

# Advisory Circular

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## OPERATIONAL APPROVAL FOR RNP-1

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### GENERAL

Advisory Circulars (ACs) are issued by the Director-General of Civil Aviation (DGCA) from time to time to provide practical guidance or certainty in respect of the statutory requirements for aviation safety. ACs contain information about standards, practices and procedures acceptable to CAAS. An AC may be used, in accordance with section 3C of the Air Navigation Act (Cap. 6) (ANA), to demonstrate compliance with a statutory requirement. The revision number of the AC is indicated in parenthesis in the suffix of the AC number.

### PURPOSE

This AC provides guidance for showing compliance with requirements regarding, and information related to the application of approval for specified navigation performance operations in accordance with ANR-98.

### APPLICABILITY

This AC is applicable to an operator seeking approval for RNP 1 operations.

### RELATED REGULATIONS

This AC relates specifically to Division 2 in Part 2 of ANR-98.

### RELATED ADVISORY CIRCULARS

Nil.

### CANCELLATION

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**EFFECTIVE DATE**

This AC is effective from 1 November 2019.

**OTHER REFERENCES**

- (a) ICAO Doc 9613
- (b) FAA AC 90-105(as revised)
- (c) RTCA DO-200A/EUROCAE ED-76
- (d) TSO C129 (as revised) Class A1 or A2, TSO C146 (as revised) Class Gamma Operational Class 1, 2 or 3
- (e) ETSO C129 (as revised) Class A1 or A2, ETSO C146 (as revised) Class Gamma Operational Class 1, 2 or 3
- (f) FAA AC 20-130(as revised), FAA AC 20-138 (as revised)

## 1 INTRODUCTION.

- 1.1 The RNP 1 specification provides a means to develop routes for connectivity between the en-route structure and terminal airspace with no or limited ATS surveillance. The RNP 1 specification is based upon GNSS. While DME/DME-based RNAV systems are capable of RNP 1 accuracy, this navigation specification is primarily intended for environments where the DME infrastructure cannot support DME/DME area navigation to the required performance.
- 1.2 RNP 1 should not be used in areas of known navigation signal (GNSS) interference.

## 2 OPERATIONAL REQUIREMENTS

- 2.1 To meet RNP 1 operational requirements, the aircraft should maintain track-keeping accuracy of 95% of flight time of  $\pm 1$  nm with on-board monitoring and alerting capabilities. RNP 1 is intended to support departure (SID) and arrival (STAR) procedures using GNSS positioning only, including initial and intermediate approach segments.

## 3 AIRCRAFT ELIGIBILITY.

- 3.1 An aircraft is eligible for a RNP 1 navigation authorisation if:
  - (a) The aircraft is equipped with a Global Positioning System (GPS) stand-alone systems approved in accordance with TSO-C146(as revised) operational Class 1, 2, or 3.
  - (b) The aircraft is equipped with a TSO-C115c flight management system (FMS) (as revised) with a TSO-C129(as revised) Class B1 or C1, TSO-C145(as revised), or TSO-C196(as revised) sensor.  
  
Note: TSO-C129a has been cancelled, but equipment with an existing TSO-C129a Technical Standard Order Authorization (TSOA) may still be installed.
  - (c) The aircraft is equipped with a TSO-C115b FMS using a TSO-C129 (as revised) Class B1 or C1, TSO-C145 (as revised), or TSO-C196 (as revised) sensor with documented compliance to the RNP requirements in RTCA, Inc.'s document, RTCA/DO-236 (revision 'B' or later) or RTCA/DO-283A.
  - (d) The aircraft complies with Part C, Chapter 3, Implementing RNP 1 in ICAO Doc 9613 PBN Manual, Volume II.

## 4 FUNCTIONALITY.

- 4.1 The following navigation displays and functions installed per FAA AC 20-130 (as revised) and AC 20-138 (as revised) or equivalent airworthiness installation advisory material are required.

Paragraph	Functional requirement	Explanation
a)	Navigation data, including a failure indicator, must be displayed on a lateral deviation display (CDI,	Non-numeric lateral deviation display (e.g. CDI, EHSI), with a to/from indication and a failure annunciation, for use as primary flight instruments for navigation of

	<p>EHSI) and/or a navigation map display. These must be used as primary flight instruments for the navigation of the aircraft, for manoeuvre anticipation and for failure/ status/ integrity indication.</p>	<p>the aircraft, for manoeuvre anticipation, and for failure/status/integrity indication, with the following six attributes:</p> <ol style="list-style-type: none"> <li>1) The capability to continuously display to the pilot flying, on the primary flight instruments for navigation of the aircraft (primary navigation display), the computed path and aircraft position relative to the path. For operations where the required minimum flight crew is two pilots, the means for the pilot not flying to verify the desired path and the aircraft position relative to the path must also be provided;</li> <li>2) Each display must be visible to the pilot and located in the primary field of view (<math>\pm 15^\circ</math> from the pilot's normal line of sight) when looking forward along the flight path;</li> <li>3) The lateral deviation display scaling should agree with any implemented alerting and annunciation limits;</li> <li>4) The lateral deviation display must also have a full scale deflection suitable for the current phase of flight and must be based on the required track-keeping accuracy;</li> <li>5) The display scaling may be set: <ul style="list-style-type: none"> <li>– automatically by default logic;</li> <li>– automatically to a value obtained from a navigation database; or</li> <li>– manually by pilot procedures.</li> </ul> <p>The full-scale deflection value must be known or must be available for display to the pilot commensurate with the required track keeping accuracy; and</p> </li> <li>6) The lateral deviation display must be automatically slaved to the computed path. The course selector of the deviation display should be automatically slewed to the computed path, or the pilot must adjust the CDI or HSI selected course to the computed desired track.</li> </ol> <p>As an alternate means of compliance, a navigation map display can provide equivalent functionality to a lateral deviation display as described in (1)-(6) above, with appropriate map scales and giving equivalent functionality to a lateral deviation display. The map scale should</p>
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		be set manually to a value appropriate for the RNP 1 operation.
b)	The following system functions are required as a minimum within any RNP 1 equipment:	<p>1) A navigation database, containing current navigation data officially promulgated for civil aviation, which can be updated in accordance with the AIRAC cycle and from which ATS routes can be retrieved and loaded into the RNP system. The stored resolution of the data must be sufficient to achieve negligible PDE. The database must be protected against pilot modification of the stored data;</p> <p>2) The means to display the validity period of the navigation data to the pilot;</p> <p>3) The means to retrieve and display data stored in the navigation database relating to individual waypoints and NAVAIDs, to enable the pilot to verify the route to be flown; and</p> <p>4) The capacity to load from the database into the RNP 1 system the entire segment of the SID or STAR to be flown.</p> <p>Note: Due to variability in systems, this document defines the RNAV segment from the first occurrence of a named waypoint, track, or course to the last occurrence of a named waypoint, track, or course. Heading legs prior to the first named waypoint or after the last named waypoint do not have to be loaded from the database. The entire SID will still be considered an RNP 1 procedure.</p>
c)	The means to display the following items, either in the pilot's primary field of view, or on a readily accessible display page:	<p>1) the active navigation sensor type;</p> <p>2) the identification of the active (To) waypoint;</p> <p>3) the ground speed or time to the active (To) waypoint; and</p> <p>4) the distance and bearing to the active (To) waypoint.</p>
d)	The capability to execute a "direct to" function.	-
e)	The capability for automatic leg sequencing with the display of sequencing to the pilot.	-

f)	The capability to load and execute an RNP 1 SID or STAR from the on-board database, by procedure name, into the RNP system.	-
g)	The aircraft must have the capability to automatically execute leg transitions and maintain tracks consistent with the following ARINC 424 path terminators, or their equivalent: – IF – CF – DF – TF	Note 1: Path terminators are defined in ARINC 424, and their application is described in more detail in RTCA documents DO-236B/EUROCAE ED-75B and DO-201A/EUROCAE ED-77.  Note 2: Numeric values for courses and tracks must be automatically loaded from the RNP system database.
h)	The aircraft must have the capability to automatically execute leg transitions consistent with VA, VM and VI ARINC 424 path terminators, or must be able to be manually flown on a heading to intercept a course or to go direct to another fix after reaching a procedure-specified altitude.	-
i)	The aircraft must have the capability to automatically execute leg transitions consistent with CA and FM ARINC 424 path terminators, or the RNP system must permit the pilot to readily designate a waypoint and select a desired course to or from a designated waypoint.	-
j)	The capability to display an indication of the RNP 1 system failure, in the pilot's primary field of view.	-

## 5 SYSTEM PERFORMANCE, MONITORING AND ALERTING

5.1 System performance, monitoring and alerting requirements for RNP 1 operations are as stated in ICAO Doc 9613 PBN Manual, implementing RNP 1.

5.2 Accuracy: During operations in airspace or on routes designated as RNP 1, the lateral TSE must be within  $\pm 1$  NM for at least 95 per cent of the total flight time. The along-track

error must also be within  $\pm 1$  NM for at least 95 per cent of the total flight time. To satisfy the accuracy requirement, the 95 per cent FTE should not exceed 0.5 NM.

- 5.3 Integrity: Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness regulations (i.e.  $1 \times 10^{-5}$  per hour).
- 5.4 Continuity: Loss of function is classified as a minor failure condition if the operator can revert to a different navigation system and proceed to a suitable airport.
- 5.5 SIS: If using GNSS, the aircraft navigation equipment shall provide an alert if the probability of SIS errors causing a lateral position error greater than 2 NM exceeds  $1 \times 10^{-7}$  per hour.

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

## **6 MINIMUM EQUIPMENT LIST**

- 6.1 The operator's MEL has to identify any unserviceability that affects an RNP 1 operation, and specify appropriate dispatch condition, if any.

## **7 CONTINUING AIRWORTHINESS**

- 7.1 The operator should submit the continuing airworthiness instructions applicable to the aircraft's configuration and the aircraft's qualification for this navigation specification. Additionally, there is a requirement for the operator to submit their maintenance programme, including a reliability programme for monitoring the equipment.
- 7.2 The operator should confirm with the OEM, or the holder of installation approval for the aircraft, that acceptance of subsequent changes in the aircraft configuration, e.g. SBs, does not invalidate current operational approvals.

## **8 NAVIGATION DATABASE INTEGRITY.**

- 8.1 The navigation database should be obtained from a supplier that complies with RTCA DO 200A/EUROCAE document ED 76, Standards for Processing Aeronautical Data. An LOA issued by the appropriate regulatory authority to each of the participants in the data chain demonstrates compliance with this requirement (e.g. FAA LOA issued in accordance with FAA AC 20-153 or EASA LOA issued in accordance with EASA Opinion Nr. 01/2005).
- 8.2 Discrepancies that invalidate a SID or STAR should be reported to the navigation database supplier, and the affected SID or STAR should be prohibited by an operator's notice to its pilots.

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

Note: To minimize PDE, the database should comply with DO 200A, or an equivalent operational means must be in place to ensure database integrity for the RNP 1 SIDs or STARs.

- 8.4 Notwithstanding paragraph 8.1 above, the operator should assume sole responsibility for the safety of the operation.

## **9 NAVIGATION ERRORS**

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

## **10 OPERATING PROCEDURES.**

### 10.1 Preflight Planning

- (a) The on-board navigation database should be current and include appropriate instrument procedures.
- (b) The availability of the NAVAID infrastructure, required for the intended routes, including any non-RNAV contingencies, should be confirmed for the period of intended operations using all available information. Since GNSS integrity is required by Annex 10, the availability of NavAid Infrastructure should also be determined as appropriate.

### 10.2 ABAS availability

- (a) RAIM levels required for RNP 1 can be verified either through NOTAMs (where available) or through prediction services. The operating authority may provide specific guidance on how to comply with this requirement (e.g. if sufficient satellites are available, a prediction may not be necessary). Operators should be familiar with the prediction information available for the intended route.
- (b) RAIM availability prediction should take into account the latest GPS constellation NOTAMs and avionics model (when available). The service may be provided by the ANSP, avionics manufacturer, other entities or through an airborne receiver RAIM prediction capability.
- (c) RAIM availability prediction software does not guarantee the service, rather, they are tools to assess the expected capability to meet the RNP. Because of unplanned failure of some GNSS elements, pilots/ANSP should realize that RAIM or GPS navigation altogether may be lost while airborne which may require reversion to an alternative means of navigation. Therefore, pilots should assess their capability to navigate (potentially to an alternate destination) in case of failure of GPS navigation.

### 10.3 General operating procedures



- (a) The pilot should comply with any instructions or procedures identified by the manufacturer as necessary to comply with the performance requirements in this navigation specification.
- (b) Operators and pilots should not request or file RNP 1 procedures unless they satisfy all the criteria in the relevant State documents. If an aircraft not meeting these criteria receives a clearance from ATC to conduct an RNP 1 procedure, the pilot must advise ATC that he/she is unable to accept the clearance and must request alternate instructions.
- (c) At system initialization, pilots have to confirm that the aircraft position has been entered correctly. Pilots have to verify proper entry of their ATC assigned route upon initial clearance and any subsequent change of route. Pilots must ensure that the waypoint sequence depicted by their navigation system matches the route depicted on the appropriate chart(s) and their assigned route.
- (d) Pilots must not fly an RNP 1 SID or STAR unless it is retrievable by procedure name from the on-board navigation database and conforms to the charted procedure. However, the procedure may subsequently be modified through the insertion or deletion of specific waypoints in response to ATC clearances. The manual entry, or creation of new waypoints, by manual entry of latitude and longitude or rho/theta values is not permitted. Additionally, pilots should not change any SID or STAR database waypoint type from a fly-by to a fly-over or vice versa.
- (e) For RNP 1 routes, pilots have to use a lateral deviation indicator, flight director, or autopilot in lateral navigation mode. Pilots of aircraft with a lateral deviation display should ensure that lateral deviation scaling is suitable for the navigation accuracy associated with the route/procedure (e.g. full-scale deflection:  $\pm 1$  NM for RNP 1).
- (f) All pilots are expected to maintain centre lines, as depicted by on-board lateral deviation indicators and/or flight guidance during all RNP 1 operations described in this manual, unless authorized to deviate by ATC or under emergency conditions.

#### 10.4 RNP 1 SID specific requirements

- (a) Prior to commencing take-off, the pilot should verify that the aircraft's RNP 1 system is available, operating correctly, and that the correct airport and runway data are loaded. Prior to flight, pilots should verify their aircraft navigation system is operating correctly and the correct runway and departure procedure (including any applicable en-route transition) are entered and properly depicted. Pilots who are assigned an RNP 1 departure procedure and subsequently receive a change of runway, procedure or transition must verify that 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 before take-off, is recommended.
- (b) Engagement altitude. The pilot should be able to use RNP 1 equipment to follow flight guidance for lateral navigation, e.g. lateral navigation no later than 153 m (500 feet) above airport elevation.
- (c) Pilots have to use an authorized method (lateral deviation indicator/navigation map display/flight director/autopilot) to achieve an appropriate level of performance for RNP 1.
- (d) GNSS aircraft. When using GNSS, the signal should be acquired before the take-off roll commences. For aircraft using TSO-C129a avionics, 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-C145(as revised)/C146(as revised) 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. If the RNP 1 SID extends beyond 30 NM from the ARP and a lateral deviation indicator is used, its full-scale sensitivity must be selected to not greater than 1 NM between 30 NM from the ARP and the termination of the RNP 1 SID.

- (e) For aircraft using a lateral deviation display (i.e. navigation map display), the scale must be set for the RNP 1 SID, and the flight director or autopilot should be used.

#### 10.5 RNP 1 STAR specific requirements

- (a) Prior to the arrival phase, the pilot should verify that the correct terminal route has been loaded. The active flight plan should be checked by comparing the charts with the map display (if applicable) and the MCDU. This includes confirmation of the waypoint sequence, reasonableness of track angles and distances, any altitude or speed constraints, and, where possible, which waypoints are fly-by and which are fly-over. If required by a route, a check will need to be made to confirm that updating will exclude a particular NAVAID. A route should not be used if doubt exists as to the validity of the route in the navigation database.
- (b) The creation of new waypoints by manual entry into the RNP 1 system by the pilot would invalidate the route and is not permitted.
- (c) Where the contingency procedure requires reversion to a conventional arrival route, necessary preparations have to be completed before commencing the RNP 1 procedure.
- (d) Procedure modifications in the terminal area may take the form of radar headings or “direct to” clearances and the pilot must be capable of reacting in a timely fashion. This may include the insertion of tactical waypoints loaded from the database. Manual entry or modification by the pilot of the loaded route using temporary waypoints or fixes not provided in the database is not permitted.
- (e) Pilots have to verify their aircraft navigation system is operating correctly, and the correct arrival procedure and runway (including any applicable transition) are entered and properly depicted.
- (f) Although a particular method is not mandated, any published altitude and speed constraints have to be observed.
- (g) Aircraft with TSO-C129a GNSS RNP systems: If the RNP 1 STAR begins beyond 30 NM from the ARP and a lateral deviation indicator is used, then full scale sensitivity should be manually selected to not greater than 1 NM prior to commencing the STAR. For aircraft using a lateral deviation display (i.e. navigation map display), the scale must be set for the RNP 1 STAR, and the flight director or autopilot should be used.

#### 10.6 Contingency procedures

- (a) The pilot should notify ATC of any loss of the RNP capability (integrity alerts or loss of navigation), together with the proposed course of action. If unable to comply with the requirements of an RNP 1 SID or STAR for any reason, pilots have to advise

ATS as soon as possible. The loss of RNP capability includes any failure or event causing the aircraft to no longer satisfy the RNP 1 requirements of the route.

- (b) In the event of communications failure, the pilot should continue with the published lost communications procedure.

10.7 Operating procedures for RNP 1 operations are as stated in ICAO Doc 9613 PBN Manual, Implementing RNP 1.

10.8 Notify ATC when the RNP accuracy ceases to meet the requirements for RNP 1.

## **11 FLIGHT CREW KNOWLEDGE AND TRAINING.**

11.1 Flight crew knowledge and training include:

- (a) the meaning and proper use of aircraft equipment/navigation suffixes;
- (b) procedure characteristics as determined from chart depiction and textual description;
- (c) depiction of waypoint types (fly-over and fly-by) and path terminators, AIRINC 424 path terminators) and any other types used by the operator), as well as associated aircraft flight paths;
- (d) required navigation equipment for operation on RNP 1 SIDs, and STARs;
- (e) RNP system-specific information:
  - i. Levels of automation, mode annunciations, changes, alerts, interactions, reversions and degradation;
  - ii. Functional integration with other aircraft systems;
  - iii. The meaning and appropriateness of route discontinuities as well as related flight crew procedures;
  - iv. Pilot procedures consistent with the operation;
  - v. types of navigation sensors utilized by the RNP system and associated system prioritization/weighting/logic;
  - vi. Turn anticipation with consideration to speed and altitude effects;
  - vii. interpretation of electronic displays and symbols; and
  - viii. understanding of the aircraft configuration and operational conditions required to support RNP 1 operations, i.e. appropriate selection of CDI scaling (lateral deviation display scaling);
- (f) RNP system operating procedures, as applicable, including how to perform the following actions:
  - i. Verify currency and integrity of the aircraft navigation data;
  - ii. Verify the successful completion of RNP system self-tests;
  - iii. initialize navigation system position;
  - iv. retrieve and fly an RNP 1 SID or a STAR with appropriate transition;
  - v. adhere to speed and/or altitude constraints associated with an RNP 1 SID or STAR;
  - vi. select the appropriate RNP 1 SID or STAR for the active runway in use and be familiar with procedures to deal with a runway change;
  - vii. verify waypoints and flight plan programming;
  - viii. fly direct to a waypoint;
  - ix. fly a course/track to a waypoint;
  - x. intercept a course/track;
  - xi. following vectors and re-joining an RNP 1 route from "heading" mode;

- xii. determine cross-track error/deviation. More specifically, the maximum deviations allowed to support RNP 1 must be understood and respected;
  - xiii. resolve route discontinuities;
  - xiv. remove and reselect navigation sensor input;
  - xv. when required, confirm exclusion of a specific NAVAID or NAVAID type;
  - xvi. change arrival airport and alternate airport;
  - xvii. perform parallel offset function if capability exists. Pilots should know how offsets are applied, the functionality of their particular RNP system and the need to advise ATC if this functionality is not available; and
  - xviii. perform RNAV holding function;
- (g) operator-recommended levels of automation for phase of flight and workload, including methods to minimize cross-track error to maintain route centre line;
- (h) R/T phraseology for RNAV/RNP applications; and
- (i) contingency procedures for RNAV/RNP failures.

## **12 WITHDRAWAL OF OPERATIONAL APPROVAL.**

- 12.1 An operational approval is conditional upon compliance with RNP 1 operational requirements and promulgations in ICAO Doc 9613.
- 12.2 Non-compliance may result in CAAS withdrawing the operational approval.