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Advisory Circular

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NAVIGATION AUTHORISATIONS – BASIC RNP 1

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1. REFERENCES

- ICAO Doc 9613 Performance-based Navigation Manual, Volume II, Part C, Chapter 3, Implementing Basic RNP 1.
- CAO 20.91 Navigation Authorisations Appendix 4, Requirements for use of Basic RNP 1.
- CASA Form 1307: *Reduced Vertical Separation Minimum and Required Navigation Performance* Application Form.
- FAA AC 20-138A Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment
- FAA AC 20-138B Airworthiness Approval of Positioning and Navigation Systems

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.

2. PURPOSE

2.1 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 Performance-based Navigation Manual (ICAO Doc 9613 PBN Manual) and include area navigation (RNAV) and Required Navigation Performance (RNP) navigation specifications.

3. STATUS OF THIS AC

3.1 This is the first AC relating to Basic RNP 1 navigation authorisations and is based on information contained in Volume II, Part C, Chapter 3, of ICAO Doc 9613 PBN Manual and Appendix 3, Requirements for use of Basic RNP 1 *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

AC	Advisory Circular
AFM	Aircraft Flight Manual
ANSP	Air Navigation Service Provider
ARINC	Aeronautical Radio Incorporated
ATC	Air Traffic Control
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulations 1998
CDI	Course Deviation Indicator
EASA	European Aviation Safety Agency
FAA	Federal Aviation Administration
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
LOA	Letter of Acceptance
MEL	Minimum Equipment List
NOTAM	Notice to Airmen
OEM	Original Equipment Manufacturer
Ops Specs	Operations Specifications
PBN	Performance Based Navigation
QRH	Quick Reference Handbook
RNAV	Area Navigation
RNP	Required Navigation Performance

SBAS	Space Based Augmentation System
SID	Standard Instrument Departure
STAR	Standard Arrival Route
TSO	Technical Standing Order

5. BACKGROUND

5.1 Basic RNP 1 is a navigation specification intended to provide connectivity between en-route structure and terminal airspace with no or limited Air Traffic Control (ATC) surveillance.

5.2 The Basic RNP 1 navigation specification is applicable to terminal area arrival and departure phases of flight and to instrument approach procedures up to the final approach fix.

5.3 Basic RNP 1 requires Global Navigation Satellite System (GNSS) as the primary navigation sensor, either as a stand-alone navigation system or as part of a multi-sensor system. Where multi-sensor systems are used and their data is integrated with that of the GNSS data a means to deselect the non-GNSS navigation sensor may be required to prevent degradation of the navigation solution.

5.4 The standards applicable to Basic RNP 1 also meet the requirements for:

- RNAV 5; and
- RNAV 1 and RNAV 2.

Note: The standards for Basic RNP 1 are in most respects identical to RNAV 1 and RNAV 2, with the additional RNP requirement for on-board performance monitoring and alerting.

5.5 Basic RNP 1 is applicable to RNAV routes defined by straight segments, where turn guidance is provided by turn anticipation algorithms.

Note: Advanced RNP is not yet implemented by ICAO but is intended to support en-route, terminal, arrival and departure operations with additional functionality such as Radius to Fix (RF) Aeronautical Radio Incorporated (ARINC) 424 path terminators which enable circular flight paths to be defined and flown.

6. APPLICABILITY

6.1 This AC is applicable to operators of Australian and foreign registered aircraft and their flight crews. A Basic RNP 1 navigation authorisation (or equivalent approval from another State) is not mandatory in order to gain access to Australian 'PBN airspace'. However, authorisation must be obtained from the Civil Aviation Safety Authority (CASA) for Basic RNP 1 operations to be conducted by the operator.

7. RELATED PUBLICATIONS

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

- CASA AC 21-37(0) Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors.
- 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 1 navigation authorisation:

- Demonstrate Aircraft Eligibility:
 - Aircraft equipment eligibility requirements for Basic RNP 1 are described in the PBN Manual and may be demonstrated through an Aircraft Flight Manual (AFM) compliance statement, AFM supplement or Original Equipment Manufacturer (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. Quick Reference Handbook (QRH), checklist etc.; and
- Document Training and Operating Procedures:
 - Methods of control for flight crew training, operational procedures and database management must be identified in the operations manual.

9. NAVIGATION AUTHORISATION PROCESS

9.1 Navigation authorisations for all PBN navigation specifications and Reduced Vertical Separation Minimum 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 *Reduced Vertical Separation Minimum and Required Navigation Performance* Application Form and forwards it to the relevant Certificate Management Team for assessment;
- The Certificate Management Team conducts the navigation authorisation assessment:
 - 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;
 - 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 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 Specs) and issues an updated Ops Specs 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, Basic RNP 1 navigation authorisations will be issued under CAO 20.91.

10. APPLICATION

10.1 Content of an application for a Basic RNP 1 navigation authorisation:

- Aircraft airworthiness documents (e.g. the AFM, AFM Supplement, OEM service letters) that establish that the aircraft is equipped with RNAV equipment that meets the requirements of Basic RNP 1;
- A description of aircraft equipment including a configuration list which details pertinent components and equipment to be used for Basic RNP 1 operations;
- A description of the proposed flight crew training, including:
 - Training syllabus.

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).

- details of the operating procedures to be used, including:
 - relevant sections of the company operations manual;
 - checklists;
 - contingency procedures, QRH etc.;
- Sections of the Minimum Equipment List (MEL) applicable to Basic RNP 1 operations; and
- Details of the method to be used to ensure the continuing integrity of the airborne navigation database.

11. AIRCRAFT ELIGIBILITY

11.1 An aircraft is eligible for a Basic RNP 1 navigation authorisation if:

- The AFM, an AFM supplement, or OEM service letter states that the aircraft navigation system is approved for RNP 1 operations; or
- The aircraft is demonstrated to comply with the requirements for Basic RNP 1 contained in ICAO Doc 9613 PBN Manual, Volume II, Part C, Chapter 3, Implementing Basic RNP 1.

12. SYSTEM PERFORMANCE, MONITORING AND ALERTING

12.1 System performance, monitoring and alerting requirements for Basic RNP 1 operations are as stated in ICAO Doc 9613, Volume II, Part C, Chapter 3 Implementing Basic RNP 1.

13. SYSTEM FUNCTIONALITY

13.1 System functionality requirements for Basic RNP 1 operations are as stated in ICAO Doc 9613 Volume II Part C Chapter 3 Implementing Basic RNP 1.

Note: Guidance in CASA AC 21-36(0) also applies to the application of the following functionality requirements.

14. OPERATING STANDARDS

14.1 Flight Planning

14.1.1 Prior to flight, consider conditions that may affect Basic RNP 1 operations, including:

- Verify that the aircraft and operating crew are approved for Basic RNP 1;
- Confirm that the aircraft can be operated in accordance with the Basic RNP 1 requirements for the planned route(s) including the route/s to any alternate aerodrome(s) and minimum equipment requirements;
- Check availability of the NAVAID infrastructure required for the intended routes, including any non-RNAV contingencies, for the period of the intended operation;
- Confirm that the navigational database is current and appropriate for the region of intended operation and includes the NAVAIDs and waypoints required for the route; and
- Consider any operating restrictions, including time limits if applicable.

14.1.2 Insert the appropriate identifier in the flight plan to indicate the RNP type (Basic RNP 1) as set out in the relevant State Aeronautical Information Publication.

14.2 GNSS Integrity Availability

14.2.1 GNSS navigation systems are equipped with a means of monitoring the integrity of the position solution. Integrity may be assured by a number of methods including Receiver Autonomous Integrity Monitor and proprietary hybrid Inertial Reference System/Global Positioning System (GPS) systems.

14.2.2 The availability of the integrity monitoring function can be predicted and can be obtained from a variety of sources such as Notice to Airmen (NOTAM), and prediction services. Operators should be familiar with the prediction information available for the intended route. Prediction services are available from Air Navigation Service Provider (ANSPs), avionics manufacturers, other entities or through an on-board prediction capability.

14.2.3 Integrity availability prediction should take into account the latest satellite constellation NOTAM and the integrity system used by the aircraft avionics.

14.2.4 In the event of a predicted, continuous loss of the integrity function more than 5 minutes for any part of the RNP 1 operation, the flight plan should be revised (i.e. delaying the departure or planning a different departure procedure).

14.2.5 Operators, pilots and ANSPs need to be aware, that a prediction of integrity availability, an unplanned failure of GNSS elements can result in a loss of integrity monitoring capability, and in some cases a complete loss of the navigation function whilst airborne, which may require reversion to an alternative means of navigation. Pilots should, therefore, assess their capability to navigate (potentially to an alternate destination) in the case of failure of GNSS navigation.

14.2.6 For aircraft navigating with Space Based Augmentation System (SBAS) receivers (all Technical Standard Order (TSO)-C145/C146), check GPS INTEGRITY availability in areas where SBAS is unavailable.

14.3 Flight Procedures

14.3.1 Comply with any instructions or procedures identified by the manufacturer as being necessary to comply with the performance requirements of the navigation specification.

14.3.2 At system initialisation, confirm the navigation database is current and verify that the aircraft position has been entered correctly. Verify proper entry of the ATC assigned route upon initial clearance from ATC to conduct the relevant RNAV route. Ensure the waypoints sequence, depicted by the navigation system, matches the route depicted on the appropriate chart/s and the assigned route.

14.3.3 An RNAV Standard Instrument Departure (SID) or Standard Arrival Route (STAR) must be selected by route name from the on-board navigation database and conform to the charted route. Modification of the route through the insertion or deletion of specific waypoints in response to ATC clearances is permitted. The manual entry or creation of new waypoints by manual entry, of latitude and longitude or rho/theta values is not permitted. Change of an RNAV SID or STAR database waypoint type from a fly-by to a flyover or visa versa is not permitted.

14.3.4 Cross-check the cleared flight plan by comparing charts or other applicable resources with the navigation system textual display and the aircraft map display, if applicable. If required, confirm the exclusion of specific navigation aids.

Note: Small differences between charted navigation information and displayed navigation data may be noted. Differences of 3 degrees or less due to the equipment manufacturer's application of magnetic variation and are operationally acceptable.

14.3.5 During flight, where feasible, confirm navigation reasonableness by cross-reference to available data from ground-based aids.

14.3.6 The use of a lateral deviation indicator (e.g. Course Deviation Indicator (CDI) or Horizontal Situation Indicator), flight director or autopilot is required.

14.3.7 Select lateral deviation display scaling suitable for the navigation accuracy associated with the route/procedure (e.g. full scale deflection ± 1 nm for RNP 1).

14.3.8 Select navigation map scale to enable monitoring of tracking accuracy applicable to RNP 1.

Note: Map scaling selection is dependent upon a number of factors including display size, resolution, any numeric cross-track indications and route complexity. Typically a 10 nm display scaling may be used.

14.3.9 Maintain route centrelines, as depicted by lateral deviation indicators and/or flight guidance, unless authorised to deviate by ATC or under emergency conditions.

14.3.10 The standard for limitation of cross-track error/deviation (the difference between the computed path and the displayed aircraft position) is $\frac{1}{2}$ the navigation accuracy (i.e. 0.5 nm for Basic RNP 1).

Note: Brief deviations from this standard during and immediately after turns, are normally considered acceptable. As accurate cross-track information may not be provided during turns, crew procedures and training need to emphasise observance of turn anticipation commands and management of rate of turn.

14.3.11 If ATC issues a heading assignment taking the aircraft off a route, do not modify the flight plan until clearance is received to rejoin the route or the controller confirms a new clearance.

14.3.12 Manually selecting aircraft bank-limiting functions may reduce the aircraft's ability to maintain its desired track and is therefore not recommended. Pilots should recognise that manually selectable aircraft bank-limiting functions might reduce their ability to satisfy ATC flight path expectations, especially when executing large angle turns. This should not be construed as a requirement to deviate from approved aircraft flight manual procedures; rather pilots should be encouraged to limit the selection of such functions within accepted procedures.

14.4 RNAV SID Requirements

14.4.1 Prior to commencing take-off, verify the aircraft's RNAV system is available, operating correctly and that the correct airport and runway data is loaded. Verify their aircraft navigation system is operating correctly and the correct runway and departure procedure (including any applicable en-route transition) is entered and properly depicted. Where an RNAV departure procedure is assigned and the runway, procedure or transition is subsequently changed, verify the appropriate changes are entered and available for navigation prior to take-off. A final check of proper runway entry and correct route depiction, shortly after take-off, within the constraints of normal operations, is recommended.

Note: Caution is required to ensure that flight crews are aware of the functional limitations of some RNAV systems. Typically stand-alone GNSS systems do not support course to altitude and some other ARINC 424 path terminators that may be required to provide complete course guidance on departure. The basic RNP 1 navigation specification accommodates such limitations but relies on flight crew intervention to ensure that the SID is followed until automatic flight guidance is available. For example, the flight crew may be required to select and maintain a course (e.g. runway alignment) until reaching a specific altitude, and to track manually to a point on the SID where automatic tracking and waypoint sequencing can be engaged. Flight crew training in the limitations of the navigation system and the correct application of manual tracking procedures is essential in such cases.

14.4.2 Ensure RNAV guidance is selected and available to provide flight guidance for lateral RNAV no later than 153 m (500 ft) above the aerodrome field elevation. The altitude at which RNAV guidance begins on a given route may be higher (e.g. climb to 304 m (1000 ft) then direct to....).

14.4.3 Use an authorised method (lateral deviation indicator/navigation map display/flight director/autopilot) to achieve an appropriate level of performance for Basic RNP 1.

14.4.4 The GNSS signal must be acquired before the take-off roll commences. For aircraft using TSO-C129/C129A equipment, the departure airport must be loaded into the flight plan in order to achieve the appropriate navigation system monitoring and sensitivity. For aircraft using TSO-C145a/146a avionics, if the departure begins at a runway waypoint, then the departure airport does not need to be in the flight plan to obtain appropriate monitoring and sensitivity.

14.4.5 Where an Basic RNP 1 SID extends beyond 30 nm from the Aerodrome Reference Point and CDI scaling automatically changes to en-route mode, manual selection of CDI scale to +/- 1 nm is required until termination of the SID.

14.5 RNAV STAR Requirements

14.5.1 Verify their aircraft navigation system is operating correctly and that the correct arrival procedure and runway (including any applicable transition) are entered and properly depicted.

14.5.2 Check the active flight plan by comparing the charts with the navigation displays. Confirm waypoint sequence, reasonableness of track angles and distances, altitude or speed constraints and, where possible, which waypoints are fly-by and which are flyover.

14.5.3 If required by a route, confirm that updating will exclude a particular navigation aid. A route must not be used if doubt exists as to the validity of the route in the navigation database.

14.5.4 The creation of new waypoints by manual entry into the RNAV system by the flight crew is not permitted.

14.5.5 Prior to commencement of the STAR provide for reversion to a conventional arrival route, if required for contingency procedures.

14.5.6 Route modifications in the terminal area may take the form of radar headings or 'direct to' clearances and may require the insertion of tactical waypoints from the navigation database. Manual entry or modification, by the flight crew, of the loaded route, using temporary waypoints or fixes not contained in the database, is not permitted.

14.5.7 Observe published altitude and speed constraints.

14.6 Contingency Procedures

14.5.1 Notify ATC when the RNAV performance ceases to meet the requirements for Basic RNP 1.

15. FLIGHT CREW KNOWLEDGE AND TRAINING

15.1 Flight crew knowledge elements include:

- The meaning and proper use of aircraft equipment/navigation suffixes;
- The capabilities and limitations of the RNAV system installed;
- The operations and airspace for which the RNAV system is approved to operate;
- The navaid limitations with respect to the RNAV system to be used for the Basic RNP 1 operations;

- Required navigation equipment for operation on RNAV routes/SIDs/STARs;
- Procedure characteristics as determined from chart depiction and textual description;
- Depiction of waypoint types (fly over and fly-by) and path terminators (both ARINC 424 path terminators and any other types used by the operator), as well as associated aircraft flight paths;
- The flight planning requirements for the RNAV operation;
- The radio/telephony phraseology for the airspace, in accordance with ICAO Doc 4444 – PANS/ATM and ICAO Doc 7030 – Regional Supplementary Procedures, as appropriate;
- Contingency procedures for RNAV failures;
- RNAV system-specific information, including:
 - Levels of automation, mode annunciations, changes, alerts, interactions, reversions and degradation;
 - Functional integration with other aircraft systems;
 - Types of navigation sensors (e.g. Distance Measuring Equipment, Inertial Reference Unit (IRU) and GNSS) utilised by the RNAV system and associated system prioritisation/weighting/logic;
 - Aircraft configuration and operational conditions required to support RNAV operations i.e. appropriate selection of CDI scaling (lateral deviation display scaling);
 - Pilot procedures consistent with the operation;
 - The meaning and appropriateness of route discontinuities and related flight crew procedures;
 - Monitoring procedures for each phase of the flight (e.g. monitor PROG or LEGS page);
 - Turn anticipation with consideration to speed and altitude effects; and
 - Interpretation of electronic displays and symbols.

15.2 Flight crew training elements include:

- Verify that the aircraft navigation data is current and valid;
- Verify the successful completion of RNAV system self-tests;
- Initialise RNAV system position;
- Perform a manual or automatic update (with take-off point shift, if applicable);
- Retrieve and fly a SID and STAR with appropriate transition;
- Verify waypoints and flight plan programming;
- Resolve route discontinuities;
- Adhere to speed and/or altitude constraints associated with a SID or STAR;
- Fly direct to waypoint;
- Fly a course/track to waypoint;
- Intercept a course/track;

- Vector off track and rejoin a procedure;
- Fly radar vectors and rejoining an RNAV route from a ‘heading’ mode;
- Determine cross-track error/deviation;
- Determine allowable deviation limits and maintain flight within those limits;
- Remove and reselect navigation sensor input;
- Perform gross navigation error checks using conventional aids;
- Confirm exclusion of a specific navigation aid or navigation aid type;
- Change arrival airport and alternate airport;
- Perform parallel offset function if capability exists. Advise ATC if this functionality is not available; and
- Contingency procedures for RNAV failures.

Note 1: Caution is required to ensure that flight crews are aware of the functional limitations of some RNAV systems. Typically stand-alone GNSS systems do not support course to altitude (CA) and some other ARINC 424 path terminators that may be required to provide complete course guidance on departure.

The basic RNP 1, navigation specification accommodates such limitations but relies on flight crew intervention to ensure that a procedure is followed when automatic flight guidance is not available. For example, in executing a SID, the flight crew may be required to select and maintain a course (e.g. runway alignment) until reaching a specific altitude, and to track manually to a point on the SID where automatic tracking and waypoint sequencing can be engaged. Flight crew training in the limitations of the navigation system and the correct application of manual tracking procedures is essential in such cases.

Note 2: Where crews have the required standard of knowledge based on previous training or experience a separate training course may not be necessary, provided the applicant details the relevant knowledge and training elements that are contained in other training programmes

16. MIMIMUM EQUIPMENT LIST

16.1 The operator’s MEL must identify any unserviceability that affects the conduct of a Basic RNP 1 operation.

17. NAVIGATION DATA BASE

17.1 A navigation database should be obtained from a supplier that complies with Radio technical Commission for Aeronautics (RTCA) DO 200A/ European Organisation for Civil Aircraft Equipment (EUROCAE) document ED-76, Standards for Processing Aeronautical Data and should be compatible with the intended function of the equipment (see ICAO Annex 6, Part 1, Chapter 7). A Letter of Acceptance (LOA), issued by an appropriate regulatory authority to each of the participants in the data chain, demonstrates compliance with this requirement (e.g. Federal Aviation Administration (FAA) LOA issued in accordance with FAA AC 20-153 or European Aviation Safety Agency (EASA) LOA issued in accordance with EASA Implementing Rule (IR) 21 subpart G)..

17.2 An operator who uses a navigation database supplier that does not meet these standards must implement navigation database integrity checks using appropriate software tools or approved manual procedures to verify data relating to all waypoints in airspace or routes where RNP 1 operations are conducted. These checks are in addition to any checks performed by the Aeronautical Information Services, unapproved navigation database suppliers or navigation equipment manufacturers.

Note: While a LOA provides assurance of minimum standards for the supply of a navigation data, errors may still occur and all operators should consider the need to conduct periodic checks to ensure database integrity.

17.3 Any discrepancy in data is to be reported to the navigation data base supplier and resolved prior to operational use by:

- re-issue of the navigation database;
- prohibition of the route; or
- instructions to flight crew.

18. NAVIGATION ERRORS

18.1 It is the responsibility of the operator to take immediate action to rectify any condition that has led to navigation error.

18.2 A report to CASA and Airservices Australia, including an initial analysis of the causal factors and the measures being taken to prevent a recurrence is due within 72 hours.

18.3 Navigation errors exceeding the following limits are reportable to CASA:

- a lateral navigational error of at least 1 nm for RNP 1;
- a longitudinal navigational error of at least 1 nm for RNP 1; or
- a navigation system failure.

18.4 The Navigation Error Investigation Form is the approved form for reporting a navigation error or an equipment failure.

18.5 CASA and the operator may determine the reasons for the apparent deviation from track or altitude and the steps to be taken to prevent a recurrence.

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