

### **Required Navigational Performance 4 (RNP 4) Operational Approval**

19 January 2005

#### **General**

Civil Aviation Authority Advisory Circulars contain information about standards, practices, and procedures that the Director has found to be an Acceptable Means of Compliance (AMC) with the associated rule.

An AMC is not intended to be the only means of compliance with a rule, and 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 Advisory Circular.

This Advisory Circular also includes **guidance material (GM)** to facilitate compliance with the rule requirements. Guidance material must not be regarded as an acceptable means of compliance.

#### **Purpose**

The Advisory Circular provides methods, acceptable to the Director, for showing compliance with requirements relating to the approval of operators for RNP 4 operations.

#### **Related Rules**

This Advisory Circular relates specifically to Civil Aviation Rules 91.246 and 91.519.

#### **Change Notice**

Initial issue.

## Table of contents

<b>Subpart C –General Flight Rules.....</b>	<b>3</b>
91.246 Operations in RNP designated airspace .....	3
<b>Subpart F — Instrument and Equipment Requirements.....</b>	<b>4</b>
91.519 IFR communication and navigation equipment.....	4
<b>APPENDIX I.....</b>	<b>5</b>
<b>Introduction .....</b>	<b>5</b>
<b>1. Purpose, Overview and Limitations.....</b>	<b>5</b>
<b>2. Related Publications.....</b>	<b>6</b>
<b>3. Applicability.....</b>	<b>7</b>
<b>4. Operational Approval .....</b>	<b>7</b>
4.1 General .....	7
4.2 Determining Eligibility of Aircraft.....	8
4.3 Airworthiness Requirements.....	8
4.4 Approved Aircraft/System List .....	8
<b>5. Operational Approval Process .....</b>	<b>8</b>
5.1 General .....	8
5.2 Pre-Application Meeting .....	8
5.3 Form of Application .....	9
<b>6. Application .....</b>	<b>9</b>
6.1 Contents.....	9
<b>7. CAA Evaluation of Proposal .....</b>	<b>10</b>
7.1 Civilian Operated Aircraft .....	10
7.2 NZDF Operated Aircraft .....	10
7.3 Form of Approval.....	10
7.4 Investigation of Navigation and System Errors.....	10
7.5 Cancellation of RNP 4 Approval .....	11
7.6 Aircraft Eligibility Groups .....	11
7.7 Maintenance Requirements.....	12
7.8 MEL .....	12
7.9 Required Performance .....	12
7.10 Required Functionalities.....	14
7.11 Recommended Functionalities .....	14
7.12 Automatic Radio Position Updating .....	15
7.13 Definitions.....	15
<b>8. Operational Requirements.....</b>	<b>19</b>
8.1 Navigational Performance .....	19
8.2 Navigation Equipage .....	19
8.3 Flight Plan Designation. ....	19
8.4 Availability of GNSS .....	20
8.5 Navigation Database .....	20
<b>9. Training Programmes, Operating Practices and Procedures .....</b>	<b>20</b>
9.1 Introduction.....	20
9.2 Flight Planning.....	21
9.3 Preflight Procedures at the Aircraft.....	21
9.4 En Route .....	21
9.5 Flight Crew Knowledge .....	21
<b>Appendix A - Sample Letter of Request for RNP 4 Operational Approval .....</b>	<b>23</b>
<b>Appendix B - Checklist for RNP 4 Operational Approval/Process .....</b>	<b>24</b>
<b>Appendix C - Sample Operations Specification .....</b>	<b>25</b>

## Subpart C –General Flight Rules

### 91.246 Operations in RNP designated airspace

Rule 91.246(a) prohibits a person from operating a New Zealand registered aircraft in RNP designated airspace unless:

- an approved RNP operations procedures manual for the aircraft and its navigation system is available in the aircraft; and
- the operations in the RNP airspace are performed in accordance with the approved manual; and
- the instruments and equipment required for the RNP operation have been inspected and maintained in accordance with an approved maintenance programme; and
- the flight crew have knowledge of the aircraft and its navigation system and procedures to be used; and
- the pilot-in-command ensures that the aircraft and navigation systems are approved for the RNP operations and that the RNP performance can be met for the planned route and any alternate routes; and
- the appropriate flight plan is submitted to the Air Traffic Service.

Appendix I provides information on applying for an RNP approval and what the CAA requires in order to process an application for RNP 4 approval.

Rule 91.246(c) requires each applicant for the approval of a RNP operation procedures manual, or an amendment to an approved RNP operation procedures manual, to submit the proposed manual or amendment to the Director.

Appendix I provides details of the required contents of an application under Section 6 Application.

Rule 91.246(d) allows the Director to approve a RNP operation procedures manual and any amendment to a RNP operation procedures manual.

Appendix I provides details on the forms of approval provided by the Director under Section 7.3 Form of Approval.

Rule 91.246(e) requires each RNP operation procedures manual to contain specific information:

Rule 91.246(e)(1), (2) and (3) require details on the operator, the aircraft and the aircraft navigation system.

Rule 91.246(e)(4) requires a maintenance programme with procedures for testing and inspection of instruments and equipment to ensure RNP performance for a particular operation is maintained and also requires specific information to be recorded in the maintenance records for any RNP operation that is discontinued due to instrument or equipment malfunction.

Appendix I provides details on this maintenance requirement under Section 7.7 Maintenance Requirements.

Rule 91.246(e)(5) requires various procedures and instructions to be included in the RNP operations procedures manual to mitigate against navigational errors, for in flight cross checking, and for updating the aircraft navigation system.

Appendix I provides details on what is required to meet some of these requirements under Section 8 Operational Requirements and Section 9 Training Programmes, Operating Practices and Procedures.

Under rule 91.246(f) the holder of an air operator certificate issued under Part 119 may incorporate the various elements of the RNP operations procedures manual, crew training, and maintenance procedures into their Part 119 operating procedures.

In the case of Part 91 operators who do not operate under a Part 119 air operator certificate the procedures manual in relation to training programmes, operating practices and procedures will need to detail how such procedures will be complied with and how the flight crew members will be assessed as having adequate knowledge and familiarity to operate in RNP designated airspace including continuing knowledge and familiarity.

## Subpart F — Instrument and Equipment Requirements

### 91.519 IFR communication and navigation equipment

91.519(b)(2)(ii) requires an aircraft operating under IFR to be equipped with a navigation system that will enable the aircraft to proceed in accordance with the designated RNP airspace where applicable.

Appendix I - Section 8 provides details on the operational requirements for RNP 4.

91.519(c) requires an aircraft and aircraft navigation system operating in accordance with RNP performance requirements to be approved by the Director for operation on the applicable RNP routes and in RNP designated airspace.

This approval is given under 91.246(d). Appendix I provide details on the forms of approval provided by the Director under Section 7.3 Form of Approval.

**The Pre-Application Meeting detailed in Appendix I under 5.2 Pre-Application Meeting is an essential element in the RNP 4 approval process and individual operators are encouraged to schedule such a meeting to ensure that their application and in particular the Flight Manual conforms to Part 91.246(e) requirements and items required by the CAA not detailed in Appendix I.**

# APPENDIX I

## Introduction

As part of a worldwide effort to implement the ICAO Air Navigation Plan for CNS/ATM systems (DOC 9750), separation standards are being reduced in Oceanic regions which will require the navigation standard of RNP 4. To support this effort, the Informal Pacific Air Traffic Service Coordination Group (IPACG) and the Informal South Pacific Air Traffic Service Coordination Group (ISPACG) are starting the development of plans to implement 30 Nautical Miles (NM) lateral and/or 30 Nautical Miles (NM) longitudinal separation on the South Pacific (SOPAC), North Pacific (NOPAC) and Central East Pacific (CEPAC) routes based on approval of RNP 4 capability for the total route of the flight. In accordance with ICAO Annex 6, operators will be required to obtain RNP 4 operational approval. RNP 4 implementation will provide benefits in terms of efficient use of airspace, optimum routings, reduced delay, increased traffic flow capacity, increased flexibility, reduced costs, reduced separation standards and increased safety.

## 1. Purpose, Overview and Limitations

The purpose of this AC is to provide information to persons wishing to operate aircraft in RNP designated airspace in accordance with Rule 91.246 and using equipment required under rule 91.519. This includes airworthiness requirements, continuing airworthiness requirements, policy, and directions for obtaining operational approval of RNP 4 Oceanic and Remote area capability. It also includes guidance on airworthiness and operational approval to enable an applicant to be approved as capable of meeting the Navigation Performance and Functional requirements for RNP 4 in oceanic and remote areas. These requirements are also specified in other documents such as Aeronautical Information Publications (AIP) and the International Civil Aviation Organization (ICAO) Regional Supplementary Procedures Document (Doc 7030). This AC does not address communications or surveillance requirements that may be specified for operations on a particular route or in a particular area. These requirements are specified in other documents such as Civil Aviation Rules (CAR), Aeronautical Information Publications (AIP) and the International Civil Aviation Organisation (ICAO) Regional Supplementary Procedures Document (Doc 7030).

The ICAO Separation and Airspace safety panel (SASP) developed the guidance material for RNP 4 approvals. This material supports the implementation by states of the 30 NM lateral and longitudinal separation minima in oceanic or remote areas airspace for use in conjunction with

RNP 4. The separation minima are described in Para 3.4.1(e) of Attachment B to Annex 11, and Section 5.4 of the PANS-ATM.

ICAO RNP 4 approval process does not incorporate all of the equipment functionalities described in Minimum Aircraft System performance Standards (MASPS) for RNP 4, that are contained in RTCA DO-236B and EUROCAE ED-75B. The 30 NM separation minima that the approval process was designed to support requires RNP 4 navigation performance as specified in ICAO RNP manual (Doc 9613), but does not require compliance with certain additional requirements specified in the MASPS.

This advisory material addresses only the approval of aircraft for which the certification of RNP 4 navigation capability for operations in oceanic or remote airspace is based upon the use of GNSS or equivalent systems as either stand-alone navigation systems, or as one of the navigation inputs to a multi-sensor system. GNSS ensures that there is no time limit imposed upon the RNP 4 approval.

The approval process in this AC is limited to aircraft that have received airworthiness certification indicating that the installed navigation systems meet the performance requirements of RNP 4. This certification may have been issued at the time of manufacture and where aircraft have been retrofitted in order to meet the requirements of RNP 4, certification may also have been achieved through the granting of a Supplement Type Certificate (STC).

## 2. Related Publications

### **Civil Aviation Authority of New Zealand**

- CAR Part 91, Part 19 and Part 119.
- AIPNZ.

### **Civil Aviation Safety Authority (CASA) - Australia**

- AC 91U-3(0) Required Navigation Performance 4 (RNP 4) Operational Certificate.

### **Federal Aviation Administration (FAA)**

- Federal Aviation Regulation (FAR) Part 121 Annex G.
- FAA AC 20-130A - Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors.
- FAA AC 20-138A - Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment.
- FAA Order 7110.82 - Monitoring of Navigation/Altitude Performance in Oceanic Airspace.
- FAA Order 8400.xx - Required Navigation Performance 4 (RNP 4) Oceanic and Remote Operational Approval.

- Handbook Bulletin for Air Transportation (HBAT) 95-09 - Guidelines for Operational Approval of Global Positioning System [GPS] to Provide the Primary Means of Class II Navigation in Oceanic and Remote Areas of Operation

### **Other Documents**

- Manual on RNP - ICAO Doc 9613-AN/937.
- DO 236A - Minimum Aircraft System Performance Standards (MASPS): Required Navigation Performance for Area Navigation.
- DO 283 - Minimum Operational Performance Standards for Required Navigation Performance for Area Navigation.
- DO 200A - Standards for Processing Aeronautical Data.

## **3. Applicability**

This guidance material applies to all RNP 4 operations conducted under Instrument Flight Rules (IFR). New Zealand registered aircraft, when operating outside New Zealand airspace, must comply with ICAO Annex 2 when over the high seas and the applicable regulations of another State when operating within that State's airspace.

## **4. Operational Approval**

### **4.1 General**

The aircraft must be qualified and the operator must be approved before conducting flight in RNP 4 airspace. In accordance with Rule 91.246(a), RNP operational procedures must be available in the aircraft when conducting flight in a RNP airspace or routes with reduced separation minima. To obtain operational approval, aircraft eligibility must be determined, appropriate flight-crew procedures for the navigation systems to be used must be identified by the applicant, database use and operating procedures must be evaluated. Appropriate Operations Specifications or a Letter of Authorisation (LOA) may be issued, as applicable to the operator.

Appendix A gives the format that may be used for application for RNP 4 approval. The operator will apply to the CAA Aircraft Certification Unit in writing for RNP 4 Oceanic or Remote area approval. The responsible Airworthiness Engineer in the Aircraft Certification Unit is the point of contact for the operators for any queries regarding RNP 4 operational approval.

## **4.2 Determining Eligibility of Aircraft**

Aircraft and Navigation system types currently in use in oceanic or remote area operations may qualify for RNP 4 based on one or more provisions of existing certification criteria. Additional aircraft certification will be necessary if the operator chooses to claim additional performance beyond that originally certified or stated in the Flight Manual or Flight Manual Supplement and if the operator cannot demonstrate the desired performance through data collection. Navigation performance must consider the navigation infrastructure used in original certification.

## **4.3 Airworthiness Requirements**

RNP 4 operations require that the aircraft navigate with a cross track and along track total system error no greater than +/- 7.4 km (+/-4 NM) for 95% of the total flight time. This includes Position Estimation Error (PEE), Flight Technical Error (FTE), Path Definition Error (PDE) and Display System Error (DSE).

## **4.4 Approved Aircraft/System List**

The Aircraft Certification Unit at the CAA will maintain a list of aircraft/navigation systems that have received approval. It will not be used as a means of determining qualifications for approval but will be provided on the CAA web site for information purposes only.

# **5. Operational Approval Process**

## **5.1 General**

The following paragraphs provide application guidelines for operators requiring RNP 4 operational approval. Appendix B to this AC provides details of the application process for an operator to apply for RNP 4 operational approval.

## **5.2 Pre-Application Meeting**

Each individual operator should schedule a pre-application meeting with the CAA. The purpose of this meeting is to discuss with the operator, the CAA's airworthiness and operational requirements for approval to operate in RNP 4 airspace, including—

- the contents of the operator's application;
- CAA review and evaluation of the application;
- limitations associated with the approval; and
- conditions for removal of the operational approval.



### **5.3 Form of Application**

A sample letter of request for an operator to obtain RNP 4 operational approval is attached as Appendix A.

## **6. Application**

### **6.1 Contents**

#### **6.1.1 Aircraft Eligibility Documents**

Flight Manual, Flight Manual Supplement or suitable Aircraft Evaluation Group (AEG) documentation.

#### **6.1.2 Description of Aircraft Equipment**

A configuration list detailing pertinent components and equipment.

#### **6.1.3 Operational Training Programmes and Operating Practices and Procedures**

Rule Part 119 Certificate holders and Rule Part 91 operators must submit training syllabi (e.g. initial, upgrade, recurrent) and other appropriate material to the CAA showing incorporation of operational practices and procedures. Training for other personnel must be included where appropriate (e.g. dispatchers, maintenance). Practices and procedures must be standardized using the guidelines of this AC.

#### **6.1.4 Operational Manuals and Checklists**

Rule Part 119 Certificate holders should revise appropriate manuals and checklists to include information/guidance on standard operating procedures detailed in this AC. Appropriate manuals must include navigation equipment operating instructions and any procedures established to operate in a specific area of operations (e.g. contingency procedures). Manuals and checklists should be submitted for review as part of the application.

#### **6.1.5 Past Performance**

An operating history for the operator should be included in the application. The applicant should address any events or incidents related to navigation errors for that operator (e.g. as reported on form CAA 005) which have been covered by training, procedures, maintenance, or aircraft/navigation modifications for the systems that are to be used.

#### **6.1.6 Minimum Equipment List (MEL)**

Those portions of the MEL required for operational approval must be reviewed and addressed.

#### **6.1.7 Maintenance**

Where applicable, the operator should submit maintenance documents for approval, in accordance with this AC, at the time the operator applies for operational approval.

## 7. CAA Evaluation of Proposal

### 7.1 Civilian Operated Aircraft

Once the application has been submitted, the CAA will begin the process of review and evaluation. If the contents of the application are deficient, the CAA will request additional information from the operator. When all the airworthiness and the operational requirements of the application are met, the CAA will issue the approval to operate in RNP 4 airspace.

### 7.2 NZDF Operated Aircraft

For aircraft operated by the New Zealand Defence Force (NZDF), the CAA will accept an application for the issue of RNP 4 approval from the Air Component Commander, Headquarters Joint Forces New Zealand. 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;
- navigation equipment installed; and
- compliance with RNP 4 requirements outlined in this AC.

### 7.3 Form of Approval

RNP 4 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 4 airspace, including—

- required navigation systems or procedures; and
- limits on time, routes, or areas of operation.

A sample Operations Specification amendment and a draft Letter of Authorisation are attached as Appendix C.

### 7.4 Investigation of Navigation and System Errors

Demonstrated navigation accuracy provides the basis for determining the lateral spacing and separation minima necessary for traffic operating on a given route. Accordingly, lateral and longitudinal navigation errors are investigated to prevent their recurrence. Radar observations of each aircraft's proximity to track and altitude, before coming into coverage of short-range nav aids at the end of the oceanic route segment, are typically noted by the Air Traffic Service (ATS). If an ATS personnel observation indicates that an aircraft is not within the established limit, the reasons

for the apparent deviation from track or altitude may need to be determined and steps taken to prevent its recurrence. Additionally, pilots/operators are to notify the CAA and Airways Corporation of New Zealand (ACNZ) of any lateral navigation errors greater than 15 NM more, longitudinal navigational errors of 10 NM or more, longitudinal navigational errors of 3 minutes or more, variation between the aircraft's estimated time of arrival at a reporting point and its actual time of arrival, or navigation system failures.

## **7.5 Cancellation of RNP 4 Approval**

When appropriate, the CAA may consider any navigation error reports in determining remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment or operator may result in cancellation of the RNP 4 approval for use of that equipment or by that operator. Information that indicates the potential for repeated errors may require a modification of an operator's training programme. Information that attributes multiple errors to a particular pilot crew may necessitate remedial training or licence review.

## **7.6 Aircraft Eligibility Groups**

### **7.6.1 Group 1**

Group 1 aircraft are those with formal certification and approval of RNP integration accounting for oceanic/remote operations in the Flight Manual. The Flight Manual will address demonstrated RNP levels and any related provisions applicable to its use (e.g. Navaid sensor requirements etc.). The operational approval is based on the performance stated in the Flight Manual. This method also applies to the cases where certification is received through a STC issued to cover retrofitting of equipment, such as GNSS receivers, to enable the aircraft to meet RNP 4 requirements in oceanic and remote areas.

### **7.6.2 Group 2**

Group 2 aircraft are those with prior navigation system certification. Aircraft that can equate their certified level of performance, under previous standards, to the RNP 4 criteria. The standards listed in the subparagraphs below, can be used to qualify an aircraft under Group 2. Other standards may also be used if they are sufficient to ensure that the RNP 4 requirements are met.

#### ***7.6.2.1 Global Navigation Satellite Systems (GNSS) as Primary Navigation***

Aircraft having GNSS as the **PRIMARY** Long Range Navigation System (LRNS) for oceanic and remote operations approval must meet performance requirements of this AC. Flight Manual(s) should indicate if the GNSS system installation meets these requirements. Dual independent GNSS equipment is required and an approved dispatch fault detection and exclusion (FDE) availability prediction programme must be used. The maximum allowable time for which FDE capability is

projected to be unavailable is 25 minutes. Maximum outage times will be included as a condition of the operational approval.

NOTE: If predictions indicate that the maximum allowable FDE outage will be exceeded, the operation must be rescheduled when FDE is available.

#### ***7.6.2.2 Multisensor Systems Integrating GPS with GPS Integrity Provided by Receiver Autonomous Integrity Monitoring (RAIM)***

Multisensor systems integrating GPS with RAIM and FDE that are approved under AC 20-130A, Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors, or equivalent, meeting the technical requirements specified in this AC.

#### ***7.6.2.3 Aircraft Autonomous Integrity Monitoring (AAIM)***

AAIM uses the redundancy of position estimates from multiple sensors, including GNSS, to provide integrity performance that is at least equivalent to RAIM. These airborne augmentations may be certified in accordance with TSO C-115B, JTSO C-115b or other equivalent. An example is using an inertial navigation system or other navigation sensors as an integrity check on GPS data when RAIM is unavailable but GPS positioning information continues to be valid.

### **7.6.3 Group 3**

New Technology – Navigation systems meeting the performance requirements of this AC for operations in airspace designated as Oceanic/Remote Areas RNP 4.

## **7.7 Maintenance Requirements**

Aircraft in Group 1, Group 2, and Group 3 must have an established maintenance programme for the individual navigation systems.

## **7.8 MEL**

The MEL must identify the necessary equipment for dispatch into the RNP 4 Oceanic/Remote environment, including two Long Range Navigation Systems (LRNS) and sufficient equipment to provide the performance and functionalities stipulated in the paragraph below.

## **7.9 Required Performance**

### **7.9.1 Flight Technical Error (FTE)**

The accuracy with which the aircraft is controlled as measured by the indicated aircraft position with respect to the indicated command or desired position is the FTE. It does not include blunder errors.

### **7.9.2 Path Definition Error (PDE)**

This is the difference between the *defined path* and the *desired path* at a specific point and time.

### **7.9.3 Display System Error (DSE)**

These errors may include error components contributed by any input, output or signal conversion equipment used by the display as it presents either aircraft position or guidance commands (e.g. course deviation or command heading) and by any course definition entry device employed. For systems in which charts are incorporated as integral parts of the display, the display system error necessarily includes charting errors to the extent that they actually result in errors in controlling the position of the aircraft relative to a desired path over the surface. To be consistent, in the case of symbolic displays not employing integral charts, any errors in waypoint definition, directly attributable to errors in the reference chart used in determining waypoint positions, should be included as a component of this error. This type of error is virtually impossible to handle and in general practice, highly accurate, published waypoint locations are used to the greatest extent possible in setting up such systems to avoid such errors and reduce workload.

### **7.9.4 Navigation System Error (NSE)**

This is the root sum square of the ground station error contribution, the airborne receiver error and the display system contribution.

### **7.9.5 Total System Error (TSE)**

This is system use error.  $TSE = \sqrt{(NSE)^2 + (FTE)^2}$

### **7.9.6 Position Estimation Error (PEE)**

This is the difference between true position and estimated position.

### **7.9.7 Accuracy +/- 4 NM (+/-7.4 km)**

Each aircraft operating in RNP airspace must have total system error components in the cross-track and along track directions that are less than the RNP value 95% of the flying time. Accuracy is defined relative to a geodesic path along the published route or defined procedure. The error components that must be considered in complying with the accuracy requirement are the flight technical error (FTE), the position estimation error (PEE), display error and path definition error (PDE). The accuracy requirement must be met for the specific length of route.

### **7.9.8 GNSS Monitor**

The GNSS navigation system must detect the satellite failures before they cause the aircraft to exceed the defined airspace or obstacle clearance area. This requirement is derived from the overall effect of a GNSS failure and applies to all navigational uses of GNSS. The probability of missed detection of satellite failures must be less than or equal to  $10^{-3}$  and the effective monitor limit for these failures on the navigation solution, known as the horizontal alert limit (HAL), must consider the other normal errors that may exist during a satellite fault, the latency of the alert, the crew reaction time to an alert and the aircraft response. An acceptable means of compliance is to use a horizontal alert limit (HAL) as follows: Oceanic (RNP 4): 4 NM

## 7.10 Required Functionalities

The following functionalities are mandatory:

- CDI in pilot's "Field of View" (FOV)
- Track to Fix (TF)
- Direct to Fix (DF)
- Direct to Function
- Course to Fix (CF)
- Parallel Offset
- Fly-by Transition Criteria
- User Interface Displays
- Flight Planning Path Selection
- Flight Planning Fix Sequencing
- User Defined Course to Fix
- Path Steering
- Alerting Requirements
- Navigation Data Base Access
- WGS 84 geodetic reference system

## 7.11 Recommended Functionalities

The following additional functionalities are recommended:

- Display cross-track error on the CDU
- Display present position in distance/bearing to selected waypoints
- Provide time to waypoints on the CDU
- Along Track Distance
- Display Ground Speed
- Indicated track angle
- Provide automatic navigation aids selection
- Purge radio updates
- Manually inhibit a navaid facility
- Automatic selection and tuning of DME and/or VOR
- Estimate of position uncertainty
- Current RNP type
- Flight Plan Discontinuity
- Navigation Sensor in Use and display of de-graded navigation

## 7.12 Automatic Radio Position Updating

Automatic updating is considered to be any updating procedure that does not require crews to manually insert coordinates. Conditions under which Automatic Radio Position Updating may be considered as acceptable for flight in airspace where RNP 4 is required are listed below. Automatic updating is the only method considered acceptable for operations in airspace where RNP 4 is applied provided that:

- Procedures for automatic updating are included in an operator's training programme; and
- Crews are knowledgeable of the updating procedures and of the effect of the update on the navigation solution.

## 7.13 Definitions

### 7.13.1 CDI in Pilot's Field of View (FOV)

A course deviation indicator (CDI) located in the pilot's primary field of view along the forward flight path, enabling the pilot to perform a natural crosscheck, is required. These displays must be visible to the pilot in the primary field of view. A scalable electronic map cannot substitute for a CDI. A fixed scale CDI is acceptable as long as the CDI demonstrates appropriate scaling and sensitivity for the intended RNP type. Differences in CDI scales from one RNP type to another may require operational procedures to check and affirm the CDI scale against the RNP type. With a scalable CDI, the scale must derive from the selection of RNP, not from a separate selection of CDI scale. Alerting and annunciation limits must match scaling values. If the equipment uses default RNP types to describe the operational mode (e.g. en route, terminal area and approach), then displaying the operational mode is an acceptable means from which the flight crew may derive the CDI scale sensitivity. The course selector of the deviation display must have a full-scale deflection required for the flight procedure and track keeping accuracy.

### 7.13.2 Track to Fix (TF)

TF leg is a geodesic path between two fixes. The first fix is either the previous leg termination or an IF leg. The termination fix is normally provided by the navigation database, but may also be a user-defined fix.

### 7.13.3 Direct to Fix (DF)

DF leg is a geodesic path starting near the area of initiation and terminating at a fix.

### 7.13.4 Direct-To Function

The Direct-To function must be able to be activated at any time by the flight crew, when required. The Direct-To function must be available to any fix. The system must be capable of

generating a geodesic path to the designated “To” fix. The aircraft must capture this path without “S-turning” and without undue delay.

#### **7.13.5 Course to Fix (CF)**

CF leg is a geodesic path terminating at a fix with a specified course at that fix. The inbound course at the termination fix and the fix are provided by the navigation database. If the inbound course is defined as a magnetic course, the source of the magnetic variation needed to convert magnetic courses to true courses is required.

#### **7.13.6 Parallel Offset**

The system must have the capability to fly parallel tracks at a selected offset distance. When executing a parallel offset, the RNP type and all performance requirements of the original route in the active flight plan must be applicable to the offset route. The system must provide for entry of offset distances in increments of 1 nautical mile, left or right of course. The system must be capable of offsets of at least 20 nautical miles. When in use, system offset mode operation must be clearly indicated to the flight crew. When in offset mode, the system must provide reference parameters (for example, cross-track deviation, distance-to-go, time-to-go) relative to the offset path and offset reference points. An offset must not be propagated through route discontinuities, unreasonable path geometries, or beyond the initial approach fix. Annunciation must be given to the flight crew prior to the end of the offset path, with sufficient time to return to the original path. Once a parallel offset is activated, the offset must remain active for all flight plan route segments until removed automatically, until the flight crew enters a Direct-To routing, or until flight crew (manual) cancellation. Parallel offset function must be available for en route TF and geodesic portion of DF leg types.

#### **7.13.7 Fly-by Transition Criteria**

Navigation system must be capable of accomplishing fly-by transitions. No predictable and repeatable path is specified, because the optimum path varies with airspeed and bank angle. However, predictable and repeatable boundaries of the transition area are defined. Path definition error is defined as the difference between the defined path and the theoretical transition area. If the path lies within the transition area, there is no path definition error. Fly-by transitions must be the default transition when the transition type is not specified. The theoretical transition area requirements are applicable for the following assumptions:

- Course changes do not exceed 120 degrees for low altitude transitions (referred as when the aircraft barometric altitude is less than FL195); and
- Course changes do not exceed 70 degrees for high altitude transitions (referred as when the aircraft barometric altitude is equal to or greater than FL195).



### 7.13.8 User Interface Displays

General user interface display features must provide for presentation of information, provide situational awareness and be designed and implemented to accommodate human factors considerations. Essential design considerations include:

- Minimising reliance on flight crew memory for any system operating procedure or task.
- Developing a clear and unambiguous display of system modes/sub modes and navigational data with emphasis on enhanced situational awareness requirements for any automatic mode changes if provided.
- Use of context sensitive help capability and error messages (e.g. invalid inputs or invalid data entry messages should provide a simple means to determine how to enter “valid” data).
- Fault tolerant data entry methods rather than rigid rule based concepts.
- Placing particular emphasis on the number of steps and minimising the time required to accomplish flight plan modifications to accommodate ATS clearances, holding procedures, runway and instrument approach changes, missed approaches and diversions to alternate destinations.
- Minimising the number of nuisance alerts so the flight crew will recognize and react appropriately when required.
- Displays and controls. Each display element used as a primary flight instrument in the guidance and control of the aircraft, for manoeuvre anticipation or for failure/status/integrity annunciation, must be located where it is clearly visible to the pilot (in the pilot’s primary field of view) with the least practicable deviation from the pilot’s normal position and line of vision when looking forward along the flight path. For those aircraft meeting the requirements of FAR/JAR 25, it is intended that provisions of certification documents such as AC 25-11, AMJ 25-11 and other applicable documents should be satisfied. All system displays, controls and annunciations must be readable under normal cockpit conditions and expected ambient light conditions. Night lighting provisions must be compatible with other cockpit lighting.
- All displays and controls must be arranged to facilitate flight crew accessibility and usage. Controls that are normally adjusted in flight must be readily accessible with standardized labelling as to their function. System controls and displays must be designed to maximize operational suitability and minimise pilot workload. Controls intended for use during flight must be designed to minimise errors, and when operated in all possible combinations and sequences, must not result in a condition whose presence or continuation would be detrimental to the continued performance of the

system. System controls must be arranged to provide adequate protection against inadvertent system shutdown.

#### **7.13.9 Flight Planning Path Selection**

The system must provide the capability for the crew to create, review and activate a flight plan. The system must provide the capability for modification (e.g. deletion and addition of fixes and creation of along-track fixes), review and user acceptance of changes to the flight plans. When this capability is exercised, guidance outputs must not be affected until modification is activated. Activation of any flight plan modification must require positive action by the flight crew after input and verification by the flight crew.

#### **7.13.10 Flight Planning Fix Sequencing**

The system must provide the capability for automatic sequencing of fixes.

#### **7.13.11 User-Defined Course to Fix**

The system must provide the capability to define a user-defined course to a fix. The pilot must be able to intercept the user-defined course.

#### **7.13.12 Path Steering**

The system must provide data to enable the generation of command signals for autopilot/flight director/CDI, as applicable. In all cases a Path Steering Error (PSE) must be defined at the time of certification, which will meet the requirements of the desired RNP operation in combination with the other system errors. During the certification process, the ability of the crew to operate the aircraft within the specified PSE must be demonstrated. Aircraft type, operating envelope, displays, autopilot performance, and leg transitioning guidance (specifically between arc legs) should be accounted for in the demonstration of PSE compliance. A measured value of PSE may be used to monitor system compliance to RNP requirements. For operation on all leg types, this value must be the distance to the defined path. For cross-track containment compliance, any inaccuracies in the cross-track error computation (e.g. resolution) must be accounted for in the total system error.

#### **7.13.13 Alerting Requirements**

The system must also provide an annunciation when the manually entered RNP type is larger than the RNP type associated with the current airspace as defined in the navigation database. Any subsequent reduction of the RNP type must reinstate this annunciation. When approaching RNP airspace from non-RNP airspace, alerting must be enabled when the cross-track to the desired path is equal to or less than one-half (1/2) the RNP value and the aircraft has passed the first fix in the RNP airspace.

#### **7.13.14 Navigation Database Access**

The navigation database must provide access to navigation information in support of the navigation systems reference and flight planning features. Manual modification of the navigation database data must not be possible. This requirement does not preclude the storage of "user defined data" within the equipment. When data are recalled from storage they must also be retained in storage. The system must provide a means to identify the navigation database version and valid operating period.

#### **7.13.15 WGS-84 Geodetic Reference System**

WGS-84 or an equivalent earth reference model must be the reference earth model for error determination. If WGS-84 is not employed, any differences between the selected earth model and the WGS-84 earth model must be included as part of the path definition error. Errors induced by data resolution must also be considered.

## **8. Operational Requirements**

### **8.1 Navigational Performance**

All aircraft must meet an along track and a cross track keeping accuracy equal to or better than  $\pm 4$  NM ( $\pm 7.4$  km) for 95% of the flight time in RNP 4 airspace.

### **8.2 Navigation Equipage**

All RNP 4 operations in oceanic and remote areas must have at least dual independent long range navigation systems of integrity such that the navigation system does not provide misleading information.

Aircraft incorporating GPS, AC 20-138() and Australian CAAP 35-1, or equivalent, provides an acceptable means of compliance for aircraft that use GPS, but do not integrate the GPS with other sensors. AC 20-130A, describes an acceptable means of compliance for multi-sensor navigation systems that incorporate GPS.

The equipment configuration used to demonstrate the required accuracy must be identical to the configuration which is specified in the MEL.

The design of the installation must comply with the design standards that are applicable to the aircraft being modified and changes must be reflected in the flight manual prior to commencing operations requiring an RNP 4 navigation approval.

### **8.3 Flight Plan Designation.**

Operators should use the appropriate CAA or ICAO flight plan designation specified for the RNP route flown. The letter "R" should be placed in Block 10 of the ICAO flight plan to indicate that

the pilot has reviewed the planned route of flight to determine RNP requirements and the aircraft and operator have been approved by the CAA to operate in areas or on routes where RNP is a requirement for operation. Operators must also comply with any additional flight planning requirements specified in ICAO Regional Supplementary Procedures Doc 7030 and State AIP. Additional information needs to be displayed in the remarks section that indicates the accuracy capability such as RNP 4 versus RNP 10. It is important to understand that additional requirements will have to be met for Operational Approval in RNP 4 airspace or routes. CPDLC and ADS will also be required when the separation standard is 30 NM lateral and /or 30 NM longitudinal.

#### **8.4 Availability of GNSS**

At dispatch or during flight planning, the operator should ensure that adequate navigation capability is available en route to enable the aircraft to navigate to RNP 4.

#### **8.5 Navigation Database**

The standards for navigation databases are contained in RTCA document DO-200A and EUROCAE document DO-76. Given that not all current suppliers of navigation databases meet these standards, the operator, as a minimum, must implement navigation database integrity checks using appropriate software tools or approved manual procedures to verify data relating to all waypoints in the subject RNP 4 airspace or routes. These checks are in addition to any checks previously performed by the Aeronautical Information Services, unapproved navigation database suppliers, or navigation equipment manufacturers. The integrity checks need to identify any discrepancies between the navigation database and the published charts/procedures. An approved third party may perform integrity checks. Discrepancies that invalidate a procedure must be reported to the navigation database supplier and affected procedures must be prohibited by an operator's notice to its flight crew. Aircraft operators should consider the need to continue their own database checks even for products obtained from approved suppliers.

## **9. Training Programmes, Operating Practices and Procedures**

### **9.1 Introduction**

The following items (detailed in paragraphs 9.2 through 9.5) should be standardized and incorporated into training programmes and operating practices and procedures. Certain items may already be adequately standardized in existing operator programmes and procedures. New technologies may also eliminate the need for certain crew actions and if this is found to be the case, then the intent of this section has been met.

## 9.2 Flight Planning

During flight planning, the flight-crew should pay particular attention to conditions which may affect operations in RNP 4 airspace (or on RNP 4 routes). These include, but may not be limited to:

- Verifying that the aircraft is approved for RNP 4 operations.
- Verify that the letter “R” is annotated in Block 10 (Equipment) of the ICAO Flight Plan.
- Requirements for GNSS, such as FDE, if appropriate for the operation.
- Accounting for any operating restriction related to RNP 4 approval, if required for a specific navigation system.
- Verification that any additional flight planning requirements specified in Regional Supplementary Procedures (Doc7030) or state AIP has been met.

## 9.3 Preflight Procedures at the Aircraft

The following actions should be completed during pre-flight:

- Review maintenance logs and forms to ascertain the condition of equipment required for flight in RNP 4 airspace or on routes requiring RNP 4 navigation capabilities.
- Ensure that maintenance action has been taken to correct defects to required equipment.

## 9.4 En Route

At least two independent Long Range Navigation systems capable of navigating to the RNP should be operational at the oceanic entry point. If this is not the case, then the pilot should consider an alternate routing or divert for repairs.

Operator in-flight operating procedures must include mandatory cross checking procedures to identify navigation errors in sufficient time to prevent aircraft from an inadvertent deviation from ATC cleared routes.

Crews must advise ATC of any deterioration or failure of the navigation equipment below the navigation performance requirements or of any deviations required for a contingency procedure.

## 9.5 Flight Crew Knowledge

Operators should ensure that the crews have been trained and have appropriate knowledge on the subject matter contained in this AC, limits of their RNP 4 navigation capabilities, and effects of updating and RNP 4 contingency procedures.

In determining whether training is adequate, the CAA may:

- Evaluate a training course before accepting a training centre certificate from a specific centre:

- Accept a statement in the operator's/owner's application for an RNP 4 approval that the operator has ensured and will continue to ensure that flight crews are familiar with the RNP 4 operating practices and procedures contained in this AC:
- Accept a statement by the operator that it has conducted or will conduct an RNP 4 training programme utilizing the guidance contained in this AC.

## Appendix A - Sample Letter of Request for RNP 4 Operational Approval

*[file reference] [date]*

Manager Aircraft Certification

Civil Aviation Authority

PO Box 31-441

Lower Hutt

Dear Sir

### APPLICATION FOR RNP 4 OPERATIONAL APPROVAL

*[aircraft operator]* requests that operational approval be given to conduct en route operations on designated RNP 4 routes and in designated RNP 4 areas with a maximum time of *[number]* hours.

The RNP Operations Procedures Manual\Amendment to RNP Operations Procedures Manual *[Delete as appropriate]* is attached for approval in accordance with CAR 91.246(c).

The following *[aircraft operator]* aircraft meet the requirements and capabilities as defined/specified in advisory circular AC91-10 for RNP 4 operations—

<b>Aircraft Type/Series</b>	<b>Navigation Systems/Equipment</b>	<b>Time Limit</b>
B747-400	List nav equip by name and type/manufacturer/model	No of Hours/unlimited
B767-300	As above	As above
B737-200	As above	As above
650 Cessna Citation III	As above	As above

Flight crews have been trained in accordance with the requirements of the ICAO RNP Manual and Rule 91.246(a)(4). *[For Part 91 Operators the RNP Operations Procedures Manual must contain details on how personnel are assessed as competent for RNP Operations and who has completed this assessment]*

Yours sincerely

*[signature]*

*[name]*

*[appointment/title]*

## **Appendix B - Checklist for RNP 4 Operational Approval/Process**

**1. Operator prepares an Application Package as described in AC91-10 for RNP 4 operations.**

### **2. Operator Self-Examination**

The operators should become familiar with Rule 91.246 and the contents of AC91-10 before contacting the CAA. AC91-10 provides the criteria for approvals by placing aircraft/navigation systems in groups. Knowledge of this Advisory Circular provides the operator with an indication of how much time might be required in obtaining an approval.

### **3. Operator Schedules a Pre-Application Meeting**

The operator should schedule a pre-application meeting with the CAA.

### **4. Operator Submits a Formal Application for Approval**

The application should be in accordance with the CAA expectations discussed in the pre-application meeting. The formal application should be made in writing in a manner similar to that shown in AC91-10.

### **5. Operator Trains Crew**

RNP 4 airspace or an RNP 4 route is a special airspace. CAR 91.246(a)(4) requires all flight crew to have specific training for RNP operations.

### **6. Operators Receive Operation Specifications Amendment or a LOA**

The CAA issues RNP 4 approval by issue of LOA for Part 91 Operation and by changing Operation Specifications for Part 119 Certificate holders.

### **7. Crews are Authorised to Perform RNP 4 Operations**

The authority is valid only for the time authorised within the parameters established for their navigation system configuration.



## Appendix C - Sample Operations Specification

### 1. Draft operations specification amendment (insert relevant number).

#### Navigation/communication systems

Operation within *[state RNP airspace or RNP routes as applicable]* Required Navigation Performance 4 (RNP 4) airspace is authorised, provided that such operation is in accordance with Rule 91.246 and the applicable requirements, as detailed in ICAO Document 7030/4 “Regional Supplementary Procedures”.

#### Appendix - Required Navigation Performance (RNP) Airspace

The following aircraft are authorised for RNP 4 operations as defined in paragraph (insert relevant paragraph number):

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

### 2. Draft letter of authorisation

*[file reference] [date]*

*[organisation name]*

*[address]*

Dear Sir/Madam

#### APPROVAL TO OPERATE IN RNP 4 AIRSPACE

In accordance with Civil Aviation Rule 91.246 approval is hereby granted for the following operator, aircraft and navigation systems for en route oceanic and remote area operations on designated RNP 4 routes and in designated RNP 4 airspace with the stated RNP 4 time limit.

**Operator:** *[name]*

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

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

**Designated RNP routes/airspace:** *[specify]*

*[signature]*

*[name]*

*[title]*