Australian Government
Civil Aviation Safety Authority

Advisory Circular

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REQUIRED NAVIGATION PERFORMANCE 4 (RNP 4) OPERATIONAL AUTHORISATION

CONTENTS

1. REFERENCES

- CASR 91.850 and Subpart 91.U
- Manual of Standards (MOS) Subpart 91.U, Chapter 4
- ICAO Doc 7030/4, MID/ASIA/RAC and PAC/RAC
- Aeronautical Information Publication (AIP)

2. PURPOSE

This Advisory Circular (AC) provides Australian aircraft owners and operators with information on a means of gaining an authorisation to undertake 'RNP 4 operations' i.e. how to obtain an *RNP 4 Operational Authorisation*. It also gives guidance on flight crew training for RNP 4 operations.

3. STATUS OF THIS AC

This is the first issue of this AC.

4. INTRODUCTION

4.1 Overview

4.1.1 The International Civil Aviation Organization (ICAO) *Annex 6 — Operation of Aircraft* states that an operator must obtain RNP operational authorisation from the State of the Operator (for international commercial air transport operations) or the State of Registry (for international general aviation operations) before conducting flights in defined portions of airspace or on routes where RNP types have been prescribed.

4.1.2 This AC provides guidance to operators for obtaining authorisation to undertake 'RNP 4 operations'. The Australian Civil Aviation Safety Authority (CASA) issues the authorisation in the form of an *RNP 4 Operational Authorisation*.

4.1.3 This AC lists the airworthiness, operational and flight crew training standards that must be met before an *RNP 4 Operational Authorisation* will be granted by CASA. These standards have mandatory effect by virtue of being required by the regulations. These standards are set out in the CASA Manual of Standards (MOS) Subpart 91.U, Chapter 4. The source document for the MOS standards is Appendix F of the *Manual on Required Navigation Performance (RNP)*, ICAO Doc 9613-AN/937.

4.1.4 The standards/mandatory requirements are expressed as a 'must' in the text of this AC since they are mandatory standards under the regulations.

4.2 Background and scope

4.2.1 Aims. The ICAO Separation and Airspace Safety Panel (SASP) developed the guidance material for RNP 4 operational authorisations. This material supports the implementation by States of the 30 NM lateral and the 30 NM longitudinal distance-based separation minima in oceanic or remote area airspace for use in conjunction with RNP 4. The separation minima are described in the following ICAO documents: paragraph 3.4.1 (e) of Attachment B to Annex 11, and Section 5.4 of the PANS–ATM.

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

4.2.3 The ICAO RNP 4 authorisation process (and hence, this AC) is limited to aircraft:

(a) that already have received airworthiness certification indicating that the installed navigation systems meet the performance requirements for RNP 4. This RNP certification is stated in the flight manual and may have been issued at the time of manufacture. Where aircraft have been retrofitted in order to meet the requirements for RNP 4, certification may also have been achieved through the granting of a Supplemental Type Certificate (STC); and

(b) for which prior navigation system certification equates to RNP 4 criteria. This certification covers 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. Therefore, no navigation time limit is imposed upon RNP 4 operations.

4.2.4 Whilst the authorisation process has been developed to support the 30 NM lateral and 30 NM longitudinal separation minima based on RNP 4, it should be noted that it addresses only the navigation requirements associated with these standards. It does not address the communications or surveillance requirements. Such requirements are listed in a State's Aeronautical Information Publications (AIP) and the Regional Supplementary Procedures (Doc 7030) for specific airspace or ATS routes.

Note 1: The provisions relating to these separation minima, including the communications and surveillance requirements, can be found in paragraph 3.4.1 e) of Attachment B to ICAO Annex 11 and Section 5.4 of the ICAO PANS-ATM. Provided that they can support the increased reporting rate required, controller pilot data link communications (CPDLC) and Automatic Dependant Surveillance (ADS) systems which meet the requirements for application of the 50 NM lateral and longitudinal minima based on RNP 10 will also meet the requirements for the application of the 30 NM lateral and longitudinal minima.

Note 2: Although the RNP 4 operational authorisation was developed to support the application of reduced separation minima in oceanic or remote area airspace, it could also be used to support other future RNAV separation minima smaller than 30 NM (e.g. in non-radar continental airspace) if the navigation performance requirements are the same. However, the communications and surveillance requirements associated with such minima may be quite different. For example, direct voice communications might be required instead of CPDLC, and an increase in the ADS reporting rate might be necessary.

4.2.5 Other requirements. While this AC deals only with the navigation requirements to gain RNP 4 authorisation, flight crews must be aware that different airspaces may have other operational requirements. These need to be considered when flight planning into RNP airspace or undertaking RNP 4 operations. The need to verify compliance with any such additional requirements is noted in the guidelines provided for flight crew training, which can be found in Section 8 of this AC.

4.2.6 Applicability. This guidance material is for use by Australian operators, those that own/operate either Australian or foreign registered aircraft, and their flight crew.

4.2.7 An *RNP 4 Operational Authorisation* (or equivalent approval/qualification from another State) is not mandatory in order to gain access to Australian 'RNP airspace'. However, operators/flight crew and aircraft must be authorised for RNP 4 operations.

4.2.8 Australian operators, flight crews and aircraft, when operating outside Australian territorial airspace (i.e. beyond the 12 NM territorial limit) must comply with the relevant requirements of ICAO *Annex 2 – Rules of the Air* - when over the high seas (mandated by Civil Aviation Regulation 3 (3)) and other States' regulations when operating within their airspace (CAR 223). Note that the Civil Aviation Regulations (CAR) will be replaced in the future by the equivalent CASR Part 91 regulations.

4.3 RNP 4 requirements

4.3.1 The navigation accuracy requirement for issue of an *RNP 4 Operational Authorisation* requires that the aircraft navigate with a cross-track Total System Error (TSE) no greater than ±7.4 km (±4NM) for 95 per cent of the total flight time.

The aircraft along-track TSE must also be no greater than ±7.4 km (±4 NM) for 95 per cent of the flight time.

4.3.2 The technical capabilities of the equipment leading to the navigation solution must be included in the RNP 4 application and must be certified by the State of Design and State of Registry prior to the grant of a full operational authorisation. This equipment approval should be reflected in either the Aircraft Flight Manual (AFM) or Aircraft Flight Manual Supplement (AFMS) and may form part of an Air Operator Certificate (AOC), if applicable.

4.3.3 The required and recommended equipment functionalities for RNP 4 operations are listed in Section 6.

4.3.4 In addition to the aircraft having the appropriate RNP certification, the issue of an *RNP 4 Operational Authorisation* requires consideration of continuing airworthiness, operational procedures, and training for the flight crew and other operational staff.

4.3.5 Sources of additional information on RNP are listed in Attachment 1.

5. RNP 4 OPERATIONAL AUTHORISATION

5.1 General

5.1.1 MOS Subpart 91.U, Chapter 4, requires that the following steps must be completed before an *RNP 4 Operational Authorisation* can be issued by CASA to an operator:

(a) eligibility of aircraft and certification of its navigation equipment for RNP 4 must be determined by CASA;

(b) flight crew training and operating procedures for the navigation systems to be used must be identified by the operator;

(c) the operator database to be used, flight crew training, and operating procedures must be evaluated by CASA.

5.1.2 This AC 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 operational authorisation.

5.2 Starting the authorisation process

5.2.1 Pre-application meeting. Operators should contact the CASA Airline/Area Office responsible for their operations to discuss CASA's airworthiness and operational requirements for issuing an authorisation. Topics for discussion should include:

(a) what should be included in the operator's application;

(b) how CASA will review and evaluate of the application;

(c) what limitations (if any) will be placed on the authorisation; and

(d) the conditions under which the operational authorisation may be cancelled by CASA.

5.2.2 Form of application. An example of a *Letter of Request* that can be used by an operator to apply for an *RNP 4 Operational Authorisation* is shown in Appendix 2-A.

5.3 Contents of an application for an RNP 4 operational authorisation

5.3.1 Aircraft eligibility. Operators must provide documentation (e.g. the AFM) to establish that the aircraft is equipped with navigation equipment that satisfies the navigation accuracy requirements of RNP 4. Operational authorisation is based upon the equipment listed in the appropriate documents having been approved by the aviation authority of the State of Design. Additional details regarding aircraft eligibility are given in Section 6 below.

5.3.2 Operators must provide a list of the equipment and components that will be used for long-range navigation and RNP 4 operations. Installed equipment must be identical to that certified in the AFM and must be operational before entering RNP airspace, unless exceptions are listed in the Minimum Equipment List (MEL) for specific non-standard conditions.

5.3.3 Training documentation. AOC holders must submit training syllabi and training material (e.g. computer based training, simulator training) to CASA. This material must show that the operational practices, procedures and training items related to RNP 4 operations have been incorporated in the operator's training programs (e.g. initial, upgrade or recurrent training for flight crew, dispatchers or maintenance personnel). Practices and procedures in the following areas must be standardized:

(a) flight planning;

(b) pre-flight procedures at the aircraft for each flight;

(c) procedures before entry into an RNP 4 route or airspace;

(d) in-flight contingency procedures;

(e) flight crew qualification procedures.

5.3.4 Private operators must also ensure flight crew are trained and be able to demonstrate that they will operate using the practices and procedures described in Section 8.

5.3.5 Operations manuals and checklists. AOC holders must revise their operations manuals and checklists to include information/guidance on the standard operating procedures detailed in Section 8. Manuals must contain navigation system operating instructions and contingency procedures where specified (e.g. weather deviation procedures). AOC holders must include manuals and checklists in their RNP 4 application.

5.3.6 Private operators must create instructions on navigation operating instructions and contingency procedures. This information must be available to crews in flight and should be entered into either the Operations Manual or the Pilot Operating Handbook. These manuals and manufacturer's instructions for operation of the aircraft navigation equipment must be submitted for review as part of the application process.

5.3.7 Past performance. Operators must include a company 'operating history' in their application. The 'operating history' must address any incidents related to navigation errors (e.g. as reported in a CASA *Navigation Error Investigation Form*) that have been covered by new or revised training programs and procedures, maintenance done, or modifications made to the aircraft to address these incidents.

5.3.8 Minimum equipment list (MEL). For AOC holders, CASA must approve any MEL revisions necessary to address the RNP 4 requirements in the MOS Subpart 91.U Chapter 4. For private operations, installed navigation equipment (listed in the AFM as required for RNP 4 operations) must be operational.

5.3.9 Maintenance and continuing airworthiness. All operators/owners must include in their RNP 4 application their maintenance program, including a reliability program for monitoring the equipment. The holder of the design approval, including either the Type Certificate (TC) or STC for each individual navigation system installation, must give to CASA at least one set of complete instructions for continuing airworthiness.

5.4 Evaluation, investigation and cancellation

5.4.1 Review and evaluation of applications. After an operator submits an application, CASA will begin the process of review and evaluation to determine if the regulatory requirements have been met. If the contents of the application are not comprehensive, CASA will request additional information from the operator. When all the mandatory certification, airworthiness and operational requirements of the application have been met, an *RNP 4 Operational Authorisation* will be issued by CASA.

5.4.2 An example of the form of the authorisation is shown in Appendix 2-B. It will identify any conditions or limitations on operations in RNP 4 airspace or on an RNP 4 route (e.g. required navigation systems or procedures, routes or areas of operation).

5.4.3 Monitoring and investigation of navigation and system errors. Demonstrated navigation accuracy provides the basis for determining the lateral route spacing and separation minima. Air Traffic Control (ATC) facilities will make radar observations of each aircraft's proximity to track and altitude, before coming into coverage of short-range navaids at the end of the oceanic route segment. Automatic Dependant Surveillance (ADS) is also used for observing navigation errors.

5.4.4 CASR 91.5170 and MOS 91.U clause 4.2.4.4 require that navigation errors must be reported to CASA when the following parameters apply:

(a) lateral navigation errors of 15 NM or more;

(b) longitudinal navigation errors of 10 NM or more;

(c) longitudinal navigation 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

(d) navigation system failures.

5.4.5 If an observation indicates that the aircraft is not within the established limits, then ATS, the pilot in command or the operator must be submit a navigation error report to CASA. CASA will then undertake an investigation to determine the reason(s) for the apparent deviation from track or altitude, in order that steps may be taken to prevent a recurrence.

5.4.6 Cancellation of an RNP 4 operational authorisation. CASA may consider any navigation error reports in determining remedial action. Repeated navigation error occurrences attributed to a specific piece of navigation equipment or operational procedure may result in cancellation of the *RNP 4 Operational Authorisation* pending replacement or modifications on the navigation equipment or changes in the operator's operational procedures.

5.4.7 If repeated errors are detected, CASA may require the operator to modify training and maintenance programs, or specific equipment certification or even conduct remedial training of pilots or a licence review.

6. AIRCRAFT ELIGIBILITY GROUPS, TECHNICAL REQUIREMENTS AND EXPLANATION OF TERMS

6.1 Aircraft eligibility groups

6.1.1 Group 1: RNP certification. Group 1 aircraft are those with formal certification and approval of RNP integration in the aircraft. RNP compliance is documented in the AFM.

6.1.2 The certification will not necessarily be limited to a specific RNP type. The AFM must address the RNP levels that have been demonstrated and any related provisions applicable to their use (e.g. navaid sensor requirements). Operational authorisation is based upon the performance stated in the flight manual.

6.1.3 This method also applies in the case 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 area airspace.

6.1.4 Group 2: Prior navigation system certification. Group 2 aircraft are those that can equate their certified level of performance, given under previous standards, to RNP 4 criteria. Those standards listed below in sub-paragraphs (a) to (c) can be used to qualify aircraft under Group 2.

(a) *Global Navigation Satellite Systems (GNSS).* Aircraft fitted with GNSS as an approved primary long-range navigation system for oceanic and remote airspace operations must meet the technical requirements specified in Section 6.2. The AFM must indicate that dual GNSS equipment approved under an appropriate standard is required. Appropriate standards are FAA Technical Standard Orders (TSO) C129a or C146a, and JAA Joint Technical Standard Orders (JTSO) C129a or C146a. In addition, an approved dispatch Fault Detection and Exclusion (FDE) availability prediction program must be used. The maximum allowable time for which FDE capability is projected to be unavailable is 25 minutes. This maximum outage time must be included as a condition of the RNP 4 operational authorisation. If predictions indicate that the maximum allowable FDE outage will be exceeded the operation must be rescheduled to a time when FDE is available.

(b) *Multi-Sensor Systems Integrating GNSS with integrity provided by Receiver Autonomous Integrity Monitoring (RAIM).* Multi-sensor systems integrating GNSS with RAIM and FDE that are approved under FAA AC 20-130A, or other equivalent documents, meet the technical requirements specified in Section 6.2. Note: There is no requirement to use dispatch FDE availability prediction programs when multi-sensor systems are fitted and used.

(c) *Multi-sensor Systems Integrating GNSS with integrity provided by 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 must be certified in accordance with TSO C115b, JTSO C115b or other equivalent documents. An example of this is the use of an inertial navigation system or other navigation sensors as an integrity check on GNSS data when RAIM is unavailable but GNSS positioning information continues to be valid. In this case, the Inertial Navigation System (INS) or Inertial Reference Unit (IRU) must be approved in accordance with FAA Part 121 Appendix G.

Additional IRU airworthiness information can be found in Appendix 1 of FAA Order 8400.33.

6.1.5 Group 3: New technology. This group has been provided to cover new navigation systems that meet the technical requirements for operations in airspace where RNP 4 is specified.

6.2 Technical requirements

6.2.1 Navigation accuracy. Accuracy is defined relative to a geodesic path along a route or defined procedure. RNP 4 operations require that aircraft navigate with a cross-track TSE no greater than ±4 NM for 95 per cent of the total flight time. This includes Position Estimation Error (PEE), Flight Technical Error (FTE), Path Definition Error (PDE) and display system error (refer MOS Subpart 91.U Chapter 3). The aircraft along-track TSE must be no greater than ±4 NM for 95 per cent of the flight time.

6.2.2 GNSS monitor. The GNSS navigation system must detect satellite failures before they cause the aircraft to exceed the defined airspace limits. 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 the 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 HAL as follows: Oceanic (RNP 4): 4NM.

6.2.3 Required functionalities. The following are mandatory functionalities (refer MOS Subpart 91.U Chapter 4):

(a) display of navigation data;

(b) track to fix (TF);

(c) direct to fix (DF);

(d) direct -to function;

(e) course to fix (CF);

(f) parallel offset;

(g) fly-by transition criteria;

(h) user interface displays;

(i) flight planning path selection;

(j) flight planning fix sequencing;

(k) user defined course to fix;

(l) path steering;

(m) alerting requirements;

(n) navigation data base access;

(o) geodetic reference system.

6.2.4 Recommended functionalities. The following additional functionalities are recommended:

(a) display cross-track error on the control display unit (CDU);

(b) display present position in distance/bearing to selected waypoints;

(c) provide time to waypoints on the CDU;

(d) display along track distance to the next waypoint;

(e) display ground speed;

(f) indicate track angle;

(g) provide automatic navigation aids selection;

(h) manually inhibit a navaid facility;

(i) automatic selection and tuning of DME and/or VOR;

(j) estimate of position uncertainty;

(k) display current RNP level and type selection;

(l) capability to display flight plan discontinuity;

(m) display navigation sensor in use and display of degraded navigation.

6.2.5 Automatic radio position updating. This is the only method acceptable to CASA for the updating of an aircraft's position.

6.3 Explanation of terms

6.3.1 The ***display of navigation data*** must use either a lateral deviation display (see (a) below) **or** a navigation map display (see (b) below) that meets the following requirements:

(a) A non-numeric lateral deviation display (e.g. CDI, electronic horizontal situation indicator display ((E)HSI), with a To/From indication and a failure annunciation, for use as primary flight instruments for navigation of the aircraft, for maneuver anticipation, and for failure/status/integrity indication, with the following four attributes:

(i) it must be visible to the pilot and located in the primary view (+/- 15 degrees from the pilot's normal line of sight) when looking forward along the flight path;

(ii) lateral deviation scaling must agree with any alerting and annunciation limits, if implemented;

(iii) lateral deviation display must be automatically slaved to the RNAV computed path. The lateral deviation display also must have a full-scale deflection suitable for the current phase of flight and must be based on the required track-keeping accuracy. The course selector of the lateral deviation display should be automatically slewed to the RNAV computed path, or the pilot must adjust the CDI or HSI selected course to the computed desired track;

(iv) display scaling may be set automatically by default logic or set to a value obtained from the navigation database. The full-scale deflection value must be known or must be available to the pilot commensurate with en-route, terminal or approach phase values. NOTE: The normal function of stand-alone GNSS equipment meets this requirement.

(b) A navigation map display, readily visible to the pilot, with appropriate map scales (scaling may be set manually by the pilot), and giving equivalent functionality to a lateral deviation display.

6.3.2 Track to fix (TF). The 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.

6.3.3 Direct to fix (DF). The DF leg is a geodesic path starting near the area of initiation and terminating at a fix.

6.3.4 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.

6.3.5 Course to fix (CF). The 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.

6.3.6 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 NM, left or right of course. The system must be capable of offsets of at least 20 NM. 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. The parallel offset function must be available for en-route TF and geodesic portion of DF leg types.

6.3.7 Fly-by transition criteria. The 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 (PDE) 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 PDE. 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:

(a) course changes do not exceed 120 degrees for low altitude transitions (referred as when the aircraft barometric altitude is less than FL 195);

(b) course changes do not exceed 70 degrees for high altitude transitions (referred as when the aircraft barometric altitude is equal to or greater than FL 195).

6.3.8 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:

(a) minimizing reliance on flight crew memory for any system operating procedure or task;

(b) 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;

(c) use of context sensitive help capability and error messages (for example, invalid inputs or invalid data entry messages should provide a simple means to determine how to enter 'valid' data);

(d) fault tolerant data entry methods, rather than rigid rule based concepts;

(e) placing particular emphasis on the number of steps and minimizing the time required to accomplish flight plan modifications to accommodate ATC clearances, holding procedures, runway and instrument approach changes, missed approaches and diversions to alternate destinations; and

(f) minimizing the number of nuisance alerts so the flight crew will recognize and react appropriately when required.

6.3.9 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). There should be 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.

6.3.10 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 minimize pilot workload. Controls intended for use during flight must be designed to minimize 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.

6.3.11 Flight planning path selection. The navigation system must provide the capability for the crew to create, review and activate a flight plan. The system must provide the capability for modification (for example, 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(s) is/are activated. Activation of any flight plan modification must require positive action by the flight crew after input and verification by the flight crew.

6.3.12 Flight planning fix sequencing. The navigation system must provide the capability for automatic sequencing of fixes.

6.3.13 User-defined course to fix. The navigation 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.

6.3.14 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 TSE.

6.3.15 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.

6.3.16 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.

6.3.17 Geodetic reference system. WGS-84 or an equivalent earth reference model must be used as 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.

7. OPERATIONAL REQUIREMENTS

7.1 Navigation accuracy

7.1.1 For RNP 4 operations, an aircraft must have a cross-track and along-track Total System Error (TSE) of no greater than ±7.4km (4 NM) for 95 per cent of the flight time.

7.2 Navigation equipage

7.2.1 For RNP 4 operations in oceanic or remote airspace, at least two fully serviceable independent long-range navigation systems (LRNSs), with integrity such that the navigation system does not provide misleading information, must be fitted to the aircraft. These will form part of the basis upon which RNP 4 operational authorisation is granted.

7.2.2 For aircraft incorporating GNSS, FAA Advisory Circular (AC) 20-138A, or equivalent documents, provide an acceptable means of complying with installation requirements for aircraft that use but do not integrate the GNSS output with that of other sensors. FAA AC 20-130A describes an acceptable means of compliance for multi-sensor navigation systems that incorporate GNSS (see also paragraph 6.1.4 (b)).

7.2.3 The equipment configuration used to demonstrate the required accuracy must be identical to the configuration specified in the MEL or AFM.

7.2.4 The design of the installation must comply with the design standards that are applicable to the aircraft being modified. Changes to these must be reflected in the AFM prior to commencing operations requiring an RNP 4 operational authorisation.

7.3 Flight plan designation

7.3.1 Operators must indicate the ability to meet RNP 4 for the route or airspace in accordance with the *Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services* (PANS- ATM, Doc 4444), Appendix 2, which requires the insertion of 'R' in 'Item 10: Equipment', of the ICAO flight plan. Operators must also comply with any additional flight planning requirements specified in ICAO Regional Supplementary Procedures (Doc 7030) and State AIP.

7.3.2 Insertion of the letter 'R' indicates that the pilot has:

(a) reviewed the planned route of flight, including the route(s) to any alternate aerodromes, to identify the types of RNP involved;

(b) confirmed that the aircraft and the operator have been approved by CASA for RNP 4 operations; and

(c) confirmed that the aircraft can comply with all conditions of the authorisation for the planned route of flight, within airspace or on routes requiring RNP 4.

7.4 Availability of GNSS

7.4.1 Before the commencement of flight, the operator must ensure that the GNSS availability requirements on which the operator's RNP 4 operational authorisation is based, will be met for the full length of the flight.

7.5 Navigation database

7.5.1 The standards for navigation databases are contained in RTCA DO-200A and EUROCAE DO-76. Not all current suppliers of navigation databases meet these standards. The navigation database should be obtained from an approved supplier. If it isn't then 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 integrity checks must be performed in addition to any checks previously performed by the Aeronautical Information Services (AIS), by unapproved navigation database suppliers, or by 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.

8. TRAINING PROGRAMS AND OPERATING PRACTICES AND PROCEDURES

8.1 Introduction

8.1.1 The following items (8.2 through 8.5) should be standardized and incorporated into training programs, operating practices and procedures. Certain items may already be adequately standardized in existing operator programs and procedures. New technologies may also eliminate the need for certain crew actions. If this is found to be the case, then the intent of this material can be regarded as having been met.

Note: This guidance material has been written for a wide variety of operator types and therefore certain items may not apply to all operators.

8.2 Flight planning

8.2.1 During flight planning, the flight crew should pay particular attention to conditions that may affect RNP 4 operations. These include, but may not be limited to:

(a) verifying that the aircraft has been approved for RNP 4 operations;

(b) verifying that the letter 'R' has been inserted in 'Item 10: Equipment' of the ICAO flight plan;

(c) verifying that any additional flight planning requirements specified in ICAO Regional Supplementary Procedures (Doc 7030) or State AIP have been met;

(d) confirming that the requirements for GNSS, such as FDE, if appropriate for the operation; and

(e) if required for a specific navigation system, accounting for any operating restriction related to the RNP 4 authorisation.

8.3 Pre-flight procedures

8.3.1 The flight crew must:

(a) review maintenance logs and forms to ascertain the condition of the equipment required for RNP 4 operations;

(b) ensure that maintenance action has been taken to correct defects in the required equipment; and

(c) review the contingency procedures for RNP 4 operations. These are no different than normal oceanic contingency procedures with one exception: crews must be able to recognize (and ATC must be advised) when the aircraft is no longer able to navigate to its RNP 4 navigational capability.

8.4 En-route

8.4.1 At least two independent LRNSs, capable of navigating to RNP 4, and listed in the AFM, must be operational at the entry point where RNP operations will be conducted. If an item of equipment required for RNP 4 operations is unserviceable, then the pilot should consider an alternate routing, or diversion for repairs.

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

8.4.3 Crews must advise ATC of any deterioration or failure of the navigation equipment that causes navigation performance to fall below the required level, and/or any deviations required for a contingency procedure.

8.5 Flight crew knowledge

8.5.1 Operators/owners must ensure that flight crews have been trained and understand this AC, the limits of their aircraft's RNP 4 navigation capabilities, the effects of updating, and RNP 4 contingency procedures.

8.5.2 In determining whether training is adequate, CASA may:

(a) evaluate a training course before accepting a training centre certificate from a specific centre;

(b) accept a statement in the operator's/owner's application for an RNP 4 authorisation to the effect that the operator has ensured, and will continue to ensure, that flight crews know and understand the RNP 4 operating practices and procedures contained in this AC; or

(c) accept a statement by the operator that it has conducted, or will conduct, an RNP 4 training program utilizing the guidance contained in this AC.

Arthur White
Acting Group General Manager
Air Transport Operations Group

2 November 2005

APPENDIX 1

SOURCES OF ADDITIONAL INFORMATION

1. WEB SITES

- Federal Aviation Administration (FAA), United States
  - ◊ http://www.faa.gov/ats/ato/rnp.htm
  - ◊ http://www.faa.gov/ats/ato/ispacg.htm (see FANS Operations Manual)
- Civil Aviation Safety Authority (CASA), Australia
  - ◊ http://www.casa.gov.au/avreg/rules/1998casr/index.htm

2. RELATED PUBLICATIONS

- Federal Aviation Administration (FAA), United States
  - ◊ Code of Federal Regulations (CFR), Part 121, Appendix G
  - ◊ Advisory Circular (AC) 20-130A. Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors
  - ◊ 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 8400.33. Procedures for Obtaining Authorization for Required Navigation Performance 4 (RNP-4) Oceanic and Remote Area Operations
- International Civil Aviation Organization (ICAO)
  - ◊ *Annex 11 – Air Traffic Services*
  - ◊ *Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM)* (Doc 4444)
  - ◊ *Manual on Required Navigation Performance (RNP)* (Doc 9613-AN/937)
  - ◊ *Air Navigation Plan for CNS/ATM Systems (Doc 9750)*

    (Copies may be obtained from the Document Sales Unit, ICAO, 999 University St, Montreal, Quebec, Canada H3C 5H7)
- RTCA
  - ◊ Minimum Aviation System Performance Standards (MASPS): Required Navigation Performance for Area Navigation (DO 236B), RTCA
  - ◊ Minimum Operational Performance Standards (MOPS) for Required Navigation Performance for Area Navigation (DO 283A), RTCA
  - ◊ Standards for Processing Aeronautical Data (DO 200A), RTCA

    (Copies may be obtained from RTCA, Inc., 1828 L Street NW, Suite 805, Washington, DC 20036, United States.)

APPENDIX 2-A

SAMPLE LETTER OF REQUEST FOR 'RNP 4 OPERATIONAL AUTHORISATION'

File Reference

Team Leader Flying Operations
Civil Aviation Safety Authority
(Address)

Dear Sir

APPLICATION FOR RNP 4 OPERATIONAL AUTHORISATION

(Aircraft operator) requests that an *RNP 4 Operational Authorisation* be granted to enable it to conduct RNP 4 operations.

The following (aircraft operator) aircraft meet the requirements stated in MOS Subpart 91.U Chapter 4 and listed in AC 91U-3(0) for RNP 4 operations.

AIRCRAFT TYPE/SERIES	NAVIGATION EQUIPMENT
B747-400	List all nav equipment (e.g. VOR DME, VHF NAV, GPS, IRS, FMS, ADC etc) by name and type/manufacturer/model
B767-	As above
B737-	As above
F900C etc	As Above

Flight crews have been trained in accordance with the standards stated in MOS Subpart 91.U Chapter 4 and listed in AC 91U-3(0).

Yours sincerely

Signature
(Name)
(Appointment/Title)
(Date)

APPENDIX 2-B

SAMPLE 'RNP 4 OPERATIONAL AUTHORISATION'

OPERATIONS IN AIRSPACE WHERE REQUIRED NAVIGATION PERFORMANCE 4 (RNP 4) APPLIES

RNP 4 Operational Authorisation Number XXX/04

I, ……, Team Leader Flying Operations, ……...Airline/Area Office, am satisfied that the following operator, aircraft and navigation systems meet the requirements for RNP 4 operations, in accordance with CASR 91.U.4.

Operator: …….. (ACN …….)

Aircraft: …….. Serial Number …….

Registration: ……

NAVIGATION EQUIPMENT

TYPE	MFG.	Part No.	Model No.
FMS NCU (2)	Universal	1116-40-1110	UNS-1K
ADC (2)	Honeywell	7014700-920	AZ-850
VHF NAV (2)	Honeywell	066-01067-0004	KN-53

For and on behalf of the Civil Aviation Safety Authority

Name:
Position/Title:
Airline/Area Office:

Date: