AC 98-2-10 (Rev0)
1 November 2019

Civil Aviation Authority of Singapore

Advisory Circular

OPERATIONAL APPROVAL FOR RNP-2

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 the operator seeking approval for RNP 2 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 RNP 2 is primarily intended for a diverse set of en-route applications, particularly in geographic areas with little or no ground NAVAID infrastructure, limited or no ATS surveillance. RNP 2 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 incorporating GNSS are used, positioning data from non-GNSS navigation sensors may be integrated with the GNSS data provided the non-GNSS data do not cause position errors exceeding the total system error budget. Otherwise a means should be provided to deselect the non-GNSS navigation sensor types. RNP 2 operations in Oceanic and Remote airspace require dual independent long-range navigation systems.

2 AIRCRAFT ELIGIBILITY.

2.1 An aircraft is eligible for a RNP 2 navigation authorisation if;

(a) The AFM, an AFM supplement, or OEM service letter states that the aircraft navigation system is approved for RNP 2 operations;
(b) The aircraft is equipped with GNSS stand-alone system certified by the manufacturer for en-route operations utilising either TSO-C129 Class A1 or A2 or TSO-C146 / ETSO-C146 Class Gamma and Operational Class 1, 2 or 3, or equivalent;
(c) The aircraft is equipped with a multi-sensor system (e.g. FMS) with GNSS equipment certified by the manufacturer for en-route operations utilising either TSO/ETSO-C129(a) sensor Class B or C, TSO/ETSO-C145 Class 1, 2 or 3 or TSO-C196 (as revised) and the requirements of ETSO-C115b FMS or equivalent; and
(d) The aircraft complies with Part C, Chapter 2, Implementing RNP 2, in ICAO Doc 9613 PBN Manual, Volume II.

3 FUNCTIONALITY.

3.1 The following navigation displays and functions installed as per FAA AC 20-130 (as revised), 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, 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.	Non-numeric lateral deviation display (eg. CDI, EHSI), a failure annunciation, for use as primary flight instruments for navigation of the aircraft, for manoeuvre anticipation, and for failure/status/integrity indication, with the following six attributes: 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 has to also be provided; 2) Each display must be visible to the pilot and located in the primary field of view (±15° from the pilot's normal line of sight) when looking forward along the flight path; 3) The lateral deviation display scaling should agree with any implemented alerting and annunciation limits; 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; 5) The display scaling may be set automatically by default logic, automatically to a value obtained from a navigation database, or manually by flight crew procedures. 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 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 has to adjust the CDI or HSI selected course to the computed desired track. 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 be set manually to a value appropriate for the RNP 2 operation.
b)	The RNP 2 operation requires the following minimum system and equipment functions:	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 RNP 2 routes can be retrieved and loaded into the RNP system. The stored resolution of the data must be sufficient to achieve negligible PDE. Database protections must prevent

		pilot modification of the onboard stored data; 2) A means to display the validity period of the navigation data to the pilot; 3) A means to retrieve and display data stored in the navigation database relating to individual waypoints and NAVAIDs (when applicable), to enable the pilot to verify the RNP 2 route to be flown; and 4) For RNP 2 tracks in oceanic/remote continental airspace using flexible (e.g. organized) tracks, a means to enter the unique waypoints required to build a track assigned by the ATS provider.
c)	The means to display the following items, either in the pilot's primary field of view, or on a readily accessible display:	1) The active navigation sensor type; 2) The identification of the active (To) waypoint; 3) The groundspeed or time to the active (To) waypoint; and 4) The distance and bearing to the active (To) waypoint.
d)	The capability to execute a "direct to" function.	The aircraft and avionics manufacturers should identify any limitations associated with conducting the "direct to" function during RNP 2 operations in the manufacturer's documentation.
e)	The capability for automatic leg sequencing with the display of sequencing to the pilot.	-
f)	The capability to automatically execute waypoint transitions and maintain track consistent with the RNP 2 performance requirements.	-
g)	The capability to display an indication of RNP 2 system failure in the pilot's primary field of view.	-
h)	Parallel offset function (optional)	If implemented: 1) The system must have the capability to fly parallel tracks at a selected offset distance;

		2) When executing a parallel offset, the navigation accuracy and all performance requirements of the original route in the active flight plan apply to the offset route; 3) The system must provide for entry of offset distances in increments of 1 NM, left or right of course; 4) The system must be capable of offsets of at least 20 NM; 5) When in use, the system must clearly annunciate the operation of offset mode; 6) When in offset mode, the system must provide reference parameters (e.g. cross-track deviation, distance-to-go, time-to-go) relative to the offset path and offset reference points; 7) The system must annunciate the upcoming end of the offset path and allow sufficient time for the aircraft to return to the original flight plan path; and 8) Once the pilot activates a parallel offset, the offset must remain active for all flight plan route segments until the system deletes the offset automatically; the pilot enters a new direct-to routing, or the pilot manually cancels the offset.

3.2 Aircraft installed with stand-alone GNSS navigation systems should provide track guidance via a CDI or HSI as the unit display is not of sufficient size or suitably positioned to allow either pilot to adequately maintain cross-track deviation.

3.3 For stand-alone GNSS systems the operating procedures and training should include limitations in respect of ARINC 424 path terminators which involve an altitude termination. Due to lack of integration of the lateral navigation system and altimetry system, pilot intervention is required.

4 SYSTEM PERFORMANCE, MONITORING AND ALERTING

4.1 System performance, monitoring and alerting requirements for RNP 2 operations are as stated in ICAO Doc 9613 PBN Manual, Implementing RNP 2.

4.2 Accuracy: During operations in airspace or on routes designated as RNP 2, the lateral TSE must be within ±2 NM for at least 95 per cent of the total flight time. The along-track error must also be within ±2 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 1 NM.

4.3 Integrity: Malfunction of the aircraft navigation equipment is classified as a major failure condition under airworthiness guidance material (i.e. 10–5 per hour).

4.4 Continuity: For RNP 2 oceanic/remote continental airspace applications, loss of function is a major failure condition. For RNP 2 continental applications, loss of function is a minor failure condition if the operator can revert to a different navigation system and proceed to a suitable airport. If a single aircraft configuration is to support all potential applications of RNP 2, the more stringent continuity requirement applies. The AFM limitations section must reflect restrictions in capability to aid in operational approvals.

4.5 SIS: The aircraft navigation equipment should provide an alert if the probability of SIS errors causing a lateral position error greater than 4 NM exceeds 1 × 10–7 per hour.

5 MINIMUM EQUIPMENT LIST

5.1 The operator's MEL has to identify any unserviceability that affects an RNP 2 operation, and specify appropriate dispatch condition, if any.

6 CONTINUING AIRWORTHINESS

6.1 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.

6.2 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.

7 NAVIGATION DATABASE INTEGRITY

7.1 The navigation database integrity must comply with RTCA DO-200A / EUROCAE ED-76 standards. The operator must ensure that the navigation database supplier or vendor to the operator hold valid Type LOA (Letter of Approval) issued in accordance with FAA AC 90–153 or EASA IR 21(G) / EASA Nr 01/2005. 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). 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.

7.2 The operator should also conduct additional navigation data check of any new or changed procedures, in particular when operating into areas with terrain.

7.3 Any significant errors must be reported to the database supplier and flight crew must be informed immediately to suspend use of the affected procedures until integrity checks are satisfactorily completed.

7.4 Notwithstanding paragraph 7.1 above, the operator should assume sole responsibility for the safety of the operation.

8 NAVIGATION ERRORS

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

9 OPERATING PROCEDURES.

9.1 The operator should comply with any instructions/procedures identified by the manufacturer as being necessary to comply with the performance requirements of the navigation specification.

9.2 At system initialisation, confirm the navigation database is current and verify that the aircraft position has been entered correctly. Verify proper entry of the Air Traffic Control (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.

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

9.4 During flight, where available, confirm navigation accuracy by cross-reference from ground-based aids.

9.5 In lieu of a lateral deviation indicator, a navigation map display with equivalent functionality to a lateral deviation indicator, as described in ICAO Doc 9613, Volume II, Part C, Chapter 2, Implementing RNP 2 is acceptable for RNP 2 operations.

9.6 Select lateral deviation display scaling suitable for the navigation accuracy associated with the route (e.g. full scale deflection ±2 NM for RNP 2 or ± 5 NM for TSO-C129 equipment).

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

9.8 The standard for limitation of cross-track error/deviation (the difference between the computed path and the displayed aircraft position) is ½ the navigation accuracy (i.e. 1 NM for RNP 2).

9.9 Notify ATC when the RNP accuracy ceases to meet the requirements for RNP 2.

10 FLIGHT CREW KNOWLEDGE AND TRAINING

10.1 Flight crew knowledge and training include:
(a) the meaning and proper use of aircraft equipment/navigation suffixes;
(b) route and airspace characteristics as determined from chart depiction and textual description;
(c) required navigation equipment on RNP 2 operations;
(d) 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/limitations;
vi. Turn anticipation with consideration to speed and altitude effects;
vii. Interpretation of electronic displays and symbols used to conduct an RNP 2 operation; and
viii. Understanding of the aircraft configuration and operational conditions required to support RNP 2 operations, e.g. appropriate selection of CDI scaling (lateral deviation display scaling);

(e) 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/manually enter and fly an RNP 2 route;
v. adhere to speed and/or altitude constraints associated with an RNP 2 route;
vi. verify waypoints and flight plan programming;
vii. fly direct to a waypoint;
viii. fly a course/track to a waypoint;
ix. intercept a course/track (flying assigned vectors and rejoining an RNP 2 route from “heading” mode);
x. determine cross-track error/deviation. More specifically, the maximum deviations allowed to support RNP 2 must be understood and respected;
xi. resolve route discontinuities;
xii. remove and reselect navigation sensor input; and
xiii. perform parallel offset function during RNP 2 operations 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.

(f) Operator-recommended levels of automation for phase of flight and workload, including methods to minimize cross-track error to maintain route centre line;
(g) R/T phraseology for RNP applications; and
(h) contingency procedures for RNP failures.

11 WITHDRAWAL OF OPERATIONAL APPROVAL

11.1 An operational approval granted by CAAS is conditional upon compliance with RNP 2 operational requirements and promulgations in ICAO Doc 9613.

11.2 Non-compliance may result in CAAS withdrawing the operational approval.