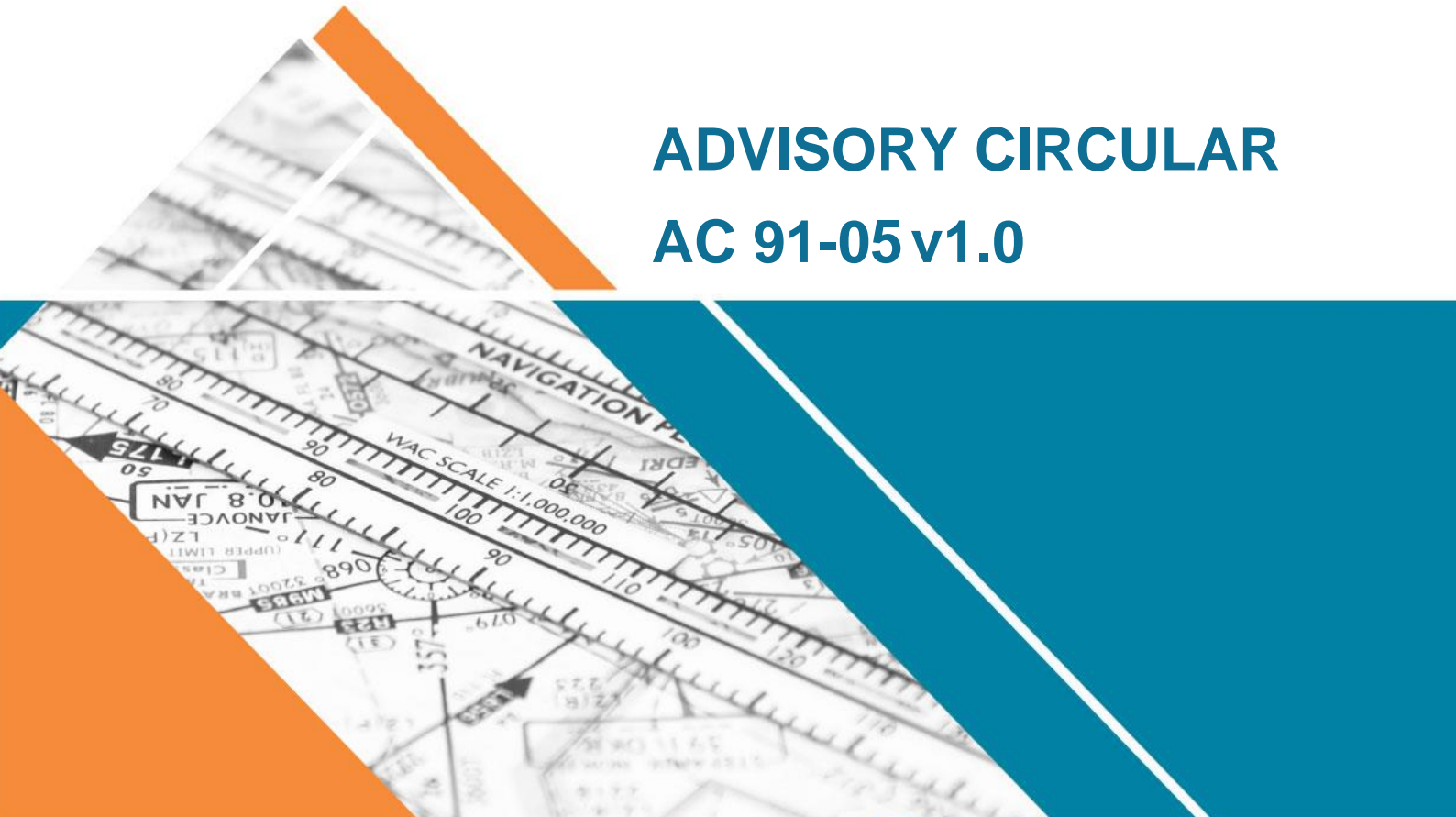




# ADVISORY CIRCULAR AC 91-05 v1.0



## Performance-based navigation



Date	October 2021
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**For Flight Operations Regulations  
commencing on 2 December 2021**

Advisory circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.

**Advisory circulars should always be read in conjunction with the relevant regulations.**

## Audience

This advisory circular (AC) applies to:

- aviation personnel in Australia who are involved in flight operations requiring the use of performance-based navigation.

## Purpose

This AC provides information on the concept of performance-based navigation and guidance on navigation specifications used in Australia.

## For further information

For further information, contact CASA's Flight Standards Branch (telephone 131 757).

## Status

This version of the AC is approved by the Branch Manager, Flight Standards.

Version	Date	Details
v1.0	October 2021	Initial AC.

Unless specified otherwise, all subregulations, regulations, Divisions, Subparts and Parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

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# 1 Reference material

## 1.1 Acronyms

The acronyms and abbreviations used in this AC are listed in the table below.

Acronym	Description
ABAS	aircraft-based augmentation system
AC	advisory circular
ADS-C	automated dependent surveillance — contract
AFM	aircraft flight manual
AFMS	aircraft flight manual supplement
AIP	aeronautical information publication
APCH	approach
APV	approach procedure with vertical guidance
A-RNP	advanced RNP
ATC	air traffic control
ATS	air traffic service
CAR	<i>Civil Aviation Regulations 1988</i>
CASA	Civil Aviation Safety Authority
CASR	<i>Civil Aviation Safety Regulations 1998</i>
DA	decision altitude
DME	distance measuring equipment
DFMC	dual frequency multiple constellation
EASA	European Union Aviation Safety Agency
EUROCAE	European Organisation for Civil Aviation Equipment
FAA	Federal Aviation Administration
FAF	final approach fix
FAP	final approach point
FAS	final approach segment
FD	fault detection
FDE	fault detection and exclusion
FMC	flight management computer
FMS	flight management system
FOSA	flight operational safety assessment

<b>Acronym</b>	<b>Description</b>
FRT	fixed radius transition
FTE	flight technical error
GBAS	ground-based augmentation system
GLONASS	global orbiting navigation satellite system
GNSS	global navigation satellite system
GRAS	ground-based regional augmentation system
GPS	global positioning system
ICAO	International Civil Aviation Organization
IMC	instrument meteorological conditions
INS	inertial navigation system
IRS	inertial reference system
LOA	letter of acceptance
LNAV	lateral navigation
LP	localiser performance
LPV	localiser performance with vertical guidance
LRNS	long-range navigation system
MAPt	missed approach point
MDA	minimum descent altitude
MEL	minimum equipment list
MOS	Manual of Standards
NAVAID	navigation aid
NDB	non-directional beacon
NOTAM	notice to airmen
NSE	navigation system error
OEI	one engine inoperative
OEM	original equipment manufacturer
OM	operations manual
PBN	performance-based navigation
PDE	path definition error
PIC	pilot in command
QRH	quick reference handbook
RADALT	radio altimeter

Acronym	Description
RAIM	receiver autonomous integrity monitoring
RF	radius to fix
RNAV	area navigation
RNP	required navigation performance
RNP AR (APCH or DEP)	RNP authorisation required (approach or departure)
SBAS	satellite-based augmentation system
SID	standard instrument departure
SIS	signal-in-space
STAR	standard instrument arrival
TAWS	terrain awareness and warning system
TSE	total system error
VFR	visual flight rules
VHF	very high frequency
VIP	vertical intercept point
VMC	visual meteorological conditions
VNAV	vertical navigation
VOR	VHF omnidirectional range
VSD	vertical situation display
XTK	cross-track error/deviation

## 1.2 Definitions

Terms that have specific meaning within this AC are defined in the table below. Where definitions from the Regulations have been reproduced for ease of reference, these are identified by 'grey shading'. Should there be a discrepancy between a definition given in this AC and the Regulations, the definition in the Regulations prevails.

Term	Definition
aircraft-based augmentation system (ABAS)	An augmentation system that augments and/or integrates the information obtained from the other GNSS elements with information available on board the aircraft.  <b>Note:</b> The most common form of ABAS is receiver autonomous integrity monitoring (RAIM).
approach procedure with vertical guidance (APV)	An instrument procedure which utilizes lateral and vertical guidance but does not meet the requirements established for precision approach and landing operations.
area navigation	A method of navigation which permits aircraft operations on any desired

Term	Definition
	<p>flight path within:</p> <p>(a) the coverage of ground or space-based navigation aids; or</p> <p>(b) the limits of the capability of self-contained navigation aids; or</p> <p>(c) a combination of paragraphs (a) and (b).</p> <p><b>Note</b> Area navigation includes PBN as well as other operations that do not meet the definition of PBN.</p>
ATS surveillance service	A term used to indicate a service provided directly by means of an ATS surveillance system.
NAVAID infrastructure	Space-based and/or ground-based NAVAIDs available to meet the requirements in the navigation specification.
navigation application	<p>The application of a navigation specification and the supporting NAVAID infrastructure, to routes and procedures, within a defined airspace volume, in accordance with the intended airspace concept.</p> <p><b>Note:</b> The navigation application is one element, along with communications, ATS surveillance and ATM procedures which meet the strategic objectives in a defined airspace concept.</p>
navigation function	<p>The detailed capability of the navigation system (such as the execution of leg transitions, parallel offset capabilities, holding patterns, navigation database) required to meet the airspace concept.</p> <p><b>Note:</b> Navigational functional requirements are one of the drivers for the selection of a navigation specification.</p>
navigation specification	<p>A set of aircraft and aircrew requirements needed to support PBN operations within a defined airspace, being either:</p> <p>(a) RNAV specification which is a navigation specification based on area navigation that does not include the requirement for on-board performance monitoring and alerting, and is designated by the prefix RNAV, for example, RNAV 5, RNAV 1; or</p> <p>(b) RNP specification which is a navigation specification based on area navigation that includes the requirement for on-board performance monitoring and alerting, and is designated by the prefix RNP, for example, RNP 2, RNP APCH.</p>
operator	<p>Means:</p> <p>(a) if the operation of the aircraft is authorised by an AOC, a Part 141 certificate or an aerial work certificate—the holder of the AOC or certificate; or</p> <p>(b) otherwise—the person, organisation or enterprise engaged in aircraft operations involving the aircraft.</p>
performance-based navigation	<p>Area navigation based on performance requirements for aircraft operating:</p> <p>(a) along ATS routes; or</p> <p>(b) on an IAP; or</p> <p>(c) in designated airspace.</p> <p><b>Note 1:</b> Performance requirements are expressed in navigation specifications (RNAV specification, and RNP specification) in terms of the accuracy, integrity, continuity, availability and functionality needed for the proposed operation in the context of a particular class of airspace.</p> <p><b>Note 2:</b> ATS routes is a defined term: see the CASR Dictionary.</p>

Term	Definition
	<p>Note 3: Availability of GNSS SIS or some other NAVAID infrastructure is considered within the airspace concept in order to enable the navigation application.</p>
receiver autonomous integrity monitoring (RAIM)	A form of ABAS whereby a GNSS receiver processor determines the integrity of the GNSS navigation signals using only GNSS signals or GNSS signals augmented with altitude (baro-aiding). This determination is achieved by a consistency check among redundant pseudo-range measurements. At least one additional satellite needs to be available with the correct geometry over and above that needed for the position estimation, for the receiver to perform the RAIM function.
RNAV system	A navigation system which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these. An RNAV system may be included as part of a flight management system (FMS).
RNP system	An area navigation system which supports on-board performance monitoring and alerting.
satellite-based augmentation system (SBAS)	A wide coverage augmentation system in which the user receives augmentation information from a satellite-based transmitter.
standard instrument arrival (STAR)	A designated instrument flight rule (IFR) arrival route linking a significant point, normally on an ATS route, with a point from which a published instrument approach procedure can be commenced.
standard instrument departure (SID)	A designated instrument flight rule (IFR) departure route linking the aerodrome or a specified runway of the aerodrome with a specified significant point, normally on a designated ATS route, at which the en-route phase of a flight commences.

## 1.3 References

### Regulations

Regulations are available on the Federal Register of Legislation website <https://www.legislation.gov.au/>

Document	Title
Part 91 of CASR	Civil Aviation Safety Amendment (Part 91) Regulation 2018
Part 91 MOS	Part 91 (General Operating and Flight Rules) Manual of Standards 2020

### International Civil Aviation Organization documents

International Civil Aviation Organization (ICAO) documents are available for purchase from <http://store1.icao.int/>

Document	Title
Doc. 9613	Performance-based Navigation (PBN) Manual



Document	Title
Doc. 9997	Performance-based Navigation (PBN) Operational Approval Manual
Doc. 9905	Required Navigation Performance Authorisation Required (RNP-AR) Procedure Design Manual

### Advisory material

CASA's advisory circulars are available at <http://www.casa.gov.au/AC>

Document	Title
AMC and GM Part 91	General operating and flight rules
FAA AC 120-29A	Criteria for Approval of Category I and Category II Weather Minima for Approach

## 1.4 Forms

CASA's forms are available at <http://www.casa.gov.au/forms>

Form number	Title
<a href="#">Form CASA-04-5515</a>	AOC application form

## 2 Introduction

### 2.1 Background

- 2.1.1 Advances in navigation technology and performance have enabled changes in airspace design, separation minima, route spacing, airport access, instrument procedure design and air traffic management. These changes form a significant part of the overall modernisation of Australia's airspace system and deliver improvements in safety and operational efficiency.
- 2.1.2 The transition in Australia away from navigation reliant on ground-based nav aids, such as VHF omnidirectional range (VOR) and non-directional beacon (NDB), to area navigation using the ICAO performance-based navigation (PBN) framework has been a key enabler of this modernisation.
- 2.1.3 PBN benefits aviation by:
- a. reducing the need to maintain sensor-specific routes and procedures, and their associated costs. For example, moving a single VOR ground facility can impact dozens of procedures, as VOR can be used on routes, VOR approaches, missed approaches, etc. Adding new sensor-specific procedures will compound this cost, and the rapid growth in available navigation systems would soon make sensor-specific routes and procedures unaffordable.
  - b. avoiding the need for development of sensor-specific operations with each new evolution of navigation systems, which would be cost-prohibitive. The expansion of satellite navigation services is expected to contribute to the continued diversity of area navigation (RNAV) and RNP systems in different aircraft. The original basic GNSS equipment is evolving due to the development of augmentations such as SBAS, GBAS and GRAS, while the introduction of new satellite constellations like Galileo and the modernisation of GPS and GLONASS will further improve GNSS performance. The use of GNSS/inertial integration is also expanding
  - c. allowing for more efficient use of airspace (route placement, fuel efficiency, noise abatement, etc.)
  - d. clarifying the way in which RNAV and RNP systems are used
  - e. facilitating standardisation by providing a limited set of navigation specifications intended for global use.

### 2.2 PBN concept

- 2.2.1 PBN, together with communications, navigation, surveillance and ATM (CNS/ATM), are enablers of an airspace concept. PBN comprises three components:
- a. the NAVAID infrastructure
  - b. the navigation specification
  - c. the navigation application.

- 2.2.2 Under PBN, generic navigation requirements are first defined based on the operational requirements. Operators then evaluate options in respect of available technology and navigation services. A chosen solution would be the most cost-effective for the operator. Technology can evolve over time without requiring the operation itself to be revisited, as long as the requisite performance is provided by the navigation system.
- 2.2.3 The PBN concept specifies that aircraft navigation system performance requirements be defined in terms of accuracy, integrity, continuity, availability and functionality required to achieve a navigation application. The navigation application identifies the navigation requirements for ATS route and instrument procedures used by pilots and air traffic controllers. The navigation application is dependent on the NAVAID infrastructure (refer to Figure 1).

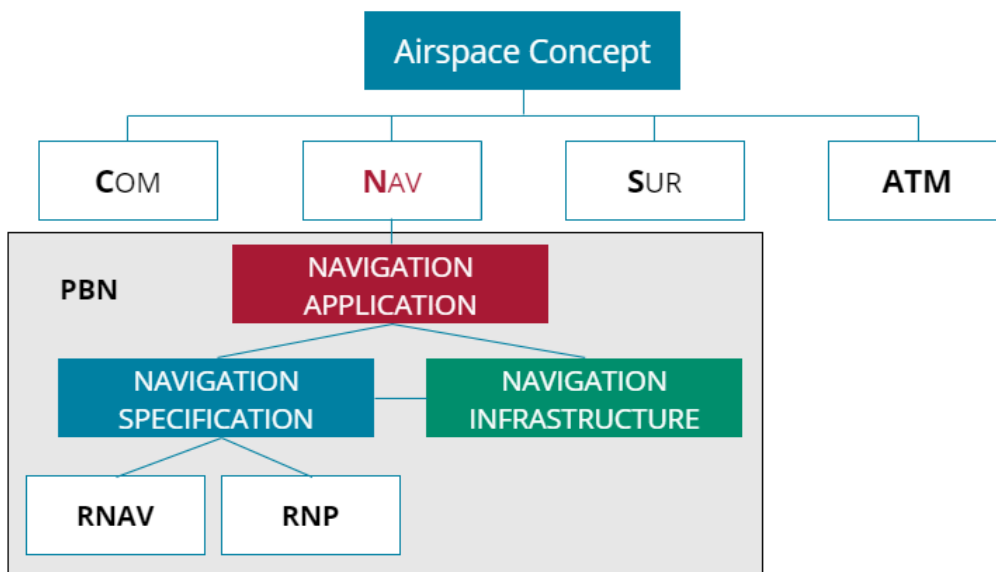


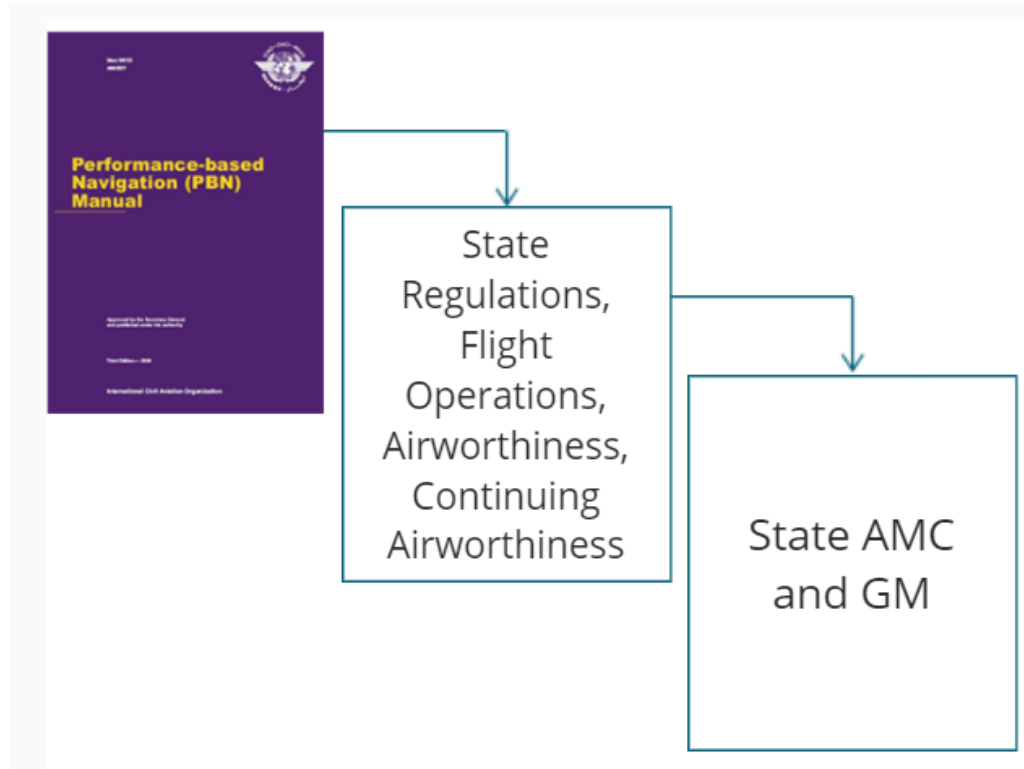
Figure 1: PBN Concept

- 2.2.4 While the NAVAID infrastructure includes ground-based, self-contained and space-based navigation aids, Australia's collection of VORs, DMEs and NDBs does not support PBN but rather forms a backup navigation network. Only GNSS and self-contained systems in aircraft support PBN in Australia.

### 2.3 PBN regulatory structure

- 2.3.1 ICAO's PBN concept is set out in ICAO Doc 9613 *Performance-based Navigation (PBN) Manual*. Australia has developed a framework to enable PBN through a range of regulatory measures which, when combined, provide for the necessary aircraft equipment, operational and airworthiness requirements to meet the applicable ICAO navigation specifications.

- 2.3.2 Parts 61 and 91 of the *Civil Aviation Safety Regulations 1998* (CASR) and the Part 91 Manual of Standards (MOS) contain the applicable requirements for aircraft equipment, pilot qualifications and training, and continuing airworthiness.



**Figure 2: PBN Regulatory Structure**

## 2.4 Navigation specifications

- 2.4.1 A navigation specification is a set of aircraft and aircrew requirements needed to support a navigation application within a defined airspace concept. The navigation specification defines the performance requirements of the navigation system, including functional requirements such as the ability to conduct curved path procedures or to fly parallel offset routes.
- 2.4.2 RNAV and RNP navigation specifications are fundamentally similar. The key difference between them is the requirement for on-board performance monitoring and alerting. A navigation specification that includes a requirement for on-board performance monitoring and alerting is referred to as an RNP specification. A navigation specification that does not require on-board performance monitoring is referred to as an RNAV specification.

2.4.3 Australia has chosen to use the ICAO PBN navigation specifications in Table 1.

**Table 1: Navigation Specifications**

Specification	Intended use
RNAV 10 (RNP 10)	Supports 50 NM lateral and longitudinal separations in oceanic/remote continental airspace
RNP 4	Supports 30 NM lateral and longitudinal separations in oceanic/remote continental airspace
RNP 0.3	For helicopter operations
RNP 2	Oceanic and en route use
RNP 1	Provides connectivity between en route airspace and instrument flight procedures in terminal airspace (SIDs and STARs)
RNP APCH	Provides RNP APCH operations NPA = LNAV (MDA) APV = LNAV/VNAV (DA)
RNP AR APCH	Authorisation Required (AR) Supports RNP 0.3 - 0.1 and radius to fix (RF) leg inside the final approach fix (FAF)

**Note:** Australia has not implemented mandatory RNP requirements for en route use. Some published lowest safe altitudes are predicated on an aircraft navigation system being capable of compliance with the RNP 2 navigation specification. No Australian airspace formally mandates aircraft must meet a specific PBN requirement. Mandatory RNP requirements are limited to some ATS routes, SIDs, STARs and instrument approach procedures. These will be published in AIP when implemented.

**Note:** Relevant abbreviations used in the table above are:

SIDs: standard instrument departures  
 STARs: standard terminal arrival routes  
 NPA: non-precision approach  
 APV: approach with vertical guidance  
 LNAV: lateral navigation  
 VNAV: vertical navigation  
 MDA: minimum descent altitude  
 DA: decision altitude

## 2.4.4 On-board performance monitoring and alerting

2.4.4.1 On-board performance monitoring and alerting is the main element that determines whether a navigation system complies with the necessary safety level associated with an RNP application; whether it relates to both lateral and longitudinal navigation performance; and whether it allows the aircrew to detect that the navigation system is not achieving, or cannot guarantee with integrity, the navigation performance required for the operation.

2.4.4.2 RNP systems provide improvements on the integrity of operations over RNAV; this may permit closer route spacing and can provide sufficient integrity to allow only RNP systems to be used for navigation in a specific airspace. The use of RNP systems may

therefore offer significant safety, operational and efficiency benefits over RNAV systems.

## 2.4.5 Navigation functional requirements

- 2.4.5.1 Both RNAV and RNP specifications include requirements for certain navigation functionalities. At the basic level, these functional requirements may include:
- continuous indication of aircraft position relative to track to be displayed to the pilot flying on a navigation display situated in primary field of view
  - display of distance and bearing to the active (To) waypoint
  - display of ground speed or time to the active (To) waypoint
  - navigation data storage function
  - appropriate failure indication of the RNAV or RNP system, including the sensors.
- 2.4.5.2 More sophisticated navigation specifications include the requirement for navigation databases and the capability to execute database procedures.

## 2.4.6 Accuracy of on-board navigation systems

- 2.4.6.1 On-board navigation systems must be certified to perform within the accuracy required by the relevant navigation specification. The accuracy in any navigation specification applies to both 'along track' and 'cross-track' and is denoted as total system error (TSE).
- 2.4.6.2 TSE is a radial vector centred at the true aircraft position. TSE is made up of the following components, as depicted in Figure 3:
- navigation system error (NSE): the difference between the aircraft's estimated position and its actual position. NSE is a radial error thus having 'along track' and 'cross-track' or 'lateral' components. In practical terms, the aircraft is NSE NM (as a vector) away from its displayed position
- Note:** The vertical component of the NSE is not considered in PBN, though navigation specifications used for approach and departure include specific vertical navigation accuracy requirements that can be achieved by barometric altimetry or augmented GNSS.
- path definition error (PDE): this occurs when the path defined in the RNAV system does not correspond to the desired path, i.e., the path expected to be flown over the ground. PDE is mostly a lateral error component
  - flight technical error (FTE): this relates to the autopilot's ability to follow the defined path or track, including any display error. FTE is a cross-track error.

**Notes:**

- Usually, PDE is quite small or negligible when the onboard navigation database is accurate and up to date. FTE and NSE however may each be up to  $\pm 1/2$  RNP value during normal operations.
- FTE is normally visible on the display, but NSE is neither visible nor measurable.

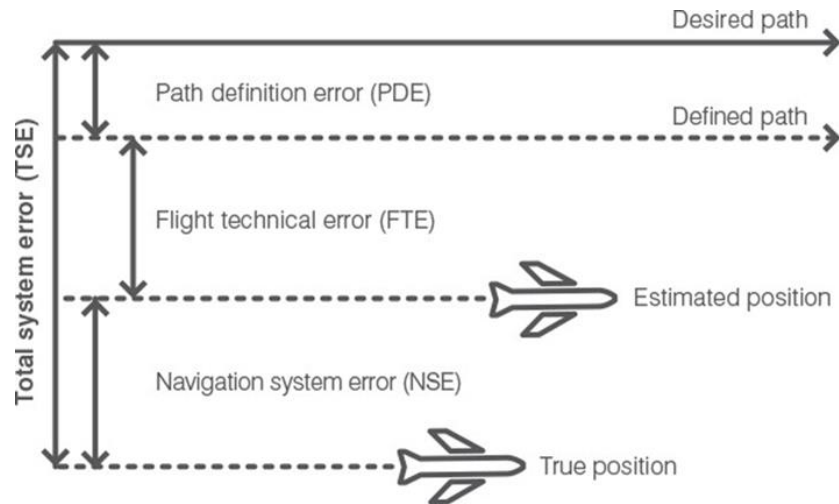


Figure 3: Errors contributing to the total system error (TSE)

## 2.4.7 RNP and RNAV designations

- 2.4.7.1 For oceanic, remote, en route and terminal operations, an RNP specification is designated as RNP X, e.g. RNP 4. An RNAV specification is designated as RNAV X, e.g., RNAV 1. If two navigation specifications share the same value for X, they may be distinguished by use of a prefix.
- 2.4.7.2 For both RNP and RNAV designations, the expression “X” (where stated) refers to the lateral navigation accuracy (TSE) in nautical miles which is expected to be achieved at least 95 per cent of the flight time by the population of aircraft operating within the airspace, route or procedure.
- 2.4.7.3 Approach navigation specifications cover all segments of the instrument approach. RNP specifications are designated using RNP as a prefix and an abbreviated textual suffix, e.g., RNP APCH or RNP AR APCH.
- Note:** Australia is transitioning to a standardised ICAO format for PBN approach procedures. Until 30 November 2022, approach charts depicting procedures that meet the RNP APCH navigation specification criteria may include the term RNAV (GNSS) in the identification (e.g. RNAV (GNSS) RWY 23). However, from 1 December 2022, only the term RNP will be permitted.
- 2.4.7.4 In cases where navigation accuracy is used as part of the designation of a navigation specification, it should be noted that navigation accuracy is only one of the functional and performance requirements included in a navigation specification.
- 2.4.7.5 Because functional and performance requirements are defined for each navigation specification, an aircraft that is capable of one RNP specification is not automatically capable of all RNAV specifications. Similarly, an aircraft capable of achieving an RNP or RNAV specification having a stringent accuracy requirement (e.g., RNP 0.3 specification) is not automatically capable of a navigation specification having a less stringent accuracy requirement (e.g., RNP 4).

## 2.4.8 Integrity monitoring of on-board navigation system

- 2.4.8.1 It is essential that the actual navigation performance (ANP) from the on-board navigation system is within the required performance for the navigation specification.
- 2.4.8.2 The position solution can be affected by the number and location (geometry) of the GNSS satellites with respect to the aircraft (see Figure 4). An aircraft must be in view of at least 4 satellites to determine its position.
- 2.4.8.3 Receiver autonomous integrity monitoring (RAIM) is a form of aircraft-based augmentation system (ABAS) whereby the on-board navigation system continuously calculates whether the actual performance solution is within the required tolerance. This process is incorporated into GNSS receivers designed to meet TSO C129, TSO C145, TSO C196a or later versions of these standards. The integrity is calculated using additional satellites in view of the aircraft. If the system detects that the ANP is estimated to exceed the RNP value, the crew will be alerted and if RNP is mandated in the airspace, air traffic control (ATC) must be notified.
- 2.4.8.4 Two types of RAIM algorithms exist in the approved standards:
- fault detection (FD): requires that a minimum of 5 satellites with satisfactory geometry be in view, and will detect if ANP exceeds RNP
  - fault detection and exclusion (FDE): requires that a minimum of 6 satellites with satisfactory geometry be in view, and will detect and exclude any satellites that cause ANP to exceed FDE allowing the navigation application to continue (see Figure 5)

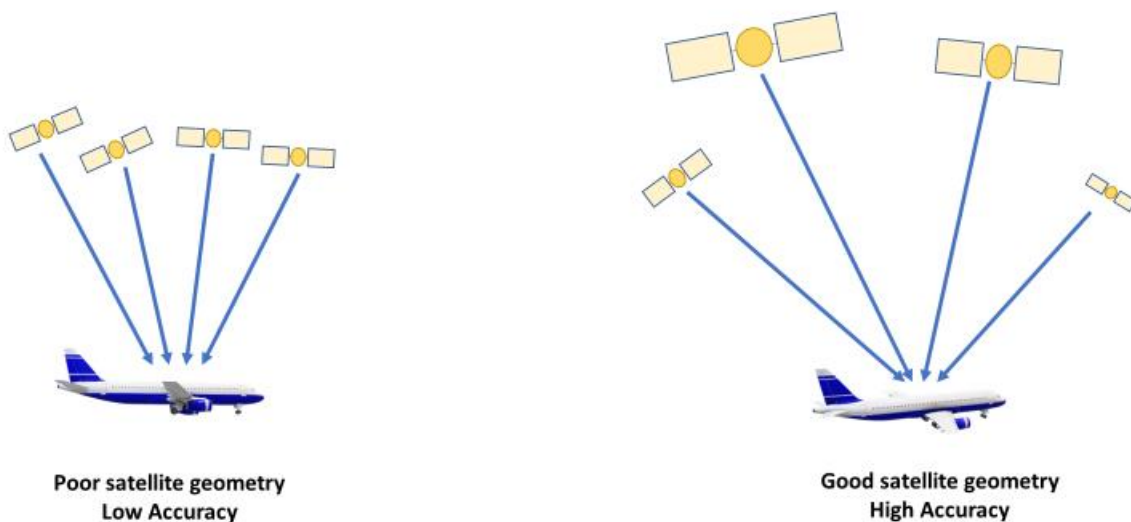


Figure 4: Effect of satellite geometry on accuracy



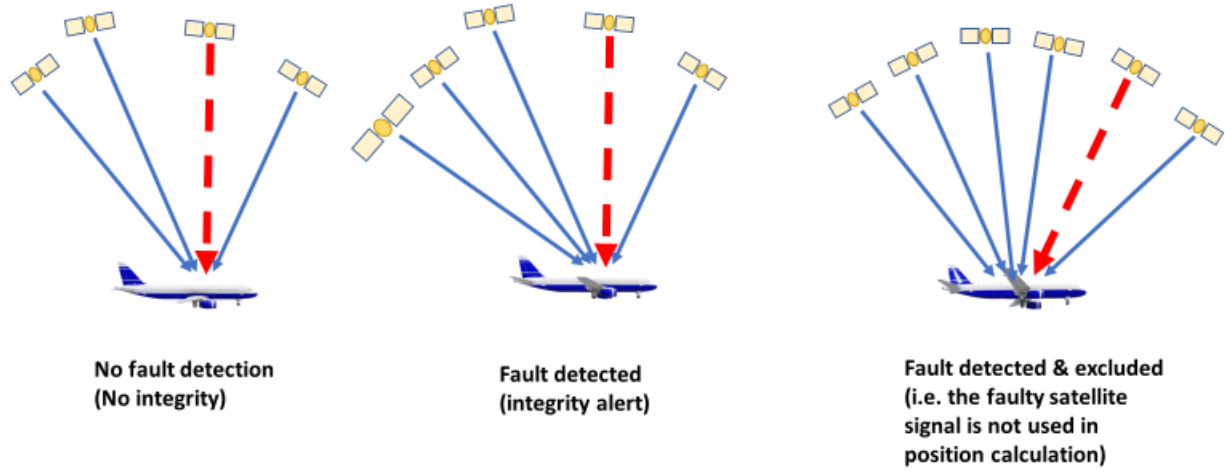


Figure 5: Receiver Autonomous Integrity Monitoring (RAIM) Concept

## 3 PBN implementation in Australia

### 3.1 Overview

3.1.1 Australia lacks the substantial ground infrastructure required to enable area navigation throughout its airspace. For this reason, GNSS is the basis of navigation for most aircraft and, consequently, RNAV specifications except RNAV 10 (also called RNP 10 for historical reasons) are not implemented or used in Australian administered airspace. Where necessary, RNP specifications are used instead.

3.1.2 Certain ATS routes, terminal procedures, and instrument approach procedures are required to be flown according to promulgated PBN navigation specifications. Figure 6 depicts Australia's planned future requirements; however these are not yet fully implemented and pilots and operators should refer to promulgated airspace, route and approach requirements.

**Note:** Australia is transitioning to RNP 1 for departure and arrival operations (SIDs and STARs) and RNP 2 for en route operations. New routes and procedures are being developed that will rely on PBN navigation specifications to provide safer and more efficient use of the airspace.



Figure 6: Future application of PBN to airspace and routes

### 3.2 Approval process

3.2.1 In accordance with ICAO Annex 6, specific approval from CASA is only required for operations under the RNP authorisation required (RNP AR) navigation specifications. In the past, CASA may have issued approvals for navigation capability based on the stated capabilities and standards of installed aircraft equipment. These approvals remain applicable unless they have been revoked or the conditions of the specific approval are no longer valid (e.g., expired or a change of ownership, etc.).

3.2.2 Figure 7 provides an outline of the generic process for PBN assessment and approval under Part 91.

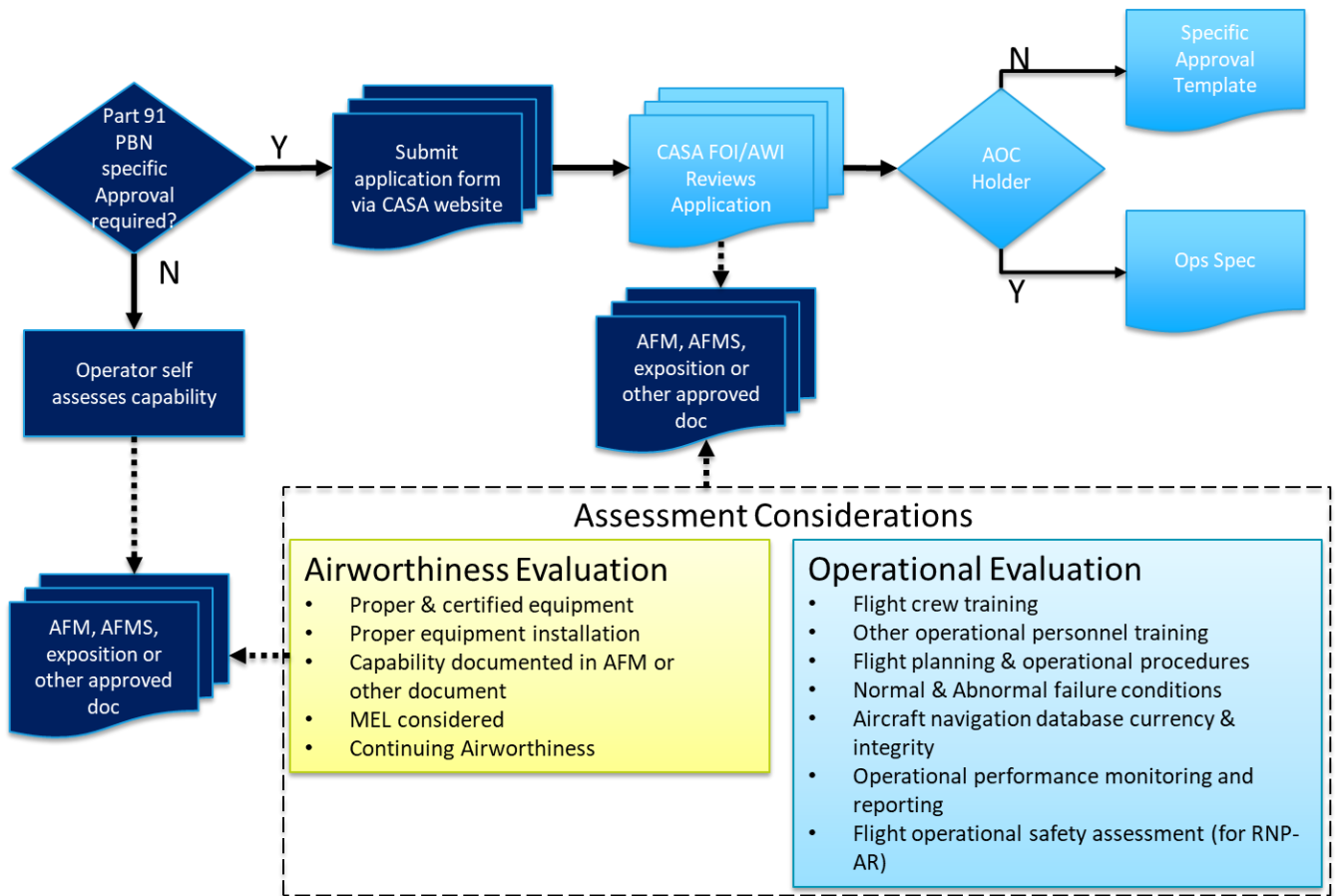


Figure 7: Part 91 PBN assessment and approval process

3.2.3 Australian regulations are aligned with ICAO and, as a result, an operator planning to conduct any RNP AR operation requires a specific approval under regulation 91.045 for the purposes of regulation 91.660.

3.2.4 In addition, under Part 91 all other navigation specifications (listed below) do not require a specific approval:

- o RNAV / RNP 10
- o RNP 4
- o RNAV 5
- o RNAV 1 & 2
- o RNP 2
- o RNP 1
- o RNP APCH

3.2.5 An aircraft is approved for operation under a particular navigation specification if it is approved for the specification by at least 1 of the following:

- the AFM

- a document approved under Part 21 as part of, or based on, an airworthiness assessment
- for a foreign registered aircraft — a document approved in writing by the NAA of the State of registration, or State of the operator of the aircraft.

3.2.6 It should, however, be noted that while specific approvals for the above navigation specifications are no longer required, in order to meet their regulatory requirements<sup>1</sup> operators are recommended to address the points illustrated in Figure 7 that are applicable to their operations. As a guide, it is recommended that operators ensure that:

- there is documented evidence, in the form of a statement in the AFM, AFMS, a service letter from the OEM, an LOA, or any other document recognised by CASA, that the aircraft is suitably equipped for and meets the requirements of the relevant navigation specification appropriate maintenance procedures are in place to ensure continued airworthiness of the airborne systems in accordance with the relevant navigation specifications
- where the aircraft is operated in accordance with a MEL, the relevant navigation specification capabilities should be included in the MEL
- there is a procedure in place to manage and ensure validity, updating, and continued integrity of the onboard navigation database
- flight crew and other relevant personnel of the operator have been properly trained and have appropriate knowledge of PBN in general and the relevant navigation specification consistent with the intended operation
- there are no unresolved issues relating to the performance of aircraft systems in meeting the relevant navigation specification
- methods to manage abnormal events and associated safety risks have been considered.

### 3.3 Navigation specification requirements

3.3.1 It is recommended that pilots use a lateral deviation indicator, flight director, or autopilot in lateral navigation mode and set to the applicable RNP value.

3.3.2 It is inherent in an air traffic control clearance in controlled airspace, and in a position report in uncontrolled airspace, that pilots are maintaining route centrelines, as depicted by on-board lateral deviation indicators and/or flight guidance, during all RNP operations unless authorised to deviate by ATC or under emergency conditions.

3.3.3 For normal operations, cross-track error/deviation (the difference between the area navigation system computed path and the aircraft position relative to the path) should be limited to  $\pm\frac{1}{2}$  RNP value associated with the route. This is because the true lateral position of the aircraft could be up to  $\pm$  NSE NM away from its displayed position (without any indication to the flight crew) and, as such, larger cross-track deviations could infringe safety margins for obstacle clearance and/or lateral separations between tracks.

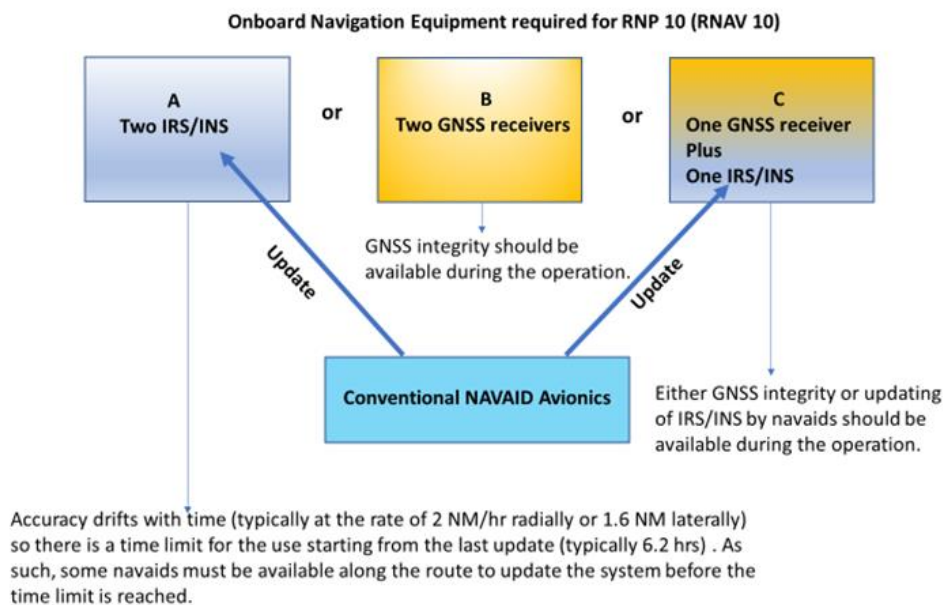
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<sup>1</sup> Refer to regulations 119.130, 121.485, 131.140, 133.375, 135.385, 138.485, 141.120 and 142.180, and Subpart 137.N.

3.3.4 The pilot must notify ATC of any loss of the RNP capability (integrity alerts or loss of navigation), in accordance with paragraph 14.02 (4) (c) of the Part 91 MOS and should also advise the proposed course of action. The loss of RNP capability includes any failure or event causing the aircraft to no longer satisfy the subject RNP requirements.

### 3.4 RNP 10

3.4.1 RNAV 10, which is designated as RNP 10 for historical reasons and documentation consistency, is used in oceanic airspace in support of 50 NM lateral and distance-based longitudinal separations. Due to scarcity of ground infrastructure in remote/oceanic areas, the continuity requirement is met using dual long-range navigation systems (LRNS). Figure 8 illustrates specific RNP 10 requirements for navigation equipment and associated requirements.



**Figure 8: RNP 10 navigation equipment**

3.4.2 Before the departure of a flight planned to operate in oceanic airspace using GNSS, the pilot in command (PIC) must obtain a RAIM prediction for GNSS FDE availability for the intended route and ensure that the maximum predicted duration of the loss of GNSS FDE availability is not more than 34 minutes<sup>2</sup>. If the integrity outage is predicted to exceed this limit, then the operation should either be rescheduled or revert to an alternate means of navigation.

**Note 1:** A RAIM prediction is not required if the aircraft has an approved multi-sensor navigation system that includes GNSS and inertial integration (refer to section 11.03 of the Part 91 MOS).

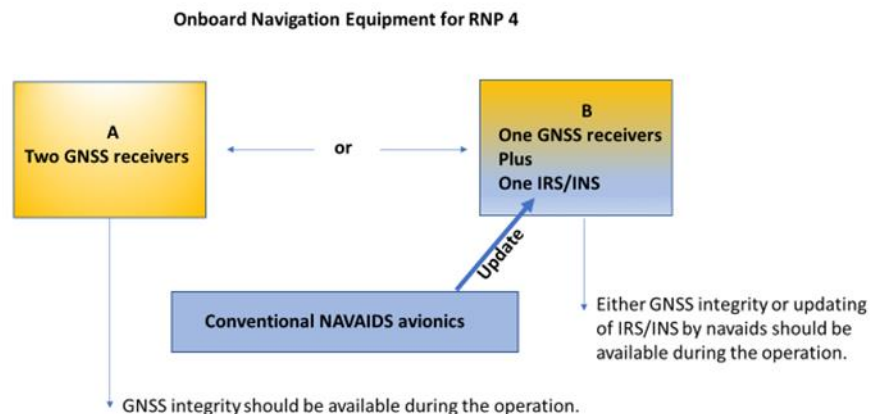
**Note 2:** The use of approved SBAS-capable or DFMC GNSS receivers in airspace served by appropriate infrastructure may obviate the need for RAIM prediction.

<sup>2</sup> This is the maximum permitted period for a GNSS FDE outage for an RNP 10 operation.

- 3.4.3 Similarly, if dual IRS/INS is the primary means of navigation, due account should be taken of the drift in position accuracy with time and therefore the time limit for using the system (typically 6.2 hours) before updating (automatically or manually) based on position information from NAVAIDs.

### 3.5 RNP 4

- 3.5.1 RNP 4 is also used in oceanic airspace in support of lower separation minima, which could be as low as 23 NM when associated communications and ATS surveillance services<sup>3</sup>, meeting appropriate performance requirements, are available. GNSS is the primary navigation sensor to support RNP 4. Therefore, the aircraft should be fitted with either two GNSS receivers, or one GNSS receiver plus one IRS/INS for meeting the continuity and integrity requirements shown in Figure 9.



**Figure 9: RNP 4 navigation equipment**

- 3.5.2 Before the departure of a flight planned to operate in oceanic airspace using GNSS, the PIC must obtain a RAIM prediction for GNSS FDE availability for the intended route and ensure that the maximum predicted duration of the loss of GNSS FDE availability is not more than 25 minutes<sup>4</sup>. If the integrity outage is predicted to exceed this limit, then the operation should either be rescheduled or revert to an alternate means of navigation.

**Note 1:** A RAIM prediction is not required if the aircraft has an approved multi-sensor navigation system that includes GNSS and inertial integration (refer to section 11.03 of the Part 91 MOS).

**Note 2:** The use of approved SBAS-capable or DFMC GNSS receivers in airspace served by appropriate infrastructure may obviate the need for RAIM prediction.

<sup>3</sup> Controller-pilot data link communications (CPDLC) and automatic dependent surveillance-contract (ADS-C)

<sup>4</sup> This is the maximum permitted period for a GNSS FDE outage for an RNP 4 operation.

### 3.6 RNP 2

- 3.6.1 RNP 2 is primarily used in continental airspace where there is some ground NAVAID infrastructure. As such, it does not require a high degree of continuity like the navigation specifications used in oceanic or remote areas. In terms of equipment requirement, this would imply that an aircraft fitted with a single GNSS receiver (stand-alone or combined with an FMS), supplemented with conventional navigation equipment (e.g., VOR and DME), could meet RNP 2 requirements.
- 3.6.2 While there are currently no RNP 2 specific routes in Australia, when implemented a prediction of the availability of GNSS integrity (e.g., by RAIM with FDE) should be conducted along the relevant RNP 2 route before the operation is commenced, particularly if NAVAIDs along the intended route are scarce. Pilots should also assess their capability to navigate (potentially to an alternate destination) in the event that GNSS service is lost (e.g., interference or failure) and reversion to NAVAIDs becomes necessary. On-board equipment requirements for RNP 2 (also applicable to RNP 1) are shown in Figure 10.

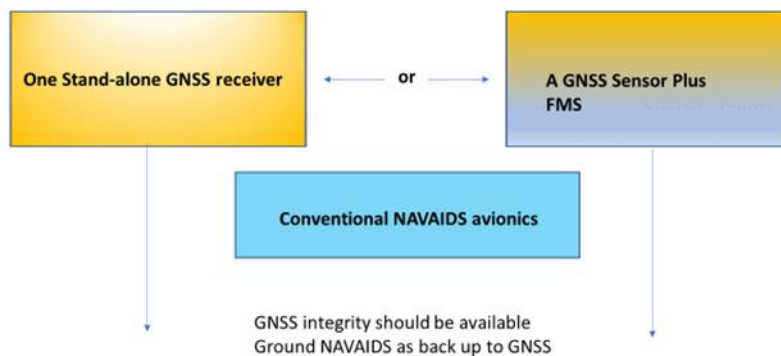


Figure 10: On-board navigation equipment for RNP 2 and RNP 1

### 3.7 RNP 1

- 3.7.1 RNP 1 is used in terminal airspace for arrival and departure procedures and is primarily based on GNSS. Although area navigation using DME/DME can meet the position accuracy requirements of RNP 1, the widespread availability of DME infrastructure for ensuring continuity of terminal operations cannot be assumed. As such, a single GNSS receiver (either stand-alone or as a sensor to the FMS), supplemented by conventional navigation avionics, is considered adequate for RNP 1 operations.
- 3.7.2 Availability of GNSS integrity (e.g., by RAIM) is necessary for arrival and departure operations based on RNP 1. As such, any predicted continuous loss of integrity for more than five (5) minutes during the operation should be considered as an outage. Pilots should also assess their capability to continue the procedure in the event that GNSS service is lost (e.g., interference or failure) and reversion to NAVAIDs becomes necessary.



**Note:** The use of approved SBAS-capable or DFMC GNSS receivers in airspace served by appropriate infrastructure may obviate the need for RAIM prediction.

- 3.7.3 Pilots are expected to maintain centrelines, as depicted by on-board lateral deviation indicators and/or flight guidance, during RNP 1 operations unless authorised to deviate by ATC or under emergency conditions. For normal operations, cross-track error/deviation (the difference between the system computed path and the aircraft position relative to the path, i.e., FTE) should be limited to  $\pm\frac{1}{2}$  the RNP value (i.e., 0.5 NM for RNP 1). Brief deviations from this standard (e.g., overshoots or undershoots) during and immediately after turns, up to a maximum of 1 RNP value (i.e., 1 NM for RNP 1), are allowable.

## 3.8 RNP APCH

- 3.8.1 RNP approach (RNP APCH) procedures are instrument approach procedures designed with a straight final approach segment and:
- a minimum descent altitude (MDA), i.e., lateral navigation (LNAV) or localiser performance (LP)
- or
- a decision altitude (DA), i.e., lateral navigation/vertical navigation (LNAV/VNAV) or localiser performance with vertical navigation (LPV).
- 3.8.2 The availability of a minimum to a pilot depends on aircraft equipment and approval, pilot authorisation, and the presence of augmentation systems (i.e., SBAS or Baro-VNAV).
- 3.8.3 Approach to LNAV minimum is entirely based on basic GNSS signal-in-space, while either GNSS, SBAS or barometric altimetry can be used for reaching LNAV/VNAV, LP or LPV minimum. For LNAV either one stand-alone GNSS receiver, or a GNSS sensor integrated with an FMS, is required. Various approach types are shown in Figure 11; the application of the two minima, MDA for LNAV approaches and DA for LNAV/VNAV approaches, is illustrated in Figures 12 and 13, respectively.
- Note:** The term approach procedure with vertical guidance (APV) is also used for non-precision approaches that include vertical guidance. For further information on various RNP APCH minima, refer to AC 91-27 - Non-precision approaches and approaches with vertical guidance<sup>5</sup>.

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<sup>5</sup> At the time of publication AC 91-27 is still under development.



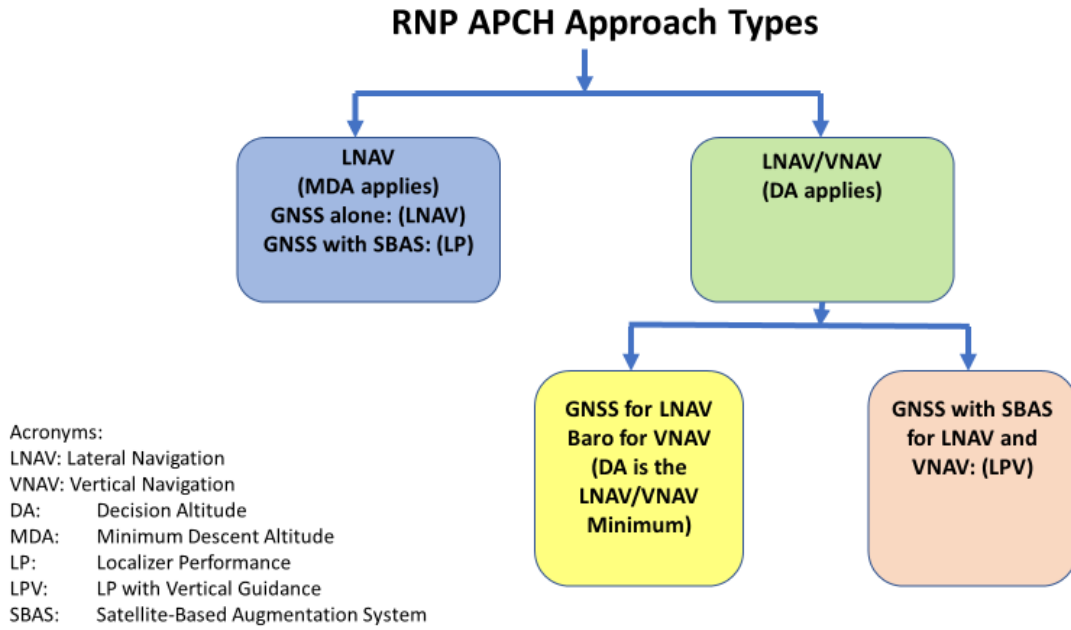


Figure 11: RNP APCH approach types

## Approach with Lateral Guidance (LNAV)

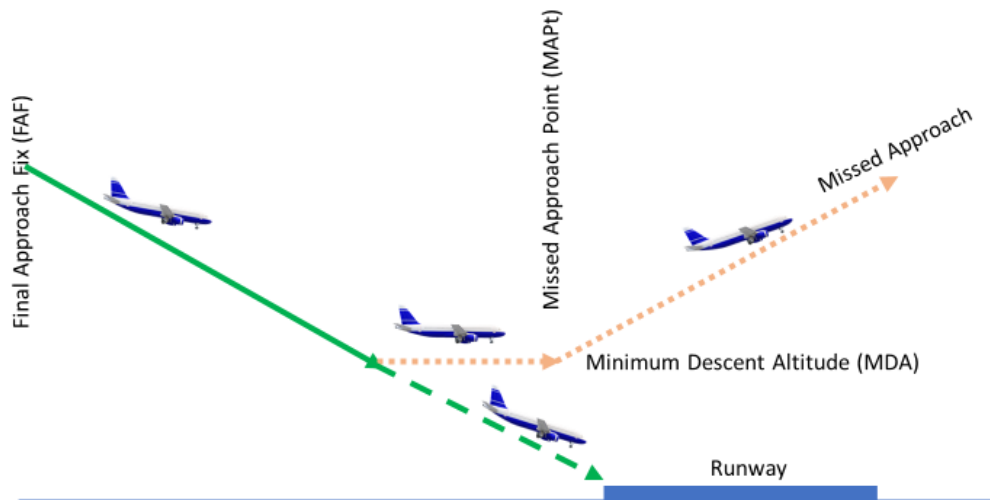


Figure 12: LNAV approach

**Note:** LNAV procedures provide descent to an MDA before requiring visual reference to the runway. An aircraft may continue level flight at the MDA until reaching the missed approach point (MAPt), where the missed approach procedure must be initiated.

## Approach with Lateral and Vertical Guidance (LNAV/VNAV)

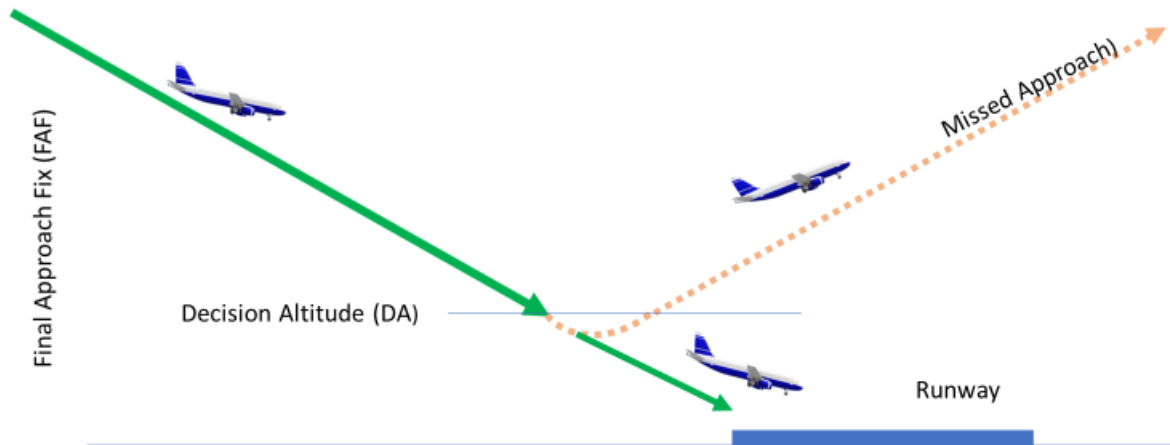


Figure 13: LNAV/VNAV approach

**Notes:**

1. **The LNAV/VNAV is an APV and the minimum is expressed as DA/H.** A DA differs from an MDA, as upon reaching the DA the missed approach must be initiated.
2. LNAV/VNAV landing minima can only be used by an aircraft that is fitted with a navigation system that provides VNAV guidance derived from a barometric source and is certified for Baro-VNAV. Such VNAV guidance should not be confused with a navigation system that provides advisory vertical guidance (e.g., LNAV+V). **Use of advisory vertical guidance does not permit descent below MDA/H.**

- 3.8.4 RNP APCH includes RNP 1 (for initial/intermediate segments of the approach and missed approach) and RNP 0.3 (for the final approach segment down to LNAV or LNAV/VNAV minimum). As such, the maximum FTE should be kept to 0.5 NM and 0.15 NM for initial/intermediate/missed and final approach segments, respectively.
- 3.8.5 The missed approach segment of an RNP APCH operation may require GNSS or conventional NAVAID (e.g., VOR, DME, NDB). However, when the NAVAID infrastructure is not available, the missed approach segment may be based upon pilot procedures (e.g., heading to a procedural altitude).
- 3.8.6 GNSS integrity should be available during any RNP APCH operation. If a continuous loss of integrity for more than five (5) minutes is predicted for any part of the RNP APCH operation, the flight plan should be revised accordingly. Moreover, pilots should assess their capability to navigate (potentially to an alternate destination) in the event of failure or loss of GNSS.

**Note:** The use of approved SBAS-capable or DFMC GNSS receivers in airspace served by appropriate infrastructure may obviate the need for RAIM prediction.

- 3.8.7 If unable to comply with the requirements of an RNP APCH procedure, pilots should discontinue the approach and advise ATS as soon as possible. The loss of RNP APCH capability includes any failure or event causing the aircraft to no longer satisfy the RNP APCH requirements of the procedure. The operator should develop contingency procedures in order to react safely following the loss of the RNP APCH capability during the approach.

## 3.9 RNP AR APCH

### 3.9.1 Authorisation by CASA

- 3.9.1.1 Specific approval by CASA is required for an operator to conduct RNP AR approach (RNP AR APCH) and departure (RNP AR DP) procedures. The application for any RNP AR authorisation should be made on the approved form and be accompanied by all of the following:

- a. an aircraft airworthiness document which satisfies CASA that the aircraft is properly equipped for RNP AR operations, for example, the AFM, the AFMS, an OEM service letter or any other recognised document. This is usually documented in accordance with State of Design guidance material. Any operational limitation should be clearly stated in the document
- b. a detailed description of relevant aircraft systems, including equipment and software, for RNP AR

**Note:** Typically, to be eligible for RNP AR, the aircraft should be equipped with duplicated GNSS sensors, FMS (both containing the navigation database), navigation displays, air data systems, RADALTs, flight directors/autopilots, annunciators, electric power sources, a single IRU and a TAWS containing the current terrain and obstacle database. This ensures no loss of guidance due to a single failure.

- c. a detailed description of the proposed flight crew training for RNP AR operations, including a copy of the training syllabus
- d. a detailed description of the operating procedures to be used for RNP AR operations supported by relevant copies of, or extracts from, the following and other documents as applicable:
  - i. the exposition
  - ii. the checklists
  - iii. the contingency procedures
  - iv. the QRH.
- e. a FOSA for the addition of new destinations requiring RNP AR, noting that:
  - i. the FOSA must set out details of the methods used by the operator to manage the risks associated with abnormal events arising from RNP AR operations and
  - ii. the FOSA must include the mitigations implemented by the operator to reduce abnormal safety risks to the level of “As Low as Reasonably Practical (ALARP)”

**Notes:**

1. Suitable methods to mitigate abnormal safety risks include flight crew procedures (including contingency procedures), flight crew training, engineering modifications, operating limitations, and procedure design.
  2. Additional guidance on provision for abnormal operations is contained in FAA AC 120-29A, Criteria for Approval of Category I and Category II Weather Minima for Approach.
    - iii. the FOSA should set out details of the methods used by the operator to manage the risks associated with adding additional destinations where RNP AR operations will be conducted.
  - f. copies of the sections of the MEL applicable to RNP AR operations
  - g. a detailed description of the maintenance program used to ensure the continuing airworthiness of the aircraft for RNP AR operations
  - h. a detailed description of the method used to ensure the continued integrity of the airborne navigation database
  - i. a detailed description of pre-flight procedure for ensuring the availability of signal-in-space of the requisite GNSS (core constellation and augmentation element(s) if any), GNSS integrity and other navigation aids applicable to the intended operation
  - j. a detailed description of the operator's RNP AR implementation program including qualification flight(s) and post-flight data analysis, performance monitoring and reporting
  - k. if requested in writing by CASA — a copy of any relevant document referred to in any of the documents mentioned in paragraphs (i) to (xi).
- 3.9.1.2 In general, an operator's application for RNP AR specific approval will be evaluated based on requirements stipulated in ICAO Doc 9613, Performance-based Navigation (PBN) Manual, to ensure aircraft eligibility and requisite operational qualifications. The grant of an RNP AR specific approval by CASA implies the approval of the final versions of all the supporting documentation. The operator should therefore conduct the operation(s) in full compliance with the approved documents and procedures.

### 3.9.2 Operational standards

#### 3.9.2.1 Before an RNP AR operation commences, the flight crew should:

- a. predict the availability of the subject RNP service considering relevant matters, including the following:
    - i. aerodrome location
    - ii. approach or departure operation
    - iii. terrain masking
    - iv. availability of GNSS signal-in-space (e.g., by NOTAMs) for navigation and for updating IRS
    - v. availability of GNSS integrity information (e.g., by RAIM with FDE)
- Note:** The use of approved SBAS-capable or DFMC GNSS receivers in airspace served by appropriate infrastructure may obviate the need for RAIM prediction.
- vi. check availability of the current navigation database

- vii. ensure that the intended approach or departure procedure is retrievable by procedure identifier from the aircraft navigation database
- viii. ensure that the correct approach or departure procedure has been selected
- ix. ensure that the appropriate RNP is entered into the FMC and its appropriateness and accurate entry is confirmed
- x. verify that the cockpit electronic displays correctly replicate the route, the waypoint sequence and significant operational details shown on the published procedure chart.

**Note:** The verification requirement in (vi) is not applicable to an OEI procedure.

- b. ensure they are informed of and familiar with the following:
  - i. effect of temperature
  - ii. temperature limitations
  - iii. cold temperature correction
  - iv. remote altimeter setting not permitted
  - v. on-board compensation equipment.

#### 3.9.2.2 During an RNP AR operation, the flight crew should:

- a. ensure that deviation from the defined lateral path does not exceed 1 x RNP at all stages of flight
- b. not modify the loaded procedure
- c. refrain from modifying the lateral path, except for:
  - i. accepting a clearance to go direct to a fix in the approach procedure that is before the FAF and that does not immediately precede an RF leg
  - or
  - ii. changing the altitude and/or airspeed waypoint constraints on the initial, intermediate, or missed approach segments of an approach (e.g., to apply cold temperature corrections or comply with an ATC clearance/instruction)
- d. comply with airspeed limitations by segment and category as set by the procedure design in accordance with ICAO Doc 9905 where applicable, or as shown in ICAO Doc 9613, Performance-based Navigation (PBN) Manual, Volume II, Part C, Implementing RNP AR APCH
- e. be prepared for possible loss of GNSS updating (of the IRS), noting that the approach may be continued if the navigation system continues to provide a solution consistent with the selected RNP

**Note:** The AFM may require an approach to be discontinued in the event of a loss of GNSS updating, in which case the approach should be discontinued.

- f. ensure deviation from the defined vertical path does not exceed the limiting value for the vertical deviation stated in the operator's RNP AR operating procedures once the aircraft has passed the FAP or VIP on an approach.

- 3.9.2.3 The recommended method of conducting an RNP AR approach operation is with the autopilot coupled. However, if the autopilot is not coupled then use of the flight director is required. The FTE is based on the use of a flight director. The use of a flight director as the default way of conducting an RNP AR approach operation requires that:
- a. the aircraft manufacturer's recommended operating procedures permit such use of the flight director
  - b. the operator has provided each member of the flight crew with:
    - i. guidance on when a flight director may be so used
    - ii. training in the conduct of RNP AR operations using the flight director.
  - c. the operator has demonstrated to CASA that when the aircraft is flown with the flight director, FTE can be maintained within the permitted tolerances during all normal, rare-normal and abnormal circumstances.

**Note:** The FTE used by the aircraft manufacturer to demonstrate RNP capability may be dependent upon the use of a coupled autopilot. A lesser RNP value may be applicable to procedures flown using the flight director.

### 3.9.3 Flight crew procedures

- 3.9.3.1 To ensure compliance with the required operational standards, the operator should have flight crew procedures for the following:

- a. monitoring lateral tracking comprising:
  - i. track deviation alerts and callouts
  - ii. flight crew intervention
  - iii. regaining track
  - iv. discontinuing the operation.

**Note:** RNP AR procedures designed in accordance with proprietary design criteria for use by operators of Australian aircraft require that the standard for track-keeping is applied during turns and that no allowance is made for overshoot or undershoot during entry or exit. All turns for these procedures are RF legs.

- b. monitoring vertical deviation from the vertical path comprising:
  - i. monitoring vertical deviation
  - ii. deviation alerts and callouts
  - iii. flight crew intervention
  - iv. missed approach.

- 3.9.3.2 An operator's procedures for limiting vertical deviations may only be determined after considered the following:

- a. the aircraft manufacturer's data relating to vertical flight path accuracy
- b. the cockpit display of vertical deviation
- c. the value used by the designer of the procedure.

- 3.9.3.3 Notwithstanding the above, the limiting value for vertical deviation should not exceed:

- a. 75 ft below the defined vertical flight path
- b. 75 ft above the defined vertical path unless a figure greater than 75 ft is determined as appropriate for the aircraft type after considering the following:

- i. aircraft flight characteristics
- ii. the effect that any deviation may have on the safe continuation of a stabilised approach
- iii. airspeed
- iv. energy management
- v. aircraft height above ground level
- vi. autopilot vertical gain performance.

### 3.9.4 Database requirements

3.9.4.1 To ensure currency, validity and integrity of the navigation database, which is an integral part of any RNP AR operation, the operator should:

- a. identify the responsible manager for the data updating process within their procedures
- b. document a process for accepting, verifying and loading navigation data into the aircraft
- c. place their documented data process under configuration control
- d. validate the navigation data before flying the actual RNP AR procedure by:
  - i. flying the entire procedure in an aircraft in VMC in daytime, or in a Level D flight simulator, from the initial approach fix through the approach including vertical angle, the missed approach, and the approach transitions for the selected aerodrome and runway
  - ii. confirming that the depicted procedure on the map display is the same as depicted on the published procedure
  - iii. observing the flight path and confirming based on the observation that the path does not have any lateral or vertical path disconnects with the procedure data, and is consistent with the published procedure
  - iv. verifying that the aircraft navigation, flight control, cockpit display and other systems function correctly, and that the procedure is flyable.

3.9.4.2 A validation of an RNP AR procedure mentioned above should not contain any abnormal operation. Any abnormal operation should be validated by simulation.

3.9.4.3 Upon receipt of each navigation database update for an RNP AR procedure, and before using the updated navigation data in a type of aircraft, the operator should compare the updated data to the previously validated procedure and identify and resolve any discrepancies.

3.9.4.4 If any aspect of the on-board systems needed for RNP AR is modified (e.g., software change), the operator should validate the procedure for the aircraft type using the modified system. However, no re-validation would be necessary if the manufacturer of the modified system has stated in writing that the modification has no effect on the navigation database or path computation for the use of the procedure in the aircraft type.



### 3.9.5 Qualification flight

3.9.5.1 An RNP AR specific approval may be issued to an operator only after a qualification flight conducted by the operator demonstrates to CASA that:

- a. the operator meets all operating standards for RNP AR operations
- b. the aircraft navigation, flight control, cockpit display and other systems function correctly
- c. the operator's flight crew procedures are adequate
- d. procedure design, aircraft systems, airworthiness and flight crew procedures function correctly and interact appropriately
- e. the operator has the capability to safely operate the most complex procedures proposed to be flown.

**Note:** Where the qualification flight does not demonstrate capability at the operator's most complex port, the RNP AR authorisation may include a condition or limitation on operations.

3.9.5.2 The qualification flight may be conducted in a Level D flight simulator only if:

- a. the flight simulator reasonably replicates the RNP AR related functions, software version, and options of the aircraft in which the RNP AR operations will be conducted
- b. CASA is satisfied that any RNP AR related functions not replicated in the flight simulator are not safety critical, and are demonstrated by other means
- c. the flight simulation is carried out by a flight crew trained in accordance the operator's RNP AR approved training program.

3.9.5.3 Where the qualification flight is flown in an aircraft, the flight is to be conducted:

- a. in an aircraft of the same type and configuration as the aircraft in which the RNP AR operations will be conducted
- b. by a flight crew trained in accordance with the operator's RNP AR approved training program
- c. in VMC by day.

**Note:** A qualification flight may be conducted on a scheduled revenue service.

### 3.9.6 Flight crew proficiency and currency

3.9.6.1 Flight crew should have the knowledge and training stipulated in ICAO Doc 9613, Performance-based Navigation (PBN) Manual, Volume II, Part C, Chapter 6, Implementing RNP AR APCH, before conducted an RNP AR operation. Table 2 sets out the proficiencies that are considered essential for RNP AR and should therefore be included in the operator's training program.

3.9.6.2 CASA may consider previous relevant RNP APCH operational experience gained by the flight crew as a substitute to the training items shown in Table 2. CASA may also accept a modified version of the list of training items depending on a specific application. Such deviations from the standard list will be duly recorded in the approval by CASA.



3.9.6.3 Additionally, where RNP AR operations are to be conducted at a restricted aerodrome or are to involve operations in the vicinity of a mountainous or obstacle enriched area, the PIC should also successfully complete a route training and restricted minima program. If, however, operations are not at restricted aerodromes or in the vicinity of a mountainous or obstacle enriched area, then the PIC should have successfully completed at least 1 RNP AR APCH at any airfield in VMC before conducting unrestricted operations.

**Table 2: RNP AR training proficiencies****Delivery method legend**

- A Paper-based training (see *Note 1*).
- B Computer-based training (CBT) or instructor lead training,
- # Recognition of prior learning if qualified to conduct RNAV (GNSS) operations in the same aircraft and FMS type. A different FMS update status is considered to be the same FMS type.
- S Level D flight simulator training.
- P Proficiency check required (see *Note 2*).

Item	RNP AR training proficiencies	Delivery methods				
1	GNSS theory (architecture, accuracy, integrity, etc.)	A	B	#		
2	RNP APCH procedure design basics	A	B	#		
3	RNP AR procedure design basics	A	B			
4	Rare normal wind protection and maximum coded speeds	A	B			
5	RNP/ANP/EPE definitions and the navigational concept	A	B			
6	RNP DEP and one engine inoperative procedures (Only required for an RNP AR DEP navigation authorisation.)	A	B			
7	OEI procedure obstacle clearance areas (Only required for an RNP AR a navigation authorisation including OEI operations.)	A	B			
8	Missed approach extraction capability	A	B			
9	FMS system architecture	A	B	#		
10	Multi-sensor navigation and sensor blending	A	B	#		
11	FMS failure modes and indications	A	B			
12	Navigation performance displays (NPS, XTK, VDEV)	A	B			
13	Allowable lateral and vertical FTE's	A	B			
14	VSD (where fitted)	A	B	#		
15	MEL	A	B			
16	Critical system losses prior to the IAF or FAP (NNDP or VIP )	A	B			P
17	Critical system losses after the IAF or FAP (NNDP or VIP)	A	B		S	P
18	Navigation system losses after the IAF or FAP (NNDP or VIP)	A	B		S	P
19	FMS database integrity	A	B			
20	RNP performance prediction	A	B			

Item	RNP AR training proficiencies	Delivery methods				
21	Flight crew procedure review					
21.1	Selecting an RNP procedure	A	B		S	P
21.2	Changing an RNP procedure	A	B			
21.3	Briefing an RNP procedure	A	B		S	P
21.4	Checking an RNP procedure	A	B		S	P
21.5	RNP missed approach requirements	A	B		S	P
21.6	Navigation system failures	A	B		S	
21.7	FAP and VIP definition	A	B			
21.8	Runway changes inside the FAP or VIP	A	B			
21.9	Managing a non-normal prior to the FAP or VIP	A	B		S	P
21.10	Managing a non-normal after the FAP or VIP	A	B		S	P
21.11	Autopilot requirements	A	B		S	P
21.12	FMS default RNP values and alerts	A	B	#		
21.13	Effect of an incorrectly set local QNH	A	B	#	S	
21.14	Effect of non-standard temperature on nominal path	A	B	#		
21.15	Approach procedures including PF and PNF/PM duties	A	B		S	P
21.16	HUGS (if fitted)	A	B		S	
21.17	Monitoring and flying raw data	A	B	#	S	
21.18	FMS modes/functionality (on approach logic, VNAV PATH, FINAL APP MODE, SPD INTV, ALT INTV, Managed/Selected modes)	A	B	#	S	
21.19	FCC lateral and vertical go-round functionality	A	B			
21.20	RNP holding patterns and managing the FMS	A	B			
22	Flight simulator training					
22.1	Departure (Only required for an RNP AR DEP navigation authorisation.)				S	
22.2	Approach				S	P
22.3	Approach dual FMC failure				S	
22.4	Departure with high drift condition (Only required for an RNP AR navigation authorisation including departure operations.)				S	
22.5	Approach with high drift condition				S	
22.6	Departure asymmetric thrust (Only required for an RNP AR navigation authorisation including				S	P

Item	RNP AR training proficiencies	Delivery methods				
	departure operations.)					
22.7	Approach IRS failure				S	
22.8	Approach with asymmetric thrust and missed approach				S	
22.9	Approach single GPS receiver failure			#	S	
22.10	Approach navigation system alerts			#	S	

**Notes:**

1. Where both paper-based and CBT methods appear, it is intended that the item is included in written study-material as well as ground school computer-based sessions.
2. Not all proficiency requirements need to be demonstrated in a flight simulator. Some proficiency items may be demonstrated by written or oral examinations, including multi-choice questions and quiz tests.
3. Some proficiencies apply to specific manufacturer/operator selected equipment options. These items must be covered if they are applicable to the aircraft type or the operator's equipment.
4. Operators may choose to nominate an NNDP (in addition to the VIP) for the purpose of defining actions to be taken in the event of systems failures.

### 3.9.7 Implementation program

3.9.7.1 RNP AR operations may only be conducted in accordance with the operator's approved implementation program. If an operator has not previously conducted RNP AR operations, or RNP AR operations using a particular aircraft type, then the implementation program should include limits on operating minima until the operator is able to demonstrate to CASA the capability to safely conduct RNP AR operations without such limits.

**Note:** The initial operating period with these limitations is determined after consideration of all relevant factors, including operator RNAV and VNAV operating experience, the number and frequency of RNP AR operations conducted, and the number of non-compliant incidents recorded.

3.9.7.2 The implementation program should have procedures to identify any negative trend in performance or operations, including procedures for monitoring RNP AR operations and collecting relevant data.

3.9.7.3 At intervals as specified in the operator's implementation program, the operator should submit to CASA a report containing a review of operations, including the following elements:

- a. the total number of RNP AR procedures conducted
- b. the number of satisfactory approaches and departures by aircraft and navigation system

**Note:** Satisfactory means the approach or departure was completed as planned without any navigation or guidance system anomalies.

- c. the reasons for unsatisfactory operations, for example:
  - i. UNABLE REQ NAV PERF – RNP, GPS PRIMARY LOST, or other RNP related messages

- ii. excessive lateral or vertical deviation
  - iii. TAWS warning
  - iv. autopilot systems disconnect
  - v. navigation data errors
  - vi. pilot report of anomaly.
- d. comments, both oral and written, from the flight crew.
- 3.9.7.4 The implementation program for RNP AR operational capability will not be completed until the operator has demonstrated to CASA satisfactory operations at defined stages in accordance with the operator's approved implementation program.
- 3.9.7.5 An RNP AR authorisation may be issued subject to:
- a. conditions to be met for each stage of the operator's approved implementation program
  - b. conditions under which the operator may progress to full operational capability
  - c. the implementation program for RNP AR is included in the operators exposition.

**Note:** A suitable implementation program will impose limits on RNP AR operations until sufficient operating experience and flight data has been collected to warrant progress (usually in stages) to full operational capability. Initial operations will normally be limited to day VMC, and subsequent phases will permit operations in IMC with ceiling, visibility and RNP limits until full capability is achieved. It is intended that a navigation authorisation will be issued before commencement of the operator's implementation program, with specified conditions under which the operator is able to progress to full operational capability.