

Required Navigation Performance in European Airspace designated for basic RNAV (BRNAV) operations (RNP5)

Revision 1
18 March 1999

General

Civil Aviation Authority advisory circulars (ACs) contain information about standards, practices, and procedures that the Director has found to be acceptable for compliance with the associated rule.

Consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices, or procedures are found to be acceptable they will be added to the appropriate AC.

Purpose

This AC describes an acceptable means of compliance with requirements relating to the approval of operators for RNP5 operations.

Related Rules

This AC relates specifically to 91.246, 91.407, 91.409 and 91.519.

Change Notice

This revised AC supersedes AC91-8 dated 23 April 1998 and it provides a means of assessment for New Zealand Defence Force (NZDF) aircraft in new para 7.4.

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Introduction

Area Navigation (RNAV) is one of the key elements needed to increase the aviation system capacity. With RNAV, airspace users could expect to benefit from more direct routing and greater fuel savings. RNAV allows greater flexibility in airspace design and reduces the need to depend totally on ground-based point source navigation aids when planning ATS routes.

With effect 23 April 1998, only RNAV equipped aircraft having a navigation accuracy meeting Required Navigation Performance 5 (RNP5) may plan for operations under Instrument Flight Rules (IFR) on the ATS routes in European airspace designated for Basic RNAV (BRNAV) operations. RNP5 was chosen as the initial stage of RNAV operations in the area to take account of existing aircraft equipment and the current navigation infrastructure. Aircraft not equipped with RNAV but having a navigation accuracy meeting RNP5 will be restricted to operations on ATS routes which States may designate within their lower airspace.

In accordance with ICAO co-ordinated regional agreements, operators must obtain an RNP5 approval from the appropriate State of Registry or State of the Operator in order to operate in RNP airspace/air routes. The RNP5 criteria and a means of obtaining operational approval from the Civil Aviation Authority (CAA) are described in this AC. This AC is one means but not the only means of satisfying the intent of Part 91 and thereby meeting the requirements detailed in ICAO Doc. 9613-AN/937, Manual on Required Navigation Performance (RNP), First Edition, 1994. It is consistent with Regional Supplementary Procedures contained within ICAO Document 7030.

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Required navigation performance 5 operational approval

1. Purpose

This AC provides direction to operators for obtaining operational approval of Required Navigation Performance 5 (RNP5) capability. It includes guidance on airworthiness and operational approvals processes. The AC enables an applicant to be approved as capable of meeting the navigation element of Communications/ Navigation/ Surveillance (CNS) requirements when and where RNP5 is specified, in particular, within European airspace designated for Basic Area Navigation (BRNAV). This AC does not address communications or surveillance requirements that may be specified to operate on a particular route or in a particular area. Those requirements are specified in other documents such as Civil Aviation Rules and the International Civil Aviation Organisation (ICAO) Regional Supplementary Procedures Document (DOC 7030).

This AC satisfies the intent of ICAO Doc 9613-AN/937, Manual on Required Navigation Performance (RNP) First Edition - 1994.

2. Promulgation

This AC should be read in conjunction with Civil Aviation Rules 91.246, 91.407, 91.409, and 91.519

3. Background

Regional Supplementary Procedures contained within ICAO Doc. 7030/4-EUR, Part 1, Rules of the Air, Air Traffic Services and Search and Rescue, have been amended to require RNP5 for operations under Instrument Flight Rules (IFR) in European airspace designated for BRNAV operations after 23 April 1998.

Joint Aviation Authorities (JAA) first published advisory material for the Airworthiness Approval of Navigation Systems for use in European airspace designated for BRNAV operations in July 1996. This material was developed by EUROCAE WG-13 and was commonly referenced as AMJ 20X2. In May 1997, Revision 1 to AMJ 20X2 was expanded to include specific guidance on the approval and use of stand-alone GPS-based equipment for the purposes of conducting BRNAV operations.

This AC identifies those navigation system types and the criteria that may be used to determine acceptable means of compliance for New Zealand operators conducting operations in European BRNAV airspace. Civil Aviation Authority (CAA) approval of New Zealand operators for European BRNAV operations is based on consideration of existing systems and previously completed airworthiness approvals, as described in the Aircraft Flight Manual (AFM), or an assessment process described in this AC.

In accordance with ICAO co-ordinated regional agreements, operators must obtain an RNP5 approval from the appropriate State of Registry or State of the Operator in order to operate in RNP5 airspace/air routes. The RNP5 criteria and a means of obtaining operational approval from the CAA are described in the following sections of the AC.

4. Applicability

This guidance material applies to all BRNAV/RNP5 operations conducted under 91.246.

New Zealand registered aircraft, when operating outside New Zealand airspace must comply with ICAO Annex 2 when over the high seas and the regulations of another State when operating within that State's airspace.

In compliance with the EUROCONTROL Convention, the BRNAV requirements do not apply to State aircraft when they are not operating under the provision of the International Civil Aviation Organisation (ICAO). In accordance with document EUROCONTROL Standard 003-93 Edition 1, tactical military aircraft are also exempt from the requirements. Accordingly, New Zealand Defence Force tactical aircraft do not require RNP5 CAA approval when operating in European airspace designated for BRNAV operations.

5. Related publications

Civil Aviation Authority (CAA)

- Civil Aviation Rules Part 91 and Part 19

Joint Aviation Authorities (JAA)

- AMJ 20X2 Revision 1, JAA Guidance Material on Airworthiness Approval and Operational Criteria for the use of Navigation Systems in European Airspace Designated for Basic RNAV Operations
- EUROCONTROL Standard 003-93 Edition 1

Federal Aviation Administration (FAA)

- AC 90-BRNAV (draft), Approval of US Operators and Aircraft to Operate in European Class I Airspace Designated for Basic Area Navigation (BRANV)/Required Navigation Performance (RNP)-5
- AC 20-121A, Airworthiness Approval of Airborne LORAN C Navigation Systems for use in the U.S. National Airspace System (NAS)
- AC 20-130(A), Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors
- AC 20-138, Airworthiness Approval of Global Positioning System (GPS) Navigation Equipment for use as a VFR and IFR Supplemental Navigation System
- AC 25-4, Inertial Navigation Systems (INS)
- AC 25-15, Approval of Flight Management Systems in Transport Category Airplanes
- AC 90-45A, Approval of Area Navigation Systems for Use in the U.S. National Airspace System
- AC 90-94, Guidelines for Using GPS Equipment for IFR En Route and Terminal Operations and for Nonprecision Instrument Approaches
- Order 8400.12A, Required Navigation Performance-10 (RNP-10) Operational Approval

International Civil Aviation Organisation (ICAO)

- Manual on Required Navigation Performance (RNP), ICAO DOC 9613-AN/937
- Regional Supplementary Procedures Doc 7030/4, Fourth Edition

RTCA

- Minimum Aviation System Performance Standards (MASPS): Required Navigation Performance for Area Navigation, RTCA

Copies may be obtained from RTCA, Inc., 1140 Connecticut Avenue, NW., Suite 1020, Washington, DC 20036

6. Definitions

Area Navigation (RNAV): This is a method which permits aircraft navigation along any desired flight path within the coverage of either station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of both methods. For the purpose of this AC, RNAV equipment is considered to be that equipment which operates by automatically determining aircraft position from one, or a combination, of the following sensors with the means to establish and follow a desired path—

- VOR/DME
- DME/DME
- INS* or IRS
- LORAN C*
- GPS*

Equipment marked with an asterisk () is subject to the limitations contained in paragraph 7.2.4.*

Due to the decommissioning of ground stations, on 30 September 1997, Omega is not considered eligible to support BRNAV/RNP5 operations.

Basic RNAV (BRNAV): For the purposes of this AC, Eurocontrol/EUROCAE basic RNAV is defined as RNAV with an accuracy that meets RNP5 for operations under IFR in that European airspace designated for BRNAV/RNP5 operations.

Global Positioning System: This is a U.S. space-based positioning, velocity, and time system composed of space, control, and user elements. The space element, consists of 24 satellites in six orbital planes. The control element consists of five monitor stations, three ground antennas and a master control station. The user element consists of antennas and receiver processors that provide positioning, velocity, and precise timing to the user.

Pseudo-Range: This is the determination of position, or the obtaining of information relating to position, for the purposes of navigation by means of the propagation properties of radio waves. The distance from the user to a satellite, plus an unknown user, clock offset distance. With four satellite signals it is possible to compute position and clock offset distance.

Receiver Autonomous Integrity Monitoring (RAIM): This is a technique whereby a civil GPS receiver/processor determines the integrity of the GPS navigation signals using only GPS signals or GPS signals augmented with altitude. This determination is achieved by a consistency check among redundant pseudo-range measurements. At least one satellite in addition to those required for navigation must be in view for the receiver to perform the RAIM function.

Required Navigation Performance: This is a statement of the navigation performance necessary for operation within a defined airspace

Required Navigation Performance Type (RNP Type): This is a value typically expressed as a distance in nautical miles – longitudinal and lateral – from the intended position, which an aircraft would be in for at least 95 percent of the total flying time

7. Operational approval

7.1 General

A number of steps must be completed before an operational approval is issued to an operator. These steps are—

- aircraft eligibility for RNP5 must be determined by the CAA
- flight crew procedures for the navigation systems to be used must be identified by the operator and
- the operator database use and operating procedures must be evaluated by the CAA

7.2 Determining eligibility and approval of aircraft for RNP5

7.2.1 Aircraft equipment

An aircraft may be considered eligible for BRNAV/RNP5 approval, if it is equipped with ONE or more RNAV systems approved in accordance with the guidance contained in this document. In the event of system failure, the aircraft should be capable of reverting to navigation with ICAO Standard Navigation Aids such as ADF, VOR, DME, and NDB.

7.2.2 Eligibility based on the aircraft flight manual.

RNAV-capable navigation systems which are installed on aircraft in accordance with the advisory material contained within FAA AC 90-45A, AC 20-130(A), AC 20-138 or AC 25-15, are considered to meet RNP4 and are acceptable for BRNAV/RNP5 operations. Where reference is made in the AFM to the above advisory material or the corresponding specific levels of RNP, no further documentation is required as evidence of aircraft navigation system eligibility for use in European airspace designated for BRNAV/RNP5 operations. However, paragraph 7.2.4 below should be reviewed for limitations, if any, associated with the use of these RNAV systems.

7.2.3 Eligibility not based on the aircraft flight manual

Under some circumstances, the operator may not be able to determine the aircraft's equipment eligibility from the AFM, or requires an RNP5 time limit extension for non-radio updated INS-based RNAV systems beyond 2 hours from alignment. In this case the operator should consult the CAA with regards to an assessment of its RNAV equipment for RNP5 eligibility. Normally this can be determined by reviewing the AFM. However, when other methods of eligibility are proposed the operator must present the equipment proposed to be used, evidence of its performance, crew operating procedures, bulletins and any other pertinent information to the CAA. If the CAA cannot determine the equipment is eligible they may elect to request assistance from the FAA or product/equipment manufacturer.

7.2.4 Limitations on the use of navigation systems

The following navigation systems, although having RNAV capability, require limitations on their use for BRNAV/RNP5 operations.

Inertial Navigation Systems (INS)

Those INS systems, approved in accordance with FAA AC 25-4, that comply with the functional criteria in Appendix 3, but do not use automatic radio updating of aircraft position, may be used for a maximum of 2 hours from the last alignment/position update. Consideration may be given to specific INS configurations – such as triple mix – where either equipment or aircraft manufacturer's data justifies extended use from the last on-ground position update.

Those INS systems, approved in accordance with FAA AC 90-45A, that comply with the functional criteria in Appendix 3, but do not use automatic radio updating of aircraft position must use the manufacturer's or a CAA approved flightcrew procedure to accomplish position updates.

LORAN C

Use of LORAN C, in compliance with FAA AC 20-121A, is considered as an acceptable means to comply with BRNAV, only in those areas of European airspace and on routes having acceptable LORAN C coverage. LORAN users must refer to the AFM, Operations Specification or Letter of Authorisation to determine if operational use of the Loran system is limited to a specified LORAN C Operational Area.

GPS

GPS systems acceptable for BRNAV/RNP5 operations include those approved in accordance with FAA AC 20-138 or 20-130A. Integrity should be provided by RAIM or an equivalent means within a multi-sensor navigation system.

VOR, DME or ADF capability needs to be installed and operative. The operator should determine that the intended route-of-flight is serviced by an appropriate ground-based navigation aid.

7.3 Approved aircraft/system list

The CAA's Aircraft Certification Unit will maintain a list of aircraft/navigation systems that have received RNP5 approval. It will not be used as a means of determining qualifications for approval. The list will be maintained for statistical purposes only.

7.4 NZDF operated aircraft

For aircraft operated by the NZDF, the CAA will accept an application for the issue of an RNP 5 approval from the Assistant Chief of Air Staff (Operations), Royal New Zealand Air Force. The application should be preceded by an NZDF assessment of the aircraft, flight operations and continued airworthiness aspects to determine compliance with the requirements outlined in this AC. The application should state—

- the model(s) of aircraft and applicable registrations
- RNP 5 time limit if any
- navigation equipment installed
- compliance with RNP 5 requirements outlined in this AC

8. Operational criteria for GPS-based operations

8.1 General criteria

For GPS-based operations, the flightcrew should be familiar with use of the GPS stand-alone equipment for the normal and non-normal operating procedures detailed in paragraphs 8.2 and 8.3.

8.2 Normal procedures

The procedures for the use of GPS stand-alone navigational equipment on BRNAV/RNP5 routes should include the following:

- During pre-flight planning, if 24 satellites are projected to be operational for the flight, then the aircraft can depart without further action. If, however, 23 or less satellites are projected to be operational, then the availability of GPS integrity (RAIM) should be confirmed for the intended flight route and time. This should be obtained from either—
 - a prediction program that is provided in the GPS unit installed in the aircraft
 - a prediction program run outside the aircraft or from an alternative method that is acceptable to the CAA
- Dispatch should not be made in the event of predicted continuous loss of RAIM of more than 15 minutes duration for any part of the intended flight (The number of satellites may be reduced by one to 23 or 22 respectively if baro-aiding is incorporated into the GPS unit. Prediction programs should use the same algorithms as those in the aircraft GPS units)
- When a navigation database is installed, the database validity should be checked before the flight (Validity is ascertained from the current AIRAC cycle)
- Navigation equipment suitable for the route of flight – VOR, DME, and ADF – should be selected so as to allow immediate cross-checking or reversion in the event of loss of GPS navigation capability

8.3 Non-normal procedures in the event of loss GPS RAIM capability

The flightcrew should be familiar with the operating procedures and actions required in the event that the GPS equipment indicates a loss of RAIM or the integrity alarm limit has been exceeded indicating an erroneous position. The operating procedures should include the following—

- In the event of loss of the RAIM detection function, the GPS equipment may continue to be used for navigation. The flightcrew should cross-check the aircraft position, where possible, with VOR, DME, and NDB information to confirm an acceptable level of navigation performance. Otherwise, the flightcrew should revert to an alternative means of navigation.
- In the event that the alarm limit has been exceeded, the flightcrew should revert to an alternative means of navigation.

9. Pilot knowledge

Pilots should be knowledgeable in the following areas—

- RNP definition as it relates to BRNAV requirements in European airspace

- airspace where RNP5 is required
- changes to charting and documents to reflect RNP5
- navigation equipment required to be operational for flight in designated BRNAV airspace
- flight planning requirements
- contingency procedures for occurrences such as equipment failure

10. Contingency procedures

10.1 Expected flightcrew actions

Pilots should notify ATC of conditions such as equipment failures and weather conditions that may affect the ability of the aircraft to maintain position within the designated RNP5. In this case, flightcrews should state their intentions, co-ordinate a plan of action, and obtain a revised ATC clearance. If unable to notify ATC and obtain an ATC clearance prior to deviating from the RNP airspace, the flightcrew should follow established contingency procedures as defined by the region of operation, and obtain an ATC clearance as soon as possible.

10.2 Air Traffic failure response actions

When advised that an aircraft is unable to maintain a designated level of RNP, Air Traffic will adjust separation as necessary and co-ordinate with other Air Traffic facilities.

11. Flight plans

Effective from the date of BRNAV implementation, New Zealand-registered aircraft filing flight plans into European BRNAV designated airspace are expected to comply with the European BRNAV airspace requirements. Approved operators should indicate approval for RNP5 operations by annotating field 10 – *Equipment* – of the ICAO flight plan with the letter "R". If there are any other flight plan annotations required by individual States, operators should make appropriate annotations.

12. Validation test

The following is intended to provide broad guidance for Validation Tests when approving an air carrier operator that plans to conduct operations in European BRNAV/RNP5 airspace. The CAA will consider each application on its own merit and apply judgement when developing validation test requirements. The CAA will communicate the objective, duration, and number of validation test flights required to the operator during the initial stages of the approval process.

12.1 Validation for operators previously approved for navigation with specific RNAV systems

If an operator is previously approved to navigate with a specific RNAV system, validation tests may NOT require a validation flight. If a review of the operator's application shows that it has addressed the guidance contained in this document, the validation test may be considered complete.

12.2 Validation tests for operators requesting approval for RNAV systems new to the operator

If an operator has not been previously approved to use a specific RNAV system, then in addition to a review of the application package, the CAA may observe at least one validation flight. If this flight is conducted in domestic airspace it may be a revenue flight.

13. Form of approval

RNP5 operational approvals will be issued as either an Operations Specification amendment or a Letter of Authorisation and will identify any conditions or limitations on operations in RNP 5 airspace, such as required navigation systems or procedures, limits on time, routes or areas of operation. A sample Operations Specification amendment and a Letter of Authorisation are at Appendix 1.

Appendix 1 - Sample operations specification and letter of authorisation for RNP5 operations

1. Draft operations specification amendment

W.X.Y. Navigation/communication systems

- (z) Operation within *[state RNP5 airspace or RNP5 routes as applicable]* Required Navigation Performance 5 (RNP5) airspace is authorised, provided that such operation is in accordance with applicable requirements, as detailed in ICAO Document 7030/4 "Regional Supplementary Procedures".

Appendix - Required Navigation Performance (RNP) Airspace

The following aircraft are authorised for RNP5 operations as defined in paragraph W.X.Y (z):

Aircraft: *[make, model, and registration mark]*

Navigation systems: *[type, manufacturer, model, and time limit]*

2. Draft letter of authorisation

[file reference]

[date]

[organisation name]

[address]

Dear Sir/Madam

APPROVAL TO OPERATE IN RNP5 AIRSPACE

Pursuant to Civil Aviation Rule 91.519 approval is hereby granted for the following operator, aircraft and navigation systems to operate on designated RNP5 routes and in designated RNP5 airspace with the stated RNP5 time limit.

Operator: *[name]*

Aircraft: *[make, model, and registration mark]*

Navigation systems: *[type, manufacturer, model, and time limit]*

Designated RNP5 routes/airspace: *[specify]*

[signature]

[name]

[title]

Appendix 2 - GPS integrity monitoring (RAIM) prediction program

Where a GPS Integrity Monitoring (RAIM) Prediction Program is used as a means of compliance with paragraph 8.2 of this AC, it should meet the following criteria—

- The program should provide prediction of availability of the integrity monitoring (RAIM) function of the GPS equipment, suitable for conducting RNP5 (BRNAV) operations in designated European airspace.
- The prediction program software should be developed in accordance with at least RTCA DO 178B/EUROCAE 12B, level D guidelines.
- The program should use either a RAIM algorithm identical to that used in the aircraft equipment, or an algorithm based on assumptions for RAIM prediction that give a more conservative result.
- The program should calculate RAIM availability based on a satellite mask angle of not less than 5 degrees, except where use of a lower mask angle has been demonstrated to be acceptable to the CAA.
- The program should have the capability to manually designate GPS satellites which have been notified as being out-of-service for the intended flight.
- The program should allow the user to select—
 - the intended route and declared alternates
 - the time and duration of the intended flight

Appendix 3 - Required functions

The following system functions are the minimum required to conduct BRNAV/RNP5 operations—

- continuous indication of aircraft position relative to the track to be displayed to the pilot-flying on a navigation display situated in their primary field-of-view. In addition, where the minimum flightcrew is two pilots, indication of aircraft position relative to track to be displayed to the pilot-not-flying on a navigation display situated in their primary field-of-view
- display of distance and bearing to the active (To) waypoint
- display of ground speed or time to the active (To) waypoint
- storage of a minimum of four waypoints
- appropriate failure indication of the RNAV system, including the sensors