ABAS RAIM	59
Navigation systems eligibility	59
Legacy Aircraft.....	59

Appendix X – RNP APCH (LP and LPV minima) Technical and

Operational Criteria	61
Purpose	61
Implementation in New Zealand	61
Applicable Specification.....	61
Airworthiness Requirements.....	61
Communications environment.....	61
Surveillance environment.....	62
Navaid infrastructure considerations.....	62
SBAS	62
ABAS RAIM	62
Navigation systems eligibility	62
Legacy Aircraft.....	62

Appendix XI – RNP AR APCH Technical and Operational Criteria

Purpose	64
Implementation in New Zealand	64
Applicable Specification.....	64
Airworthiness Requirements.....	64
Communications environment.....	64
Surveillance environment.....	64
Navaid infrastructure considerations.....	64
SBAS	64
ABAS RAIM	65
Navigation systems eligibility	65

Appendix XII – RNP 0.3(H) Technical and Operational Criteria.....

Purpose	66
Implementation in New Zealand	66
Applicable Specification.....	66
Airworthiness Requirements.....	66
Communications environment.....	67
Surveillance environment.....	67
Navaid infrastructure considerations.....	67
SBAS	67
ABAS RAIM	67
Navigation systems eligibility	67

Appendix XIII – Baro-VNAV Technical and Operational Criteria.....

Purpose	68
Implementation in New Zealand	68
Applicable Specification.....	68
Airworthiness Requirements.....	68
Communications environment.....	68
Surveillance environment.....	68
Navaid infrastructure considerations.....	68
SBAS	68
Navigation systems eligibility	69

Appendix XIV – RF Legs Technical and Operational Criteria.....	70
Purpose	70
Implementation in New Zealand	70
Applicable Specification.....	70
Airworthiness Requirements.....	70
Communications environment.....	70
Surveillance environment.....	71
Navaid infrastructure considerations.....	71
SBAS	71
ABAS RAIM	71
Navigation systems eligibility	71

1. Introduction

The purpose of this 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 rules 91.261 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 AC 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 as per the CAA Notices referred to in rule 91.263:

- i. RNAV 10 (RNP 10)
- ii. RNP 4
- iii. RNAV 5
- iv. RNAV 1 and RNAV 2^a
- 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)

PBN also includes the following additional, optional capabilities, which may be applicable to more than one Navigation Specification:

- xii. Baro-VNAV
- xiii. RF Legs

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

Note: Existing 'GNSS IFR en route' approvals may operate in accordance with Notice of requirement NTC 91.263 "*Non RNAV/RNP designated GPS procedures & PBN Operations with a Part 19D operational approval*" until the conditions of the Notice expire, or the notice is revoked.

It should be noted that not all navigation specifications are implemented in New Zealand airspace. However, operators may be approved by the Director for navigation specifications not implemented in the New Zealand FIR, provided the technical and operational requirements of that navigation specification are complied with. This allows operators to carry out these navigation specifications where they may be available. (For international operations, additional approval may be needed from the applicable NAA.)

An overview of the navigation specifications is included in Section 4 - 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 the CAA Notices referenced in rule 91.263.

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, 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 CAA at their earliest convenience should an alternative means of compliance be contemplated.

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. CAA acknowledges the contribution of industry stakeholders in the development of this document.

2. Abbreviations

The following abbreviations specifically pertaining to this AC are included below. See also Part 1 for other abbreviations not specific to this AC.

ABAS	Aircraft-Based Augmentation System
AC	Advisory Circular
ADS-B	Automatic Dependent Surveillance - Broadcast
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
AMoN	Alternative Means of Navigation
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
DR	Dead Reckoning
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
GBNA	Ground-Based Navigation Aid
GLS	GBAS Landing System
GNSS	Global Navigation Satellite system
GPS	Global Positioning 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 / Letter of Approval
LP	Localiser Performance (without Vertical Guidance)
LPV	Localiser Performance with Vertical Guidance
LRCS	Long Range Communication System

LRNS	Long Range Navigation System
LRU	Line Replaceable Unit
MDA	Minimum Descent Altitude
MPS	Minimum Performance Specification
MSL	Mean Sea Level
NAA	National Aviation Authority
NSE	Navigation System Error
NSS	New Southern Sky
NZ FIR	New Zealand flight information region
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
PMoN	Primary Means of Navigation
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 to 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 AC are included below. See also Part 1 for other terms not specific to this AC.

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).
RNP 0.3(H)	This term is used instead of the ICAO En route RNP 0.3 definition used in DOC 9613. This to differentiate better between the various navigation specification that use RNP 0.3 as part of the specification such as RNP <i>APCH and RNP AR</i> .
Part 91 operators	This term is used to refer to participants operating under Part 91 who: • do not hold a Part 119 certificate, but • have a requirement to conduct PBN operations within New Zealand.

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*
7. Doc 9997 – *Performance-Based Navigation (PBN) Operational Approval Manual*, and
8. Doc 9905 – *RNP AR Required Navigation Performance Authorization Required (RNP AR) Procedure Design Manual*

The following documents are referenced in this AC:

Note: Titles are new, not the references.

Note: A number of the documents referenced have become obsolete. This, however, does not invalidate existing approvals to these references, therefore they are included.

1. CAA AC61-17 - *Pilot licences and ratings - Instrument ratings*
2. CAA AC91-7 - *Required navigation performance (RNP 10)*
3. CAA AC91-8 - *Required navigation performance in European airspace designated for basic RNAV (BRNAV) operations (RNP 5)*
4. CAA AC91-10 - *Required Navigational Performance 4 (RNP 4) Operational Approval*

5. CAA AC91-18 - *Aircraft Software Configuration Management*
6. FAA AC20-129 - *Airworthiness Approval of Vertical Navigation (VNAV) Systems for use in the U.S. National Airspace System (NAS) and Alaska*
7. FAA AC20-130A - *Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors*
8. FAA AC20-138() - *Airworthiness Approval of Positioning and Navigation Systems*
9. FAA AC20-138D Change 2 - *Airworthiness Approval of Positioning and Navigation Systems (Including Change 2)*
10. FAA AC20-153 - *Acceptance of Data Processes and Associated Navigation Databases*
11. FAA AC90-100 - *U.S. Terminal and En Route Area Navigation (RNAV) Operations*
12. FAA AC90-100A - *U.S Terminal and En Route Area Navigation (RNAV) Operations with Change 2*
13. FAA AC90-101A - *Approval Guidance for Required Navigation Performance (RNP) Procedures with Authorization Required (AR) Including Change 1*
14. FAA AC90-105 - *Approval Guidance for RNP Operations and Barometric Vertical Navigation in the U.S. National Airspace System*
15. FAA AC90-107 - *Guidance for Localizer Performance with Vertical Guidance and Localizer Performance without Vertical Guidance Approach Operations in the U.S. National Airspace System*
16. EASA CS-ACNS Issue 2 - *Airborne Communications, Navigation and Surveillance*
17. EASA AMC 20-4 - *Airworthiness Approval and Operational Criteria For the Use of Navigation Systems in European Airspace Designated For Basic RNAV Operations*
18. EASA AMC 20-26 - *Airworthiness Approval and Operational Criteria for RNP Authorisation Required (RNP AR) Operations*
19. EASA AMC 20-27 - *Airworthiness Approval and Operational Criteria for RNP APPROACH (RNP APCH) Operations Including APV BARO-VNAV Operations*
20. EASA AMC 20-28 - *Airworthiness Approval and Operational Criteria related to Area Navigation for Global Navigation Satellite System approach operation to Localiser Performance with Vertical guidance minima using Satellite Based Augmentation System*
21. JAA TGL-3 - *Guidance Material on Airworthiness Approval and Operational Criteria for the use of the Navstar Global Positioning System (GPS)*
22. JAA TGL-10 – *Airworthiness and Operational Approval for Precision RNAV Operations in Designated European Airspace*

5. Background

PBN Specifications used in the NZ FIR

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

Table 1 – ICAO PBN Specifications in relation to Flight Phase

Navigation Specification	Flight Phase							
	En route		Terminal		Approach			
	Oceanic/ Remote	Continental/ Domestic	Arrival	Departure	Initial	Intermediate	Final	Missed
RNAV 10 (RNP 10)	10							
RNP 4	4							
<i>RNAV 5 (BRNAV)</i>		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
<i>A-RNP</i>	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
<i>RNP APCH (LP)</i>					1	1		1
<i>RNP APCH (LPV)</i>					1	1		1
RNP AR APCH					1-0.1	1-0.1	0.3-0.1	1-0.1
<i>RNP 0.3(H)</i>		0.3	0.3	0.3	0.3	0.3		0.3

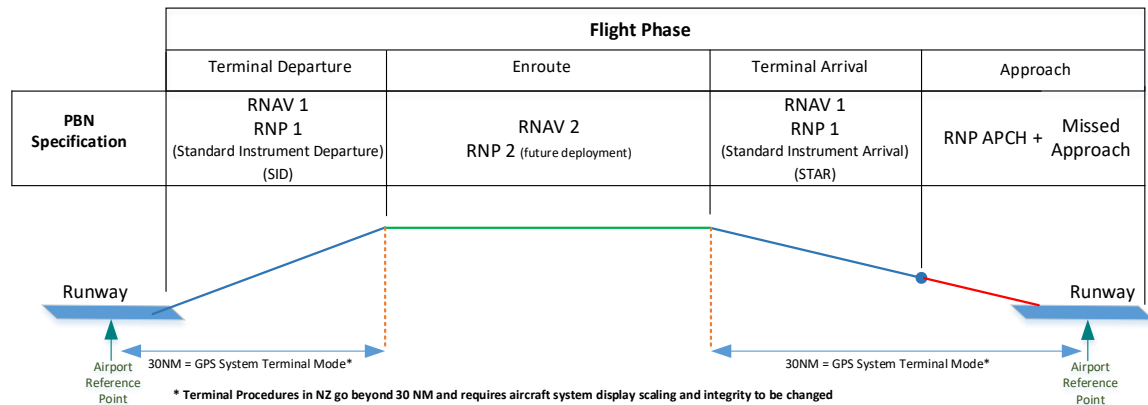
Note: RNAV 2 PANS OPS design criteria are used for those routes that are designated as ATC monitored. Currently, RNAV 2 routes outside of surveillance are based on basic GNSS criteria to account for 'GPS IFR en route' approved receivers and those without on board monitoring and alerting (XTT 4 NM, ATT 2 NM, semi width 8 NM). Existing 'GNSS IFR en route' approvals may operate RNAV 2 until the conditions in the related CAA Notice under rule 91.263 expire or when the notice is revoked. After this date, the operator must have applied for and been approved for RNAV 2/RNP 2 operations as defined in this AC.

Note: 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 are not yet implemented in NZ FIR. The number in the above table specifies the required accuracy level.

A pictorial presentation is shown below, 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 Appendices II through XIV. The technical requirements to comply with the navigation specifications and to obtain operational approval are contained in the CAA Notices under rule 91.263.

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 (continental) are conducted in direct controller-pilot communication. RNP 2 (remote/oceanic) may require performance-based communication RCP at levels depended on track spacing Ref ICAO ATN DOC 4444
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 limited application in New Zealand. Refer to the AIP for details, limitations, and requirements.

Terminal Operations

Applicable terminal PBN Specifications:

- **RNAV 1** SIDs and STARs (reliant on GNSS, GPS) (Note that 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. Manual scaling requirements may exist in older GNSS equipment (TSO-C129()), but most newer GNSS systems automatically scale appropriately based on the SID and STAR information in the navigation database regardless of the 30NM radius. Check your equipment manual whether this applies to your GNSS navigator.

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 an 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 4.

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, so 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 AC 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 the operator 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 Part 91 operators, CAA will issue/amend a Letter of Operational Approval (LOA).

Note: The Part 91 LOA will be issued against the specific aircraft, and stipulate the further compliance requirements for the pilot of the aircraft wishing to carry out the PBN operations.

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 operational approvals 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 as possible 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 CAA 24091/07:

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 identifies the Level associated with the equipment. (Refer to AC43-10, *Aircraft radio station - 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 rules 91.261, 91.501(2)(ii)(A) and rule 91.519, as well as any air operator certification instrument and equipment requirements (e.g. rules 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 rules 91.261 and 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.

Minimum Equipment List (MEL)

The applicant should submit an amended MEL, or MEL to be approved, in accordance with rule 91.539, and requirements defined in the applicable CAA Notice as per rule 91.263. Section 8 of this AC provides guidance about some of the operations that can be 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 to be 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, system 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 while 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 applicable navigation specification related CAA Notices issued under rule 91.263. If not, NSS SOP guidance material (at <https://www.nss.govt.nz/> or <https://www.aviation.govt.nz/>) may be useful for developing an SOP to meet requirements.

For Part 119 operators –**PBN Procedures Manual**

This document shall address all requirements of the applicable navigation specification related CAA Notice issued under rule 91.263.

Standard Operating Procedures

The applicant may produce a Procedures Manual as defined above or include the requirements of the applicable navigation specification related CAA Notice issued under rule 91.263 in the organisation's standard operating procedures or exposition.

These procedures must be documented in a PBN manual (as applicable), or as part of the operator's exposition. 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.

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 (as outlined in AC 61-17, *Pilot licences and ratings - Instrument ratings*) 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, 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.

CAA's 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 CAA Notice for the navigation specifications 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 detail on these requirements.

Human Factors:

There are several 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 related CAA Notices issued under rule 91.263, for guidance on compliance see the following Appendices:

- (i) Appendix I – Contingency Procedures in the Event of loss of Primary Means of Navigation (PMoN)Appendix I – Contingency Procedures in the Event of loss of Primary Means of Navigation (PMoN)
- (ii) Introduction
- (iii) The intent of rule 91.261(2)(iii) is for all aircraft conducting IFR flights to be capable of landing safely in the event of loss of their PMoN, irrespective of whether that loss is due to an internal aircraft system failure, loss of GNSS signal, or failure of a system external to the aircraft (e.g. GNSS disruption or GBNA failure). To enable this intent to be met, the loss of PMoN must be proactively planned for prior to the flight departing, as opposed to the situation being addressed in a reactive manner when it occurs.

Rule 91.261(2)(iii) is considered to be complementary to rules 121.353, 125.353 and 135.353 which require operators to ensure that aircraft used for air operations are equipped with sufficient navigation equipment to enable continued safe navigation for the route being flown, in the event of the failure of any onboard independent system.

Part 121, 125 and 135 operators conducting air transport operations are required to have contingency procedures for the loss of PMoN event documented in their CAA approved exposition. These procedures need to cover each route and procedure flown by the operator.

Those operating solely under Part 91 while not needing to have documented procedures, should still ensure that their contingency planning is relevant to the route planned to be flown and addresses the elements identified in this section.

General Information

Factors Causing a Loss of Navigational Capability:

The loss of navigational capability includes any failure or event causing the aircraft to no longer satisfy the requirements of the navigation specification being flown at the time, for example:

- Loss of GNSS Signal-In-Space (SIS) which may result in the GNSS system displaying a Loss of Integrity (LOI) warning.
- The GNSS receiver (or GBNA-based PMoN) system or equipment fails in flight.
- RAIM warning in flight. A prolonged display of a RAIM warning indicates that the GNSS receiver's navigational capability may not be reliable.
- A GNSS receiver operating in DR. A GNSS receiver displaying operating in DR for longer than one minute indicates the loss of that GNSS receiver's navigational capability.

While the need to consider loss of navigational capability has become more apparent as GNSS based navigation systems have proliferated throughout aviation, the underlying reasons for such planning is equally relevant to an aircraft fitted with only GBNA-based navigation systems.

Impact of Loss of Navigational Capability:

The consequences of a loss of navigational capability are dependent upon the operational environment at the time and the availability of a suitable Alternative Means of Navigation (AMoN). In the event of losing the aircraft's PMoN, the PIC must be aware of what navigational capability still exists in their aircraft. This will differ from aircraft to aircraft based on its navigation system equipment. As the required navigation performance for a PBN procedure can change depending upon the phase of flight, the PIC must also take this into account when planning for the loss of PMoN.

Pre-Flight Planning for loss of PMoN

During pre-flight planning pilots and operators must make contingency plans to deal with the loss of PMoN. The following are some of the factors that need to be considered, however, this is not an exhaustive list and it is important that other factors relevant to the route or specific environment be properly considered:

- Phase of flight:
 - Departure, En route, Arrival, Approach and Missed Approach.
- Route:
 - Terrain, minimum safe altitudes, effective range of AMoN (if GBNA).
- Aircraft Equipment:
 - Warnings/Cautions/Alerts related to on-board/external failures.
 - Other relevant aircraft systems/capabilities (e.g. RADALT, ice protection).
 - Impact of loss of GNSS signal on other aircraft systems (e.g. TAWS, ADS-B).
 - Pilot qualification and currency with all on board systems and equipment.

- Weather:

If forecast conditions suggest IMC then an AMoN must be planned.

Dead Reckoning (DR) navigation may only be used while proceeding to be within range of the AMoN, as long as the aircraft remains above MSA until it is able to descend in accordance with a published procedure based on the AMoN.

- If the forecast conditions are for VMC, then a transition to DR navigation techniques and VFR navigation may be considered as an AMoN.

Note: there must be a very high assurance of VMC if the planning relies on a transition to VFR and a subsequent visual approach to landing.

- ATC:
 - Range of ATC reception.
 - Limitations on ATC's ability to provide surveillance and navigation support in the event of a loss of PMoN, including:

- whether procedural control is the only tool available to the controller
- whether the aircraft might be below MVA, and
- the impact of other traffic in the vicinity who may also be affected by a GNSS outage and its effect on:
 - Aircraft separation, or
 - Duration of holding.
- Fuel:
 - In addition to Part 91.403 IFR Fuel Requirements, consideration of additional fuel may be required to enable the implementation of the contingency plan in the event of loss of PMoN.

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

- (xvi) Appendix XIII – Baro-VNAV Technical and Operational Criteria
- (xvii) Appendix XIV – RF Legs Technical and Operational Criteria

It should be noted that the navigation specification Notices do not necessarily imply a need for re-certification to the technical and operational criteria. Technical data approved by another State that meet the technical requirements of these Notices, are generally accepted by CAA without the need for re-approval. (For example, aircraft with an AFM stating compliance of the RNP 1 navigation system installed that complies with the airworthiness requirements of the applicable Notice does not require a CAANZ airworthiness approval, but the local operator's procedures may require CAANZ assessment and operational approval in accordance with this AC.)

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, 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, CAA will issue an **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.

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, AC or similar documents issued by the State of Design, and/ or
- 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 appendices 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 CAA Notice issued under rule 91.263. 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 applicable navigation specification Notice issued under rule 91.263 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 applicable Notice.

Surveillance equipment: refer to the applicable Notice.

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 rules that may apply to the operation.

Table 5 Equipment requirement per Nav Spec.

Navigation Specification	NAV	COM	Surveillance
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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: Systems included in brackets can meet the requirements of the navigation specification and or communication considerations, but their use may not always be by the route infrastructure.

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 91.261 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 programme.

The operator must note and address how 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.

MEL

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.

Rule 121.353(a)(1)(iii) states: *“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.”* (Rules 125.353 and 135.353 have the same meaning but slightly different phrasing.)

As PBN relies on containment within the specified boundaries of the track to be able to navigate safely along the route being flown, this carries an implicit expectation 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.

Operators developing a 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 below, 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 rules 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 thus 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 when only 1 GNSS is fitted* Qty 1 Transponder Qty 1 VHF Com	Qty 2 GNSS Qty 2 Alternate non-GNSS means of navigation Qty 1 Transponder** Qty 2 VHF Com
RNP 1	Qty 1 GNSS Qty 1 Alternate non-GNSS means of navigation external to GNSS LRU when only 1 GNSS is fitted* 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 when only 1 GNSS is fitted* 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 when only 1 GNSS is fitted* 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 Qty 2 Level 1 long range com
RNP APCH	Qty 1 GNSS Qty 1 Alternate non-GNSS means of navigation external to GNSS LRU when only 1 GNSS is fitted* 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.

** More than 1 transponder is recommended to provide redundancy and not significantly increase workload on failure due to increased radio contact with ATC.

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 5 of this AC.

Part 91 Operators:

The application shall include a copy of the operations manual/standard operating procedures required to operate in accordance with rule 91.261.

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.
- (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 91.261 for RNP operations and must include similar requirements for RNAV operations.

Part 119 operators:

In addition to the above, Part 119 operators must include in their checklists/manuals the operational and training requirements defined in the applicable Navigation Specification Notices under rule 91.263.

Contingency Procedures in the event of loss of Primary Means of Navigation (PMoN)

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 is a planned response to the loss of primary means of navigation (PMoN), whereby the aircraft is able to be safely transitioned from being navigated by way of its PMoN to being navigated by way of an alternative means of navigation (AMoN) to enable the flight to continue safely to the intended destination aerodrome or diversion to an alternate aerodrome. The aircraft must be fuelled to allow for a loss of PMoN at any point in the flight.

For the purposes of rule 91.261(2)(iii), an AMoN acceptable to the director is one that allows for the aircraft to navigate and land safely without the use of GNSS.

For further guidance on Contingency Procedures, see Appendix I.

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. A LOA (or other equivalent document) issued by the appropriate regulatory authority demonstrates compliance with this requirement (e.g. an FAA LOA issued in accordance with FAA AC 20-153 or an 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 (for example, exceedance of cross-track boundary) by crew members, and appropriate investigation and response by operators. 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 issued under rule 91.261, 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:

- Part 61, Subpart Q Instrument ratings
- Rules 119.53 and 19.103 Personnel competency requirements
- Part 121, Subpart I, Training, and Subpart J, Crew Member Competency Requirements
- Part 125, Subpart I, Training, and Subpart J, Crew Member Competency Requirements, and

- 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 AC 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 of AC61-17, *Pilot licences and ratings - Instrument ratings*.

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, and
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 of pre-flight planning contingency procedures appropriate to the operation, are considered in the event of a loss of GNSS capability. For further information, refer to Appendix I.

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 recognise 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 – Contingency Procedures in the Event of loss of Primary Means of Navigation (PMoN)

Introduction

The intent of rule 91.261(2)(iii) is for all aircraft conducting IFR flights to be capable of landing safely in the event of loss of their PMoN, irrespective of whether that loss is due to an internal aircraft system failure, loss of GNSS signal, or failure of a system external to the aircraft (e.g. GNSS disruption or GBNA failure). To enable this intent to be met, the loss of PMoN must be proactively planned for prior to the flight departing, as opposed to the situation being addressed in a reactive manner when it occurs.

Rule 91.261(2)(iii) is considered to be complementary to rules 121.353, 125.353 and 135.353 which require operators to ensure that aircraft used for air operations are equipped with sufficient navigation equipment to enable continued safe navigation for the route being flown, in the event of the failure of any onboard independent system.

Part 121, 125 and 135 operators conducting air transport operations are required to have contingency procedures for the loss of PMoN event documented in their CAA approved exposition. These procedures need to cover each route and procedure flown by the operator.

Those operating solely under Part 91 while not needing to have documented procedures, should still ensure that their contingency planning is relevant to the route planned to be flown and addresses the elements identified in this section.

General Information

Factors Causing a Loss of Navigational Capability:

The loss of navigational capability includes any failure or event causing the aircraft to no longer satisfy the requirements of the navigation specification being flown at the time, for example:

- Loss of GNSS Signal-In-Space (SIS) which may result in the GNSS system displaying a Loss of Integrity (LOI) warning.
- The GNSS receiver (or GBNA-based PMoN) system or equipment fails in flight.
- RAIM warning in flight. A prolonged display of a RAIM warning indicates that the GNSS receiver's navigational capability may not be reliable.
- A GNSS receiver operating in DR. A GNSS receiver displaying operating in DR for longer than one minute indicates the loss of that GNSS receiver's navigational capability.

While the need to consider loss of navigational capability has become more apparent as GNSS based navigation systems have proliferated throughout aviation, the underlying reasons for such planning is equally relevant to an aircraft fitted with only GBNA-based navigation systems.

Impact of Loss of Navigational Capability:

The consequences of a loss of navigational capability are dependent upon the operational environment at the time and the availability of a suitable Alternative Means of Navigation (AMoN). In the event of losing the aircraft's PMoN, the PIC must be aware of what navigational capability still exists in their aircraft. This will differ from aircraft to aircraft based on its navigation system equipment. As the required navigation performance for a PBN procedure can change depending upon the phase of flight, the PIC must also take this into account when planning for the loss of PMoN.

Pre-Flight Planning for loss of PMoN

During pre-flight planning pilots and operators must make contingency plans to deal with the loss of PMoN. The following are some of the factors that need to be considered, however, this is not an exhaustive list and it is important that other factors relevant to the route or specific environment be properly considered:

- Phase of flight:
 - Departure, En route, Arrival, Approach and Missed Approach.
- Route:
 - Terrain, minimum safe altitudes, effective range of AMoN (if GBNA).
- Aircraft Equipment:
 - Warnings/Cautions/Alerts related to on-board/external failures.
 - Other relevant aircraft systems/capabilities (e.g. RADALT, ice protection).
 - Impact of loss of GNSS signal on other aircraft systems (e.g. TAWS, ADS-B).
 - Pilot qualification and currency with all on board systems and equipment.
- Weather:

If forecast conditions suggest IMC then an AMoN must be planned.

Dead Reckoning (DR)² navigation may only be used while proceeding to be within range of the AMoN, as long as the aircraft remains above MSA until it is able to descend in accordance with a published procedure based on the AMoN.

- If the forecast conditions are for VMC, then a transition to DR navigation techniques and VFR navigation may be considered as an AMoN.

Note: there must be a very high assurance of VMC if the planning relies on a transition to VFR and a subsequent visual approach to landing.

² For the purpose of contingency planning; Dead Reckoning (DR) is the technique of navigation by estimation of a specific heading for a specific time in order to reach a desired location, in the event of a loss of PMoN.

- ATC:
 - Range of ATC reception.
 - Limitations on ATC's ability to provide surveillance and navigation support in the event of a loss of PMoN, including:
 - whether procedural control is the only tool available to the controller
 - whether the aircraft might be below MVA, and
 - the impact of other traffic in the vicinity who may also be affected by a GNSS outage and its effect on:
 - Aircraft separation, or
 - Duration of holding.
- Fuel:
 - In addition to Part 91.403 IFR Fuel Requirements, consideration of additional fuel may be required to enable the implementation of the contingency plan in the event of loss of PMoN.

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

Purpose

This appendix provides guidance to operators seeking RNP 10 approval and is applicable to 50 NM lateral and the 50 NM longitudinal distance-based separation minima in oceanic or remote area airspace.

This appendix has been titled RNAV 10 for consistency with the other chapters in the ICAO PBN manual. RNAV 10 does not require on-board performance monitoring and alerting. However, the designation of the airworthiness and operational approval, as well as airspace/route designation, remains “RNP 10” in order to retain the validity of the present publications and extensive approvals. Recognising the extent of existing airspace designations and operational approvals under RNP 10 designation, it is anticipated that any new airspace designations and aircraft approvals will continue to use the “RNP 10” term while the required PBN application will now be known as “RNAV 10.”

Implementation in New Zealand

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

Applicable Specification

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

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 the systems for the navigation specification, and to establish what documentation to provide to the CAA as evidence of the aircraft and its system eligibility. The responsibility for airworthiness approval/certification of the aircraft and systems to these airworthiness requirements lies with the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness requirements refer to CAA Notice 91.263 RNP 10.

Communications environment

There is no specific requirement for ATS communications for RNP 10. Communications and ATS surveillance requirements associated with implementation of route systems and lateral separation minima utilising RNP10 are normally determined in the implementation process taking into account any local and regional characteristics. For example, procedural-pilot position reports and voice communications through a third party have been demonstrated to be acceptable in some implementations; however, DCPC may be required in certain areas, such as those of known convective weather.

Surveillance environment

This navigation specification is primarily intended for oceanic and remote environments. ATS surveillance requirements for distance-based longitudinal separation utilising RNP10 are specified in ICAO PANS-ATM.

Navaid infrastructure considerations

RNP 10 was developed for operation in oceanic and remote areas and does not require any ground-based NAVAID infrastructure or assessment.

SBAS

RNP 10 is not dependent on the availability of SBAS service.

Navigation systems eligibility

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

Three methods of determining aircraft eligibility have been defined:

Method 1 — RNP certification

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

Method 2 — Aircraft eligibility through prior navigation system certification

Method 2 can be used to approve aircraft whose level of performance, under other/previous standards, can be equated to the RNP 10 criteria. The standards listed in CAA Notice NTC 91.236 RNAV 10 (RNP 10) can be used to qualify an aircraft. Other standards may also be used if they are sufficient to ensure that the RNP 10 requirements are met. If other standards are to be used, the applicant must propose an acceptable means of compliance.

Method 3 — Aircraft eligibility through data collection

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

There are two data collection methods for Method 3:

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

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

Appendix III – RNP 4 Technical and Operational Criteria

Purpose

This appendix may be used for RNP 4. RNP 4 was originally developed to support 30 NM lateral and the 30 NM longitudinal distance-based separation minima in oceanic or remote area airspace.

This appendix provides guidance for implementing RNP 4. The operational approval process described herein is limited to aircraft which have received airworthiness certification indicating the installed navigation systems meet the performance requirements for RNP 4 per CAA Notice NTC 91.263 RNP 4.

Implementation in New Zealand

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

Applicable Specification

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

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 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 lies with the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness requirements refer to CAA Notice 91.263 RNP 4.

Communications environment

There is no specific requirement for ATS communications for RNP 4, however in order to ensure the magnitude and frequency of gross lateral errors are kept within acceptable limits, and to manage contingency and emergency events, consideration should be given to the use of DCPC (voice) or CPDLC communications, plus ADS-C surveillance, utilising waypoint/periodic reporting and lateral deviation event contracts.

Surveillance environment

In respect of longitudinal separation, communications and ATS surveillance requirements for distance based longitudinal separation utilising RNP 4 are specified in ICAO PANS-ATM.

Note: An existing application of 30 NM lateral and 30 NM longitudinal separation minimum requires a communications capability of DCPC or CPDLC and an ATS surveillance capability by an ADS system in which an event contract must be set that includes a lateral deviation event report whenever a deviation from track centre line greater than 9.3 km (5 NM) occurs.

Navaid infrastructure considerations

This navigation specification was developed for operations in oceanic and remote airspace, therefore, it does not require any ground-based NAVAID infrastructure. GNSS is the primary navigation sensor to support RNP 4, either as a stand-alone navigation system or as part of a multi-sensor system.

SBAS

RNP 4 is not dependent on the availability of SBAS service.

Navigation systems eligibility

The following systems meet the accuracy, integrity and continuity requirements for RNP 4.

- 1) Aircraft fitted with GNSS only as an approved long-range navigation system for oceanic and remote airspace operations must meet the technical requirements specified in CAA Notice NTC 91.263 RNP 3. The flight manual must indicate that dual GNSS equipment approved under an appropriate standard is required. Appropriate standards are FAA TSOs C129A or C146(), and JAA JTOSs C129A or C146(). In addition, an approved dispatch FDE availability prediction programme must be used.
- 2) Multi-sensor systems integrating GNSS with integrity provided by RAIM. Multi-sensor systems incorporating GPS with RAIM and FDE that are approved under FAA AC20-130a, or other equivalent documents, meet the technical requirements specified in 1.3.3. Note that there is no requirement to use dispatch FDE availability prediction programmes when multi-sensor systems are fitted and used.
- 3) Aircraft autonomous integrity monitoring (AAIM). AAIM uses the redundancy of position estimates from multiple sensors, including GNSS, to provide integrity performance that is at least equivalent to RAIM. These airborne augmentations must be certified in accordance with TSO C-115b, JTOS C-115b or other equivalent documents. An example is the use of an INS or other navigation sensors as an integrity check on GNSS data, when RAIM is unavailable but GNSS positioning information continues to be valid.

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

Purpose

This appendix provides guidance to operators seeking RNAV 5 approval and is applicable to operation in airspace where the carriage of RNAV meets 5 NM lateral accuracy (e.g. ECAC B-RNAV). It avoids the need for further approvals in other regions or areas needing to implement RNAV with the same lateral accuracy and functional requirements.

Implementation in New Zealand

This navigation specification is not implemented on ATS routes in NZ FIR.

Note: This Navigation spec may be of use to operators who carry out operations in Europe or the Middle East where this specification is in use

Applicable Specification

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

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 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 lies with the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness requirements refer to CAA Notice 91.263 RNAV 5.

Communications environment

Direct pilot to ATC (voice) communications is required for RNAV 5.

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

- a) VOR/DME
- b) DME/DME
- c) INS or IRS, and
- d) GNSS.

SBAS

RNAV 5 is not dependent on the availability of SBAS service, when GNSS is the providing sensor.

Navigation systems eligibility

RNAV 5 does not have a predefined systems eligibility criterion as the performance can be met and or demonstrated in many ways.

Refer to CAA Notice NTC 91.236 RNAV5, for the system criteria for RNAV 5.

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

Purpose

This specification is the result of the harmonisation 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 refers 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 by 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 lies with the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness requirements refer to CAA Notice 91.263 relating to RNAV 1 and/or RNAV 2.

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 coverage³.

Note: Most modern RNAV systems prioritise 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 standardisation. 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 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, and/or
- 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, and/or
- 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 only one of these two specifications, the following has to be verified:

³ 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 authorised 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.

RNAV Systems Compatibility Compliance Table

The FAA has published AC90-100, Compliance Tables document, which can be found at:

https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_90-100A_CHG_1.pdf

Table 7 - RNAV System Capability Compliance Table, overleaf, 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. Pre-flight 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 LOA for navigation database.	Yes	No

Manufacturer	System	Part Number	Software Version	Approval Using GPS	RNAV 2 Routes	RNAV 1 SID/STARS
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 procedures. No plans to obtain Type 2 LOA for navigation database.	Yes	No

Manufacturer	System	Part Number	Software Version	Approval Using GPS	RNAV 2 Routes	RNAV 1 SID/STARS
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
Honeywell	KLN-90A	066-04031-0X11	All	Yes	Yes	No

Manufacturer	System	Part Number	Software Version	Approval Using GPS	RNAV 2 Routes	RNAV 1 SID/STARS
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 VI – 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 by 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 lies with the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness requirements refer to CAA Notice 91.263 RNP 2.

Communications environment

Communication performance on RNP 2 routes will be 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 relieve 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.

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.

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), and
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, or
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 allow 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.

Appendix VII – 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 by 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 lies with the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness requirements refer to CAA Notice 91.263 RNP 1.

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.

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.

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), and
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, and
- 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 allow 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.

Appendix VIII – 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 regards 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

<i>Approval</i>	<i>Routes and procedures access</i>
A-RNP	RNAV 5
	RNAV 1
	RNAV 2
	RNP 2
	RNP 1
	RNP APCH (lateral)
Note: A-RNP approval gives access to routes and procedures listed; however, having obtained these approvals individually does not equate to an A-RNP approval and does not give access to A-RNP published routes and / or procedures	
Additional Capabilities Included with A-RNP	
Description	A-RNP Inclusion
RF	Included
Note: Additional Capabilities (i.e. baro-VNAV) are optional to A-RNP and may not be present with the aircraft A-RNP documented capability	

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 by 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 lies with the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness requirements refer to the applicable Notice under rule 91.263.

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.

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.

Navigation systems eligibility

The aircraft eligibility has to be determined through demonstration of compliance against the relevant airworthiness criteria and the requirements of the applicable CAA Notices. 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.

Appendix IX - 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 CAA Notice NTC 91.263 Baro-VNAV. If the system is approved for APV with augmented GNSS, the installation must be compliant with the requirements in CAA Notice NTC 91.263 RNP APCH (LP and LPV), or must have demonstrated to an airworthiness authority performances at least equivalent to those described in Notice NTC 91.263 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 5, section 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 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 lies with the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness requirements, refer to CAA Notice NTC 91.263 RNP APCH (LNAV and LNAV/VNAV).

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.

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.

Navigation systems eligibility

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

1. GNSS stand-alone systems and 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 receivers approved in accordance with E/TSO-C129(), capability for satellite FDE is recommended to improve continuity of function, and/or
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, or
- 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 20-130A, or
- 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, or
- 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.

Appendix X – 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 APV 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 *CAA Notice NTC 91.263 RNP APCH (LNAV and LNAV/VNAV)*. Curved approaches are addressed in *CAA Notice NTC 91.263 RNP AR APCH*.

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 be used by 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 lies with the OEM and State of Design/Manufacture.

Airworthiness Requirements

For airworthiness requirements refer to CAA Notice NTC 91.263 RNP APCH (LP and LPV).

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.

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.

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, and
- 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, or
- 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.

Appendix XI – 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 authorisation. 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 lies with 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 requirements refer to CAA Notice NTC 91.263 RNP AR APCH.

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.

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.

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, and
- 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
- 2) dual FMS
- 3) dual air data systems
- 4) dual autopilots, and
- 5) a single IRU.

Appendix XII – 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.

While this specification has been defined primarily for helicopter applications, this does not exclude the application to fixed wing operations where demonstrated performance is sufficient to meet the functional and accuracy requirements of this specification for all phases of flight.

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 lies with 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 requirements refer to CAA Notice NTC 91.263 RNP 0.3(H).

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 XIV – RF Legs Technical and Operational Criteria Legs.

SBAS

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

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.

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), and
3. Rotorcraft with RNP 0.3 capability certified or approved to equivalent standards (e.g. TSO-C193).

Appendix XIII – 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 lies with 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 requirements refer to CAA Notice NTC 91.263 Baro-VNAV.

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, and
- 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.

Appendix XIV – 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

RF Legs are implemented in certain navigation specifications within the NZ FIR, further implementations of RF Legs may expand within new procedure designs.

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 lies with 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 requirements refer to CAA Notice NTC 91.263 RF Legs.

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, so surveillance considerations of the parent RNP specification are applicable if present.

Navaid infrastructure considerations

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

SBAS

RF Legs are not dependent on SBAS coverage.

ABAS RAIM

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

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, recognising 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 operator's 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.