



**DRAFT**

# Advisory Circular

**AC 91U-II-C-6 (0)**

**JULY 2011**

## NAVIGATION AUTHORISATIONS – RNP AR OPERATIONS

### CONTENTS

1. References	1
2. Purpose	1
3. Status of this AC	2
4. Acronyms	2
5. Background	3
6. Applicability	5
7. Related Publications	5
8. Navigation Authorisation	5
9. Navigation Authorisation Process	6
10. Application	7
11. Aircraft Eligibility	8
12. System Performance, Monitoring and Alerting	9
13. System Functionality	9
14. Operating Standards	11
15. Flight Crew Knowledge And Training	15
16. MiNimum Equipment List	16
17. Continuing Airworthiness	16
18. Navigation Data Base	17
19. Implementation Programme	18
20. Conditions On A Navigation Authorisation	19

### 1. REFERENCES

- ICAO Doc 9613 Performance Based Navigation Manual Volume II Part C Chapter 6 Implementing RNP AR APCH.
- CAO 20.91 Navigation Authorisations, Appendix 7, Requirements for use of RNP AR.
- FAA AC 120-29A Criteria For Approval of Category I and Category II Weather Minima for Approach.
- CASA Form 1307 *Reduced Vertical Separation Minimum and Required Navigation Performance* Application Form.

### 2. PURPOSE

This Advisory Circular (AC) provides information for operators of Australian, or foreign registered aircraft, who wish to gain approval to conduct Performance Based Navigation (PBN) operations in Australian airspace. These operations are consistent with the navigation specifications described in International Civil Aviation Organization (ICAO) Document 9613 PBN Manual and include Area Navigation (RNAV) and Required Navigation Performance (RNP) navigation specifications.

*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.*

*Where an AC is referred to in a 'Note' below the regulation, the AC remains as guidance material.*

*ACs should always be read in conjunction with the referenced regulations.*

*This AC has been approved for release by the Executive Manager Standards Development and Future Technology Division.*

### 3. STATUS OF THIS AC

**3.1** This is the first AC relating to RNP AR Navigation Authorisations and is based on information contained in Volume II, Part C, Chapter 6, of ICAO Doc 9613 Performance Based Navigation (PBN) Manual and Appendix 5, Requirements for use of RNP AR, *Civil Aviation Order (CAO) 20.91 Navigation Authorisations*. The numbering convention used in the title of this AC is also aligned to the relevant part of the PBN manual.

### 4. ACRONYMS

<b>AC</b>	Advisory Circular
<b>AFM</b>	Aircraft Flight Manual
<b>AHRS</b>	Attitude and Heading Reference System
<b>ALARP</b>	As Low as Reasonably Practical
<b>AOC</b>	Air Operators Certificate
<b>AMOC</b>	Alternative Means of Compliance
<b>ATS</b>	Air Traffic Services
<b>Baro-VNAV</b>	Barometric Vertical Navigation
<b>CAR</b>	Civil Aviation Regulations 1988
<b>CASA</b>	Civil Aviation Safety Authority
<b>CASR</b>	Civil Aviation Safety Regulations 1998
<b>CBT</b>	Competency Based Training
<b>CDI</b>	Course Deviation Indicator
<b>DA</b>	Decision Altitude
<b>DME</b>	Distance Measuring Equipment
<b>EOSID</b>	Engine Out Standard Instrument Departure
<b>FAA</b>	Federal Aviation Administration
<b>FFS</b>	Full Flight Simulator
<b>FOSA</b>	Flight Operational Safety Assessment
<b>FMC</b>	Flight Management Computer
<b>FMS</b>	Flight Management System
<b>FTE</b>	Flight Technical Error
<b>GNSS</b>	Global Navigation Satellite System
<b>IAF</b>	Initial Approach Fix
<b>IAL</b>	Instrument Approach and Landing
<b>ICAO</b>	International Civil Aviation Organization
<b>IRS</b>	Inertial Reference System
<b>LNAV</b>	Lateral Navigation
<b>MEL</b>	Minimum Equipment List

<b>MMR</b>	Multi Mode Radio
<b>NNDP</b>	Non Normal Decision Point
<b>NOTAM</b>	Notice to Airmen
<b>OEI</b>	One Engine Inoperative
<b>OEM</b>	Original Equipment Manufacturer
<b>Ops Specs</b>	Operations Specifications
<b>PBN</b>	Performance Based Navigation
<b>PIC</b>	Pilot in Command
<b>QRH</b>	Quick Reference Handbook
<b>RF</b>	Radius Fixed
<b>RNAV</b>	Area Navigation
<b>RNP</b>	Required Navigation Performance
<b>RNP APCH</b>	RNP Approach
<b>RNP AR APCH</b>	RNP Authorisation Required Approach
<b>RNP AR DEP</b>	RNP Authorisation Required Departure
<b>RPL</b>	Recognition of Prior Learning
<b>RVSM</b>	Reduced Vertical Separation Minimum
<b>SAAAR</b>	Special Aircraft and Aircrew Authorisation Required
<b>TAWS</b>	Terrain Awareness and Warning System
<b>TOGA</b>	Take Off Go Around
<b>TSE</b>	Total System Error
<b>VEB</b>	Vertical Error Budget
<b>VIP</b>	Vertical Intercept Point
<b>VMC</b>	Visual Meteorological Conditions
<b>VNAV</b>	Vertical Navigation

## **5. BACKGROUND**

**5.1** An RNP AR (Authorisation Required) navigation authorisation entitles an operator to conduct:

- RNP AR approach (RNP AR APCH) procedures;
- RNP AR departure (RNP AR DEP) procedures; and
- RNP AR engine-out SID (RNP AR EOSID) procedures.

**5.2** RNP AR APCH is an ICAO PBN Manual navigation specification which supports GNSS based lateral navigation (LNAV) and barometric vertical navigation (VNAV) instrument approach procedures. The barometric vertical navigation accuracy requirements for an RNP AR APCH procedure are demanding and as such RNP AR operations are applicable to aircraft equipped with GNSS and suitably capable Flight Management Systems (FMS), supported by advanced flight control and cockpit control and display systems.

*Note:* This requirement reflects the limitations of current available technology and is not intended to preclude the approval of RNP AR operations based on non-FMS aircraft and other vertical navigation systems. An operator may use any acceptable means to meet the system performance monitoring and alerting requirements for the path definition, lateral accuracy and vertical error budget (VEB) and airspace containment requirements of RNP AR APCH.

**5.3** Australia operates RNP AR proprietary procedures which include APCH, DEP and EOSID procedures. The APCH element of these procedures conforms to the highest level ICAO Doc 9613 PBN Manual Vol II Part C Chapter 6 Implementing RNP AR APCH with the following additions:

- Proprietary procedures always operate to full One Engine Inoperative (OEI) standards, are highly tailored (e.g. to aircraft specific thrust ratings and configuration changes) and require significant training, procedure design/validation and regulatory oversight resources.
- RNP AR (proprietary) are defined path procedures utilising highly accurate track keeping following a predetermined ground track. RNP AR (proprietary) uses both straight and turning segments with Radius to Fix (RF) leg transitions used exclusively for all turning segments.
- RNP AR (proprietary) use a two times RNP value methodology for TSE and  $\frac{1}{2}$  RNP value for FTE and as such are able to be supported by a two times RNP value parallel containment procedure design criteria. This design criteria results in significant operational, safety and environmental benefits through reduced airspace requirements and reduced aircraft noise and emissions.

**5.4** Australia will also implement RNP AR APCH procedures that conform to ICAO Doc 9613 PBN Manual Vol II Part C Chapter 6 Implementing RNP AR APCH and ICAO Doc 9905 RNP AR APCH Procedure Design Manual. RNP AR APCH (ICAO) are public instrument approach procedures which do not include DEP or EOSID procedures. RNP AR (ICAO) are available to appropriately authorised aircraft and operate to an All Engine Operating (AEO) standard. RNP AR (ICAO) procedures may or may not include a requirement for RF leg transitions.

**5.5** An RNP AR (proprietary) navigation authorisation may be limited by the type of procedure ie; APCH, DEP and EOSID or the RNP capability of the aircraft. For example an RNP AR (proprietary) navigation authorisation may be limited to only APCH and DEP procedures with an RNP of not less than 0.3 due to operational or airworthiness considerations.

**5.6** Due to the higher standard of operation an RNP AR APCH (proprietary) navigation authorisation entitles an operator to also receive an RNP AR APCH (ICAO) navigation authorisation. An RNP AR APCH (ICAO) navigation authorisation is by definition limited to approach operations only but still requires annotation of the minimum RNP value to which an operator is permitted to operate e.g. *RNP AR APCH (ICAO) – RNP 0.2*. Similarly, due to the higher standard of operation an RNP AR EOSID navigation authorisation entitles an operator to also receive an RNP AR DEP navigation authorisation.

**5.7** AOC holders and operators of other RNP AR capable aircraft, typically those equipped with an FMS, are required to operate in accordance with an RNP AR navigation authorisation as described in this AC.

**5.8** Due to the complexity and high regulatory oversight required to implement RNP AR (proprietary) procedures, navigation authorisations for RNP AR (proprietary) operations will initially be limited to CAR 217 approved (or equivalent approval from another State) operators. RNP AR APCH (ICAO) procedures may be used by non-CAR 217 approved operators and RNP AR APCH (proprietary) DEP (AEO only) procedures may also be considered in the future for non-CAR 217 approved operators as operational and regulatory experience is developed.

## **6. APPLICABILITY**

**6.1** This AC is applicable to operators of Australian and foreign registered aircraft and their flight crews. An RNP AR navigation authorisation (or equivalent approval from another State) is not mandatory in order to gain access to Australian ‘PBN airspace’. However an RNP AR navigation authorisation (or equivalent approval from another State) must be obtained from CASA in order to conduct an RNP AR (proprietary) APCH, DEP or an EOSID procedure in Australia.

**6.2** An RNP AR APCH navigation authorisation meets the GNSS lateral and barometric vertical navigation requirements of an RNP APCH –LNAV/VNAV navigation authorisation (see AC 91U-II-C-5 (0) Navigation Authorisations - RNP APCH). However while foreign operators holding an FAA RNP SAAAR (or equivalent approval from another State) meet the requirements of an RNP APCH –LNAV/VNAV and an RNP AR APCH (ICAO) navigation authorisation they *do not* meet Australian RNP AR APCH (proprietary) requirements. Holders of an FAA SAAAR (or equivalent approval from another State) must obtain an approval from CASA prior to conducting an RNP AR APCH (proprietary) operation in Australia.

## **7. RELATED PUBLICATIONS**

**7.1** For further information on this topic, operators are advised to view the following regulations/publications:

- ICAO Doc 9905 RNP AR Procedure Design Manual;
- CASA AC 21-37(0) Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors; and
- CASA AC 21-36(0) Global Navigation Satellite System (GNSS) Equipment: Airworthiness Guidelines.

## **8. NAVIGATION AUTHORISATION**

**8.1** An operator should carry out the following steps so that CASA has sufficient information to issue a RNP AR Navigation Authorisation:

- Demonstrate Aircraft Eligibility:
  - Aircraft equipment eligibility requirements for RNP AR are described in the PBN Manual and may be demonstrated through an AFM compliance statement, AFM supplement or OEM service letter; however where aircraft equipment varies from these requirements subsequent eligibility will be determined by CASA;
- Describe Training and Operating Procedures:
  - Flight crew training and operating procedures for the navigation systems to be used must be described by the operator in a syllabus of training and an aid memoir e.g. QRH, checklist etc ; and
- Document Training and Operating Procedures:
  - Methods of control for flight crew training, operational procedures and data base management must be identified in the operations manual.

## **9. NAVIGATION AUTHORISATION PROCESS**

**9.1** Navigation Authorisations for all PBN navigation specifications and RVSM operations are as follows:

- An aircraft operator applies for a navigation authorisation through the CASA Permission Application Centre using form 1307 Reduced Vertical Separation Minimum and Required Navigation Performance Application Form;
- The CASA Permission Application Centre registers the Form 1307 and forwards it to the relevant Certificate Management Team for assessment;
- The Certificate Management Team conducts the navigation authorisation assessment and;
  - Where the application meets the criteria listed in the PBN Manual and this AC, the Certificate Management Team approves the application and returns it to the Permission Application Centre; or
  - Where the application does not meet the criteria listed in the PBN Manual and this AC (e.g. a non-standard application due to specific aircraft equipment functionality or training requirements) the Certificate Management Team seeks further information from the applicant. Once sufficient information has been received such that CASA may assess the application as 'equivalent' to the requirements of the PBN Manual, CAO 20.91 and this AC the Certificate Management Team approves the application and returns it to the Permission Application Centre; and
- The CASA Permission Application Centre registers the approved navigation authorisation application in the operator's Operations Specifications (Ops Spec) and issues an updated Ops Spec to the operator.

**Note:** Ops Specs are yet to be provided with a legislative head of power through Subpart 91U of the Civil Aviation Safety Regulations 1998 (CASR 1998). This will occur in the future through the Subpart 91U of CASR 1998 update and rewrite process which will align all navigation authorisations with the ICAO PBN Manual. Until such time, RNP AR Navigation Authorisations will be issued under CAO 20.91.

## 10. APPLICATION

**10.1** An application for an RNP AR navigation authorisation requires a detailed description of all aspects of the proposed operation and full documentation of the elements listed in this section, sufficient to provide CASA with the means to satisfy its regulatory obligations associated with the issue of a navigation authorisation for operations which are designated ‘Authorisation Required’.

**10.2** Content of an application for an RNP AR navigation authorisation:

- Aircraft airworthiness documents (e.g. the AFM, AFM Supplement, OEM service letters) that establish that the aircraft is equipped to meet the requirements for RNP AR operations;
- A description of aircraft equipment and components, including a configuration list that details the components and equipment that the operator will use for RNP AR operations;
- A description of the proposed flight crew training, including:
  - Training syllabus; and
  - Arrangements to manage RNP AR recurrent training.

**Note:** Course material, lesson plans and other training products are subject to CASA approval of the operator’s Regulation 217 Training and Checking organisation of the Civil Aviation Regulations 1988 (CAR 1988) or training service provider as appropriate.

- A description of training programs for maintenance personnel, dispatchers and any other relevant training details of the operating procedures to be used, including:
  - Relevant sections of the company operations manual;
  - Checklists; and
  - Contingency procedures, QRH etc.
- Sections of the MEL applicable RNP AR operations;
- A description of the maintenance program including any provisions necessary to ensure the continuing airworthiness of relevant navigation equipment;
- Details of the method to be used to ensure the continuing integrity of the airborne navigation database;
- An implementation programme, including the proposed method to monitor RNP AR operations to identify, report and investigate any failure or potential failure in the aircraft systems or operating procedures; and

- A Flight Operational Safety Assessment (FOSA) is required to meet all aspects of an RNP AR navigation authorisation. A FOSA detailing the methods used to manage the risks associated with non-normal events associated with each RNP AR operation. The FOSA is to be consistent with ICAO Doc 9613 PBN Manual Volume II Part C Chapter 6 Implementing RNP AR APCH. The FOSA must include mitigations implemented to reduce risks to the level of As Low as Reasonably Practical (ALARP). Suitable methods to mitigate risk include:
  - Flight crew procedures (including contingency procedures);
  - Flight crew training;
  - Engineering modifications;
  - Operating limitations; and
  - Procedure design.
- When the FOSA is assessed to have met all requirements associated with non-normal events an RNP AR navigation authorisation may be issued and annotated as follows:
  - RNP AR APCH (proprietary or ICAO as appropriate);
  - RNP AR DEP; and
  - RNP AR EOSID.

*Note:* Additional guidance on provision for non-normal operations is contained in FAA AC 120-29A Criteria for Approval of Category I and Category II Weather Minima for Approach.

## **11. AIRCRAFT ELIGIBILITY**

**11.1** An aircraft is eligible for an RNP AR navigation authorisation if:

- The aircraft manufacturer has documented that the aircraft is capable of RNP approach and/or departure operations;
- The aircraft meets the requirements for RNP AR operations in accordance with ICAO Doc 9613 PBN Manual Volume II Part C Chapter 6 Implementing RNP AR APCH as applicable;
- The aircraft is equipped with the following minimum equipment:
  - For aircraft certified to TSO-C129a (or equivalent) standards
  - 2 FMS;
  - 2 GNSS receivers (may be included in an MMR);
  - 1 IRS;
  - 2 Flight Directors
  - 2 Flight Mode Enunciators;
  - 2 RADALT;
  - Duplicated primary flight and navigation displays;
  - Duplicated AC power source (APU may be used);
  - 1 Autopilot channel; and
  - 1 TAWS appropriate to class of operation;
- For aircraft certified to TSO-C145a/C146a (or equivalent) standards:

- 2 FMS;
  - 2 GNSS receivers (may be included in an MMR);
  - 1 Flight Director;
  - 1 Flight Mode Annunciator;
  - 1 RADALT;
  - Duplicated primary flight and navigation displays;
  - Duplicated AC power source (APU may be used); and
  - 1 Autopilot channel; and
  - 1 TAWS appropriate to class of operation;
- Any modifications, options, or particular part numbers required by the manufacturer are installed.

**Note:** *An assessment of aircraft capability may include individual assessments made by a number of sources including the aircraft manufacturer, avionics supplier, the operator, CASA, and other regulatory bodies.*

## 12. SYSTEM PERFORMANCE, MONITORING AND ALERTING

**12.1** System performance, monitoring and alerting requirements for RNP AR operations are stated in ICAO Doc 9613 Volume II Part C Chapter 6 Implementing RNP AR APCH, with the following qualification:

- RNP AR lateral navigation tolerances are dependent on GNSS positioning. Positioning data from other navigation sensors may be integrated with GNSS data provided that data does not cause position errors exceeding the total system error (TSE) budget. If this is the case a means must be provided to deselect the other navigation sensor type's inputs.

**Note:** *An FMS position is commonly derived from inputs from a multi-mode receiver, and combined (where fitted) with IRS data. In the general case GNSS position has priority, however less accurate positioning derived from DME or VOR may also be used, commonly when GNSS updating is unavailable. Consequently it is possible that input from DME and/or VOR may degrade the GNSS/IRS position. Where degradation of position accuracy is possible, input from DME or VOR may need to be prevented either by crew de-selection of specific stations, or by inhibiting DME and/or VOR updating by the FMS. Inhibition may be available as the default FMS operation, or manually by crew input prior to each approach. Aircraft OEMs and FMS suppliers are generally able to provide information on the effect of DME and VOR input to the position solution and options for managing this function.*

## 13. SYSTEM FUNCTIONALITY

**13.1** System functionality requirements for RNP AR operations are stated in ICAO Doc 9613 Volume II Part C Chapter 6 Implementing RNP AR APCH 6.3.3.3 Functional requirements, with the following qualification:

- The capability to execute leg transitions and maintain tracks consistent with an RF leg is required for an RNP AR (proprietary) navigation authorisation.

**Note:** *ICAO Doc 9613 includes this requirement only where approaches are designed with RF legs, however all Australian RNP AR proprietary operations are dependent upon RF leg capability.*

- The standard for the display of cross-track deviation is:
  - A suitably scaled course deviation indicator and a map display with a numeric indication of cross-track deviation in 1/100th NM or less, both in the pilot's primary field of view;
  - For an RNP AR approach or departure with an RNP not less than 0.3, a map display in the primary field of view with a numeric display of cross-track deviation of 1/10th NM or less; or
  - For an RNP AR approach or departure with an RNP less than 0.3, an alternative means of compliance (AMOC) where an operational assessment has determined after consideration of the following factors that the flight crew is able to adequately monitor and manage cross-track deviations under all normal and non-normal conditions within the FTE appropriate to the RNP to be used:
    - Information displayed in the pilot's primary field of view;
    - Information displayed outside the pilot's primary field of view;
    - The resolution, scaling, numeric and other cross-track indications available;
    - The predictive display of aircraft flight path;
    - The crew procedures used to monitor and manage FTE;
    - Operator procedures for initiation of a missed approach;
    - Information provided by the aircraft manufacturer; and
    - Simulator demonstration of FTE management.

***Note 1:** The recommended standard for the display of cross-track error is a CDI and map display with a numerical display in 1/100th NM. However it is recognised that the preferred level of display is not available in some aircraft and in order to permit such aircraft to achieve the safety and operational advantages of RNP AR some objectivity in meeting the standard for cross-track deviation display is considered appropriate. The outcome of a FOSA may determine that limits should apply to the RNP used. The FOSA may determine that different limits are applicable to approach and departure operations.*

***Note 2:** In conducting an assessment of alternative means of display, it should be recognised that track adherence with auto-pilot coupled is normally excellent, and that the requirement for the crew to manage any cross-track error is infrequent. Consequently the primary consideration is the ability of the crew to recognise a deviation in sufficient time to take appropriate action, such as a go-round on approach, or a manual correction during a missed approach or departure.*

- A crew alert when GNSS updating is lost is not required for navigation systems that provide an alert when the selected RNP no longer meets the criteria for continued navigation.

***Note:** This requirement does not remove the need for the annunciation of a GNSS receiver failure, nor the ability of the crew to determine at any stage of flight that GNSS updating is available. However in some systems the loss of GNSS updating is not enunciated, where the navigation accuracy for the selected RNP is able to be maintained, typically by reversion to IRS coasting. For RNP AR departure operations, lateral navigation guidance after take-off is required to be available at or below 400ft above departure runway end elevation.*

- Lateral navigation guidance throughout a go-round, conducted at any point in the approach is required. (This function is commonly referred to as TOGA to LNAV.)
- Where continuous lateral navigation guidance is not available an alternative means may be acceptable if:
  - Flight crews receive specific training in accurate track keeping during a go-round; and
  - The operator demonstrates that the lateral track can be accurately maintained under all normal and non-normal conditions.

*Note:* Aircraft not equipped with TOGA to LNAV function will normally revert to IRS track hold mode when TOGA is activated. On an RF leg, if TOGA is selected, such aircraft will immediately roll off bank and begin to diverge from the flight path. Crew procedures need to ensure that the bank angle is maintained despite flight director commands in these cases. No provision is made in proprietary RNP AR approach procedures for reduction in track keeping accuracy during a go-round and the maximum FTE of 1 RNP applies throughout the approach and missed approach.

## **14. OPERATING STANDARDS**

### **14.1 General**

**14.1.1** The operating procedures contained in ICAO Doc 9613 Volume II Part C Chapter 6 Implementing RNP AR APCH are replaced by the operating standards in this Section.

### **14.2 RNP Availability Prediction**

**14.2.1** A prediction of the availability of an RNP service is required prior commencement of an RNP AR operation. The factors to be taken into account in predicting the availability of service include:

- Aerodrome location;
- Approach or departure operation;
- Terrain masking;
- Satellite serviceability (NOTAM); and
- Installed avionics algorithms.

### **14.3 Radio Updating**

**14.3.1** Where radio updating may degrade the GNSS position procedures are required for the crew to inhibit radio updating.

### **14.4 Procedure Selection**

**14.4.1** Approach or departure procedures (as appropriate) are required to be retrievable by procedure identifier from the aircraft navigation database.

## 14.5 Procedure Verification

**14.5.1** Crew procedures are required to verify, prior to execution of a procedure, that the correct approach or departure procedure has been selected and that the cockpit electronic displays correctly replicate the route, waypoint sequence and significant operational details shown on the published IAL procedure chart.

*Note:* As additional requirements are placed upon the integrity of the navigation database for RNP AR operations, procedure verification does not require detailed checking of all elements of the charted procedures, and emphasis is placed upon ensuring that the crew has extracted the correct procedure from the database, that it is properly displayed by the navigation system and that pertinent operating elements are displayed and recognised by the flight crew.

## 14.6 Procedure Modification

**14.6.1** Modification of the loaded procedure by the flight crew is not permitted.

## 14.7 Vectoring

**14.7.1** A procedure may be intercepted at a position inside the IAF but no later than the VIP when vectored by ATS. Descent on an approach procedure below the minimum vectoring altitude is not permitted until the aircraft is established within the vertical and lateral tolerances of the procedure and the appropriate navigation mode(s) is engaged.

## 14.8 Required List of Equipment

**14.8.1** Prior to commencement of an RNP AR operation it is necessary that the flight crew confirms that the equipment required is serviceable. A list of required equipment should be readily available to the crew.

## 14.9 Autopilot and Flight Director

**14.9.1** The standard flight control method for RNP AR procedures is autopilot coupled. The use of a flight director is acceptable provided:

- The operator provides guidance to crews on the circumstances when a flight director may be used in lieu of the autopilot;
- The manufacturer's recommended operating procedures permit the use of the flight director in lieu of an autopilot;
- Flight crews are trained in the conduct of RNP AR operations using the flight director; and
- The operator has demonstrated that FTE can be maintained within the permitted tolerances during all normal, rare-normal and non-normal circumstances, when flown with flight director.

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

## 14.10 RNP Selection

**14.10.1** A flight crew procedure is required to confirm that prior to commencement of an RNP AR operation the appropriate RNP is entered into the FMC.

*Note:* The appropriate RNP is determined by the flight crew after consideration of the published DA (or multiple DAs), weather and other ambient conditions, the current RNP service and the predicted RNP service. For proprietary RNP AR procedures, other than a system default value, RNP is not extracted from the navigation database.

## 14.11 GNSS Updating

**14.11.1** A flight crew procedure to confirm that GNSS updating is operative prior to commencement of an RNP AR operation is required. If GNSS updating is lost during an approach but the navigation system continues to provide a solution consistent with the selected RNP then the approach may be continued.

*Note:* This paragraph is not intended to contradict the manufacturer's approved operating procedures which may require an approach to be discontinued in the event of a loss of GNSS updating.

## 14.12 Track Deviation Monitoring

**14.12.1** The flight crew is responsible for ensuring that deviation from the defined lateral path does not exceed 1 x RNP at all stages of flight. Flight crew procedures are required for:

- Monitoring of lateral tracking;
- Track deviation alerts/callouts;
- Flight crew intervention;
- Regaining track; and
- Discontinuing the procedure.

*Note:* Proprietary RNP AR procedures require that the standard for track-keeping is applied during turns and no allowance is made for overshoot/undershoot during entry/exit as all turns for proprietary RNP AR procedures are RF legs.

## 14.13 Vertical Deviation Monitoring

**14.13.1** The flight crew is responsible for ensuring that deviation from the defined vertical path after the aircraft has passed the Vertical Intercept Point (VIP) on an approach does not exceed the limiting value stated in the operator's RNP AR operating procedures. The operator's limiting value for vertical deviation is determined after consideration of the aircraft manufacturer's data relating to vertical flight path accuracy, the cockpit display of vertical deviation, and the value(s) used by the designer of the IAL procedure(s). The operator defined vertical limitation is not to exceed 75 ft below the vertical flight path. The limit for deviation above the flight path is determined by the operator (FOSA) after consideration of the aircraft flight characteristics, the effect that any deviation may have on the safe continuation of a stabilised approach, airspeed and energy management. Flight crew procedures are required for:

- Monitoring of vertical deviation;
- Deviation alerts/callouts;

- Flight crew intervention; and
- Missed approach.

*Note 1: From the VIP the vertical clearance from obstacles is dependent upon a statistical evaluation of the factors that are associated with barometric vertical guidance, as defined by a Vertical Error Budget (VEB). The VEB includes a statistical value for vertical FTE which may vary between aircraft types. The establishment of a maximum permitted FTE does not affect the computation of the VEB, but provides a means for the flight crew to monitor the vertical flight accuracy and to intervene when the deviation exceeds a nominal limit, thereby limiting the vertical FTE and ensuring that the statistical basis for the VEB is protected.*

*Note 2: The PBN Study Group is seeking to harmonise the vertical FTE requirements for both RNP APCH – LNAV/VNAV and RNP AR APCH (Chapters 5 and 6 respectively of Volume II of the PBN Manual) and it is possible that both specifications will list an FTE of plus or minus 75ft. Irrespective of the vertical FTE required during the approach it is accepted that at the VIP aircraft inertia and/or configuration changes may cause some types of aircraft to balloon above the upper FTE limit. Such transitions above the FTE are normal and acceptable.*

#### **14.14 Maximum Airspeeds**

**14.14.1** For approach procedures the limiting indicated airspeeds by segment and category are as stated in ICAO Doc 9613 Volume II Part C Chapter 6 Implementing RNP AR APCH unless other speeds are specified by the procedure designer. Limiting indicated airspeeds for departure procedures are specified by the procedure designer.

#### **14.15 Limiting Temperature**

**14.15.1** Temperature limitations do not apply to aircraft equipped with temperature compensated barometric vertical navigation systems provided the operator;

- Determines that the temperature limits are not required (including OEI considerations);
- Instructions are provided to flight crew detailing the circumstances when temperature limitations do not apply; and
- Flight crew training includes the use of temperature compensated barometric vertical navigation systems.

*Note: RNP AR approach and/or departure procedures may be limited by maximum or minimum operating temperatures. Limiting temperatures for RNP AR procedures are determined after consideration of OEI performance as well as the effect of temperature on barometric vertical navigation. Where an aircraft is equipped with a temperature compensated vertical navigation system, temperature limitations applicable to vertical navigation may not apply, however the temperature limits may still be required for other considerations*

## 14.16 Altimeter Setting

14.16.1 Remote altimeter settings are not permitted.

## 14.17 Qualification Flight

14.17.1 Prior to issue on a navigation authorisation, the operator will conduct a qualification flight to enable the operator and CASA to assess that the operator has met the required standards for RNP AR operations. The CASA assessment will include:

- The operator meets the operating standard;
- The aircraft navigation, flight control, cockpit display and other systems function correctly;
- The overall interaction of procedure design, aircraft systems, airworthiness and crew procedures function correctly; and
- The operator's capability to 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 navigation authorisation may include a limitation on operations.

14.17.2 The qualification flight may be conducted in a full flight simulator provided;

- the simulator reasonably represents the RNP AR related functions, software version, and options of the aircraft to be flown;
- CASA is satisfied that any RNP AR related functions not replicated in the full flight simulator are not safety critical and may be demonstrated by other means;
- Where the qualification is flown in an aircraft:
  - The flight is to be conducted in an aircraft of the type and configuration to be operated;
  - flown by a crew trained in accordance the operator's RNP AR training program; and
  - in VMC by day.

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

## 15. FLIGHT CREW KNOWLEDGE AND TRAINING

15.1 The flight crew knowledge and training for RNP AR operations provided in ICAO Doc 9613 Volume II Part C Chapter 6 Implementing RNP AR APCH is applicable to RNP AR operations, with the following qualifications.

15.2 Guidance on suitable training is provided in Appendix A.

15.3 Where crews have previous relevant RNAV (GNSS) operational experience, recognition of prior learning (RPL) may be taken into account in the provision of RNP training. (For this paragraph operational experience in FMC based RNAV procedures is considered relevant.)

**15.4** Recency requirements for RNP AR APCH operations are satisfied if RNP AR procedures are included in an approved CAR 217 recurrent training programme. For non-CAR 217 operators RNP AR APCH recency requirements are as for ILS (ie: one procedure within the preceding 35 days).

**15.5** Recency requirements for RNP AR APCH, RNP APCH - LNAV/VNAV and RNP APCH – LNAV are reciprocal and the conduct of any one of these approaches meets the recency requirements for the other two, provided all approaches are conducted in an FMS equipped aircraft.

**15.6** A Route Training and a Restricted Minima Program should be considered for the PIC where operations are at a Restricted Airport or involve operations in the vicinity of mountainous terrain.

*Note:* A Restricted Airport is one that has specific restrictions placed on it by the operator for risk mitigation e.g. additional crew training or equipment requirements.

**15.7** If route training is not conducted, the PIC should complete at least one RNP approach at any airfield in VMC prior to unrestricted operations. There are no restrictions to RNP Departure operations.

*Note 1:* The extent of training will vary depending upon many factors including the crew's previous experience in use of RNAV/RNP systems, the navigation system complexity, aircraft type and the method of training delivery. As a guide, crews typically require 4-8 hours ground training in knowledge elements.

*Note 2:* Flight training programs vary considerably due to the differences in equipment function and complexity. Stand-alone systems commonly used in general aviation and flown in single-pilot operations, typically require a number of actual and/or simulated flight training exercises to achieve proficiency. FMS equipped aircraft flown by crews familiar with FMS use, commonly require one or more (2-4 hr) simulator exercises per crew.

*Note 3:* Normal operations are generally relatively simple and proficiency can be achieved with minimum training. However operations involving multiple approaches, changes to procedure selection, contingency procedures and non-normal operations can be challenging and adequate training in these elements needs to be provided.

## **16. MINIMUM EQUIPMENT LIST**

**16.1** The operator's minimum equipment list must identify any unserviceability that affects the conduct of an RNP AR operation.

**16.2** Redundancy is required for essential systems prior to dispatch ensuring that capability is maintained following a loss of any individual system. Where redundant equipment is unserviceable the MEL requirements are determined by consideration of the effect on the RNP operation caused by a loss of system availability taking into account any mitigating provisions incorporated in the procedure design or operating procedures.

**16.3** The operator's MEL for RNP AR operations should provide for all operations at all ports where RNP AR operations are conducted. The MEL may be varied to allow increased operational flexibility where some MEL items are not warranted at specific ports.

## **17. CONTINUING AIRWORTHINESS**

**17.1** The operator is required to implement procedures to ensure the continuing airworthiness of the aircraft for RNP AR operations.

17.2 Aircraft equipment and configuration control consistent with the RNP AR capability and minimum equipment requirements is required.

17.3 Engineering personnel are to be provided with training, where required, to ensure that they are familiar with RNP AR airworthiness requirements.

## 18. NAVIGATION DATA BASE

### 18.1 General

18.1.1 The requirements for the management of the navigation databases provided in ICAO Doc 9613 Volume II Part C Chapter 6 Implementing RNP AR APCH are applicable to RNP AR operations, subject to the following qualifications:

- Data Updates
  - The provisions of ICAO Doc 9613 Volume II Part C Chapter 6 Implementing RNP AR APCH relating to Data Updates do not apply to proprietary procedures.
- Cyclic Data Checks
  - A procedure is required to ensure the continued validity of navigation data at each data cycle. Any discrepancy in data is to be resolved prior to operational use by:
    - Re-issue of the navigation database;
    - Withdrawal of the approach or departure procedure; or
    - Instructions to flight crew.
- Flight Validation
  - Where a certificated procedure designer has not conducted a flight validation in an aircraft of the type and configuration to be operated, the operator is required to conduct a flight validation for each aircraft type/configuration to verify that:
    - The aircraft navigation, flight control, cockpit display and other systems function correctly;
    - The procedure is flyable;
    - The operator's crew procedures are adequate; and
    - The overall interaction of procedure design, aircraft systems, airworthiness and crew procedures function correctly.
  - The validation flight may be conducted in a flight simulator provided:
    - The simulator reasonably represents all RNP AR related functions, software version, and options of the aircraft to be flown; or
    - Where the simulator does not fully replicate the aircraft configuration;
    - The procedure is typical of other procedures previously validated in the aircraft type by the operator; and
    - The procedure is not complex; and
    - CASA is satisfied that the validation is adequate.

*Note:* For purposes of this paragraph a procedure may be considered complex if there are turns within the final approach segment, the missed approach includes more than one

*turn in order to achieve obstacle clearance, or a departure includes a turn below 1000ft or more than one turn in order to achieve obstacle clearance.*

- In all other cases the validation flight is to be conducted in the operator's aircraft in VMC by day.

**Note:** *The validation flight may be conducted on a scheduled revenue service.*

- Prior to entry into operational service each procedure is to be flight checked by the operator in an aircraft of the type/configuration operated;
  - In VMC;
  - Flown by an RNP AR qualified crew; and
  - Assessed in writing as fit for service by the aircraft captain.

**Note:** *The flight check may be conducted on a scheduled revenue service.*

## **19. IMPLEMENTATION PROGRAMME**

**19.1** The implementation of RNP AR operations is to be managed in accordance with a programme developed by the operator in consultation with CASA.

**19.2** For an operator that has not previously conducted RNP AR operations or has not previously conducted RNP AR operations using a particular aircraft type, the implementation program will include limits on operating minima until the operator has demonstrated the capability to safely conduct RNP AR operations.

**19.3** The implementation programme will include the monitoring of RNP AR operations and the collection of data to enable any negative trend in performance or operations to be identified.

**19.4** At intervals as specified in the operator's implementation programme, the operator will submit to CASA a report containing a review of operations including the following elements:

- Total number of RNP AR procedures conducted;
- Number of satisfactory approaches and departures by aircraft/system (satisfactory if completed as planned without any navigation or guidance system anomalies);
- Reasons for unsatisfactory operations, such as:
  - UNABLE REQ NAV PERF - RNP, GPS PRIMARY LOST, or other RNP related messages;
  - Excessive lateral or vertical deviation;
  - TAWS warning;
  - Autopilot system disconnect;
  - Navigation data errors; and
  - Pilot report of any anomaly;
- Crew comments.

**Note:** *The structure of the implementation program, including limited operating minima or the number or duration of operations applicable to any particular phase of the operator's program are subject to many variables and is not specified. Factors such as the operator's previous experience in RNAV and RNP approach and departure operations, the frequency of*

*RNP AR operations, the number of qualified crews available should be considered and a suitable programme developed in consultation with CASA. A phased implementation programme which provides for goals to be met at the conclusion of each phase is recommended.*

## **20. CONDITIONS ON A NAVIGATION AUTHORISATION**

**20.1** A navigation authorisation is issued when the operator has met the standards for RNP AR operations in accordance with this AC.

**20.2** However, full operational capability may not be achieved until the operator has demonstrated satisfactory operations at defined stages in accordance with the operator's approved implementation program.

**20.3** The navigation authorisation will specify the conditions to be met at each stage of the operator's implementation programme, and the conditions under which the operator may progress to full operational capability.

***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 to IMC operations with ceiling/visibility limits and/or RNP limits until full capability is achieved. It is intended that a navigation authorisation is issued prior to commencement of the operator's implementation program, with specified conditions under which the operator is able to progress to full operational capability.*

---

Executive Manager  
Standards Development and Future Technology

July 2011

## APPENDIX A

## RNP AR TRAINING PROFICIENCIES

**Introduction:**

RNP AR Training Proficiencies are the required knowledge or skill sets that are necessary at the completion of a training course.

Listed below are a set of RNP AR Training Proficiencies which provide guidance when planning RNP AR training.

**Delivery Method Legend**

A Paper based training<sup>1</sup>

B CBT or class room tutorial

# Recognition of prior learning if qualified to conduct RNP APCH - LNAV or RNP APCH –LNAV/VNAV operations in the same aircraft and FMS type. A different FMS update status is considered to be the same FMS type.

S Full flight simulator training

P Proficiency check required<sup>2</sup>

RNP AR TRAINING PROFICIENCIES	DELIVERY				
GNSS Theory (Architecture, Accuracy, Integrity, etc)	A	B	#		
RNP APCH Procedure Design Basics	A	B	#		
RNP AR Procedure Design Basics	A	B			
Rare Normal wind protection and maximum coded speeds.	A	B			
RNP/ANP/EPE Definitions and the Navigational Concept	A	B			
RNP DEP and Engine Out Procedures*	A	B			
EO SID obstacle clearance areas*	A	B			
Missed Approach Extraction Capability	A	B			
FMS System Architecture	A	B	#		
Multi Sensor Navigation and Sensor Blending	A	B	#		
FMS Failure Modes and Indications	A	B			
Navigation Performance Displays (NPS, L/DEV, V/DEV)	A	B			

RNP AR TRAINING PROFICIENCIES	DELIVERY				
Allowable Lateral and Vertical FTE's	A	B			
Vertical Situation Display (VSD) (Where fitted)	A	B	#		
Minimum Equipment List	A	B			
Critical System Losses Prior to the VIP or NNDP <sup>4</sup>	A	B			P
Critical System Losses after the VIP or NNDP <sup>4</sup>	A	B		S	P
Navigation System Losses after the VIP or NNDP <sup>4</sup>	A	B		S	P
FMS Database Integrity	A	B			
RNP Performance Prediction	A	B			
<b>Flight Crew Procedure Review</b>					
Selecting an RNP procedures	A	B		S	P
Changing an RNP procedure	A	B			
Briefing an RNP procedure	A	B		S	P
Checking an RNP procedure	A	B		S	P
RNP Missed Approach Requirements	A	B		S	P
Navigation System Failures	A	B		S	
VIP Definition	A	B			
Runway Changes inside the VIP	A	B			
Managing A Non-Normal prior to the VIP	A	B		S	P
Managing a Non-Normal after the VIP	A	B		S	P
Autopilot Requirements	A	B		S	P
FMS Default RNP Values and Alerts	A	B	#		
Effect of an Incorrectly Set Local QNH	A	B	#	S	
Effect of Non Standard Temperature on Nominal Path	A	B	#		
Approach Procedures including PF and PNF/PM duties	A	B		S	P
HUGS (if fitted)	A	B		S	

RNP AR TRAINING PROFICIENCIES	DELIVERY				
Monitoring and Flying Raw Data	A	B	#	S	
FMS Modes/Functionality (On Approach Logic, VNAV PATH, FINAL APP MODE, SPD INTV, ALT INTV, Managed/Selected modes)	A	B	#	S	
FCC Lateral and Vertical Go-around functionality	A	B			
RNP Holding Patterns and Managing the FMS	A	B			
<b>Simulator</b>					
Departure*				S	
Approach				S	P
Approach Dual FMC Failure				S	
Departure with High Drift Condition*				S	
Approach with High Drift Condition				S	
Departure Asymmetric Thrust*				S	P
Approach IRS Failure				S	
Approach with Asymmetric Thrust and Missed Approach				S	
Approach Single GPS Receiver failure			#	S	
Approach Navigation System Alerts.			#	S	

**Notes:**

1. Where both paper based and CBT/classroom delivery methods appear, it is intended that the item is included in written study material as well as ground school/tutorial sessions.
  2. Not all proficiency requirements need to be demonstrated in a Full Flight Simulator (FFS). Some proficiency items may be demonstrated by exam or quiz.
  3. Some RNP AR proficiencies apply to specific manufacturer/operator selected equipment options. These items need not be covered if they are not 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.
- \* Training requirement for proprietary procedures only.