



**Australian Government**  
**Civil Aviation Safety Authority**

I, WILLIAM BRUCE BYRON, Director of Aviation Safety, on behalf of CASA, make this instrument under regulation 91.5010 of the *Civil Aviation Safety Regulations 1998 (CASR 1998)*.

**[Signed Bruce Byron]**  
William Bruce Byron  
Director of Aviation and  
Chief Executive Officer

24 November 2005

**Manual of Standards Subpart 91.U Instrument 2005**

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**1 Name of instrument**

This instrument is the *Manual of Standards Subpart 91.U Instrument 2005*.

**2 Commencement**

This instrument commences on the day after it is registered on the Federal Register of Legislative Instruments.

**3 Manual of Standards Subpart 91.U**

For regulation 91.5010 of CASR 1998, the Manual of Standards (*MOS*), as set out in Schedule 1, is issued.

**Schedule 1 Manual of Standards Subpart 91.U**

**Chapter 1 Introduction**

**Section 1.1 General**

**1.1.1 Application**

1.1.1.1 Under CASR 91.5005, this instrument applies to the standards for the following navigation authorisations:

- (a) Reduced Vertical Separation Minimum (RVSM) airworthiness authorisation;
- (b) RVSM operational authorisation;

- (c) Required Navigation Performance 10 (RNP 10) operational authorisation;
- (d) Required Navigation Performance 4 (RNP 4) operational authorisation;
- (e) Basic Area Navigation (B-RNAV) operational authorisation;
- (f) Precision Area Navigation (P-RNAV) operational authorisation;
- (g) Minimum Navigation Performance Specification (MNPS) operational authorisation;
- (h) Australian Area Navigation (AUSEP) operational authorisation;
- (i) Navigation trial operational authorisations;
- (j) Area navigation (RNAV) operational authorisations.

### **1.1.2 Background**

1.1.2.1 CASA may issue navigation approvals to Australian operators under CASR Subpart 91.U, in the form of navigation authorisations, to enable operators to meet specific navigation requirements set by Australia and other States.

1.1.2.2 This MOS sets out the standards to be met for the issue of navigation authorisations.

1.1.2.3 The standards include:

- (a) equipment requirements; and
- (b) flight crew training requirements; and
- (c) continuing airworthiness; and
- (d) operating procedures; and
- (e) reporting of navigation or system errors.

### **1.1.3 Document set**

1.1.3.1 The relevant legislation and legislative instruments are:

- (a) the Act; and
- (b) the CASR; and
- (c) the MOS.

1.1.3.2 The Advisory Circulars (ACs) are also part of the relevant documents, but they are advisory rather than legislative.

1.1.3.3 The Act establishes CASA with functions relating to civil aviation, particularly the safety of civil aviation, and for related purposes.

1.1.3.4 The CASR establishes the regulatory framework (regulations) within which all service providers must operate.

1.1.3.5 This MOS is issued by CASA as uniformly applying specifications or standards necessary for the safety of air navigation. Where it would help to see the context of the standards, the relevant CASR regulations are mentioned.

1.1.3.6 This MOS is a legislative instrument. This means that it becomes effective on the day after it is registered in the Federal Register of Legislative Instruments. It

must be tabled in Parliament within 6 sitting days after it is registered and Parliament can disallow it or any of its provisions.

- 1.1.3.7 If there is any difference of intent or meaning between the MOS and the CASR, the CASR prevail.
- 1.1.3.8 Service providers and operators must document their own internal actions (rules) in operational manuals, to ensure that they maintain and comply with these standards.
- 1.1.3.9 ACs are intended to provide recommendations and guidance to illustrate a means, but not necessarily the only means, of complying with the CASR. ACs may explain regulatory requirements by providing interpretative and explanatory materials.
- 1.1.3.10 ACs that deal with the navigation authorisations issued under CASR Subpart 91.U also list the standards included in this MOS.

#### **1.1.4 Differences between ICAO and MOS standards**

- 1.1.4.1 If there is a difference between a standard prescribed in ICAO documents and the MOS, the MOS standard prevails.

#### **1.1.5 Differences published in AIP**

- 1.1.5.1 Differences in this MOS from ICAO Standards, Recommended Practices and Procedures are published in AIP Gen 1.7.

#### **1.1.6 MOS documentation change management**

- 1.1.6.1 The relevant technical area in the Air Transport Operations Group (*ATOG*) of CASA is responsible for the technical content in the MOS.
- 1.1.6.2 If you think that a change to the MOS is necessary, send your suggestions for change to the Group General Manager, ATOG.
- 1.1.6.3 Suggestions for changes to this MOS may come from:
  - (a) technical areas within CASA; or
  - (b) aviation industry service providers or operators; or
  - (c) individuals or authorisation holders.
- 1.1.6.4 The need to change standards in the MOS may arise for any of the following reasons:
  - (a) to ensure safety;
  - (b) to ensure standardisation;
  - (c) to respond to changed CASA standards;
  - (d) to respond to ICAO prescription;
  - (e) to accommodate new initiatives or technologies.

#### **1.1.7 Related documents**

- 1.1.7.1 These standards should be read in conjunction with the following:
  - (a) CASR Subpart 91.U;

- (b) CASR Part 11 — Regulatory Administrative Procedures;
- (c) AC 91.U-2(0) — Required Navigation Performance 10 (RNP 10) Operational Authorisation;
- (d) AC 91.U-3(0) — Required Navigation Performance 4 (RNP 4) Operational Authorisation;
- (e) Australia Aeronautical Information Publication (AIP);
- (f) Australia Aeronautical Information Publication (AIP) Supplement.

1.1.7.2 Other useful references include:

- (a) FAR 121.355 and Appendix;
- (b) FAA AC 25-15 — Approved Flight Management Systems in Transport Category Airplanes;
- (c) FAA AC 20-129 — Airworthiness Approval of Vertical Navigation (VNAV) Systems for use in the US National Airspace System (NAS) and Alaska;
- (d) FAA AC20-130A — Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors;
- (e) FAA AC20-138 — Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment;
- (f) FAA Order 8400.12A — Required Navigation Performance 10 (RNP-10) Operational Approval;
- (g) FAA Order 8400.33 — Procedures for Obtaining Authorization for Required Navigation Performance 4 (RNP4) Oceanic and Remote Area Operations;
- (h) FAA TSO-C115b — Airborne Area Navigation Equipment using Multi-sensor Inputs;
- (i) FAA TSO-C129a — Airborne Supplemental Equipment using the Global Positioning System (GPS);
- (j) FAA TSO-C146a — Airborne Navigation Sensors using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS);
- (k) JAA JTSOs C115b, C129a and C146a;
- (l) RTCA DO-236B — Minimum Aviation System Performance Standards (MASPS): Required Navigation Performance for Area Navigation;
- (m) RTCA DO-200A — Standards for Processing Aeronautical Data;
- (n) ICAO Annex 2 — Rules of the Air;
- (o) ICAO Annex 6 — Operations of Aircraft;
- (p) ICAO Annex 11 — Air Traffic Services;
- (q) ICAO Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM) — Doc 4444;

- (r) ICAO MID/ASIA/RAC and PAC/RAC Regional Supplementary Procedures — Doc 7030/4;
- (s) ICAO Manual on Airspace Planning Methodology for the Determination of Separation Minima — Doc 9689-AN/953;
- (t) ICAO Manual on the Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive - Doc 9574-AN/934;
- (u) ICAO Manual on Required Navigation Performance (RNP) Doc 9613-AN/937.

## Section 1.2 Definitions

1.2.1 In this MOS:

*AOC holder* means an operator that has an AOC.

*aviation authority* means an authority or organisation to which a State has delegated the legal responsibility for issuing navigation airworthiness and operational authorisations.

*CASR* means the *Civil Aviation Safety Regulations 1998*.

*operational authorisation* means a navigation authorisation granted to an Australian operator by CASA under CASR Subpart 91.U.

*private operator* means an Australian operator who does not hold an Australian AOC.

## Chapter 2 Reduced Vertical Separation Minimum (RVSM) (reserved)

## Chapter 3 Required Navigation Performance (RNP) 10

### Section 3.1 Overview

#### 3.1 Introduction

3.1.1.1 For separation by a minimum of 50 NM from other RNP 10 approved aircraft in oceanic or remote airspace, or to conduct flights in airspace where RNP 10 has been authorised, ICAO Annex 6 requires an operator to obtain RNP 10 operational authorisation from:

- (a) the operator's State of registry; or
- (b) the State of the operator.

#### 3.1.2 Applicability

3.1.2.1 Under CASR 91.005, the standards in this chapter apply to Australian operators of Australian or foreign registered civil aircraft, and flight crew, seeking authorisation to undertake RNP 10 operations.

3.1.2.2 Australian registered aircraft, when operating outside Australian territorial airspace (i.e. beyond the 12 NM territorial limit) must comply with:

- (a) when over the high seas — ICAO Annex 2; and

- (b) when operating within another State's airspace — the applicable regulations of that State.

### **3.1.3 Approval to undertake RNP 10 operations**

- 3.1.3.1 Under CASR Division 91.U.4, CASA may grant an approval in the form of an RNP 10 operational authorisation to an operator to undertake RNP 10 operations.

## **Section 3.2 Operational authorisation process**

### **3.2.1 General**

- 3.2.1.1 Under CASR 91.5155 (3), 91.5160 and 91.5170, the steps that must be completed before an operational authorisation is issued to an operator are:
  - (a) CASA reviews the existing certification of the aircraft navigation equipment and makes a determination that it is eligible for RNP 10 operational authorisation;
  - (b) the operator identifies the flight crew training and operating procedures for the navigation systems to be used for RNP 10 operations;
  - (c) CASA evaluates the operator's database use, flight crew training and operating procedures.

### **3.2.2 Contents of an operator's RNP 10 application**

- 3.2.2.1 Under CASR 91.5155 (3) and for CASR 91.5010, an application for RNP 10 operational authorisation must include the following information:
  - (a) aircraft airworthiness eligibility documents (eg AFM, AFM supplement) that establish that the aircraft is equipped with Long Range Navigation Systems (*LRNSs*) that meet the requirements of RNP 10;
  - (b) a description of aircraft equipment, including a configuration list that details components and equipment to be used for long-range navigation for the RNP 10 operations;
  - (c) a statement of the RNP 10 time limit for Inertial Navigation Systems (*INS*) or Inertial Reference Units (*IRU*) (if applicable) that has taken into account the effect of headwinds in the areas where RNP 10 operations will be conducted (see section 3.8) to determine the feasibility of the proposed operation;  
  
*Note* For an aircraft that is not capable of autopilot or flight director coupling, the FTE value to be taken into account in determining any limitations for oceanic or remote area operations is 2 NM — see 3.3.2.2.
  - (d) a description of operational training programs and operating practices and procedures, including:
    - (i) for an AOC holder — training syllabi, an example of 1 training program to show that the operational practices and procedures and training items related to RNP 10 operations mentioned in section 3.10 are incorporated in the relevant training programs (eg initial, upgrade, recurrent); and

- (ii) for a private operator — evidence that the operator will operate using the practices and procedures mentioned in section 3.10;
- (e) operations manuals and checklists that:
  - (i) for an AOC holder — shows any revisions made to the manuals and checklists to include standard operating procedures mentioned in section 3.10; and
  - (ii) for a private operator — shows revisions made to them to include navigation and operating instructions and contingency procedures;

*Note* The manuals, the aircraft navigation equipment and the manufacturer's checklist, as appropriate, form part of the package to be submitted as part of the application process.
- (f) an operating history that describes incidents related to navigation errors by the operator (eg as reported in a CASA Navigation Error Investigation Form) that are dealt with in the training, procedures, maintenance or aircraft or navigation modifications for the systems that are to be used;
- (g) a revised Minimum Equipment List (**MEL**) that addresses the standards listed in this MOS and approved by CASA;
 

*Note* If *approval* is based on Triple-Mix, the MEL must reflect that 3 navigation units are to be operating.
- (h) a maintenance program (if applicable) in accordance with sections 3.6 and 3.7.

### **3.2.3 Evaluation, investigation and cancellation**

- 3.2.3.1 Under CASR 91.5155 (3) and 91.5160, if an application is submitted, CASA may begin the following evaluation, investigation and cancellation process:
  - (a) an examination of each element mentioned in subsection 3.2.2; and
  - (b) a decision by CASA on whether or not the material presented can be approved (eg revisions to the MEL, operating history).
- 3.2.3.2 Under CASR 91.5160 (b), the RNP 10 operational authorisation may be issued subject to conditions or limitations on operations, eg time limits.
- 3.2.3.3 For CASR 91.5010, navigation accuracy must be determined by radar observations of an aircraft's proximity to track and altitude before:
  - (a) the aircraft comes into range of short range nav aids; and
  - (b) the pilot or operator reports provide the basis for determining the lateral route spacing and separation minima.
- 3.2.3.4 For CASR 91.5010 (e), the pilot in command must report navigation errors to CASA if there is:
  - (a) a lateral navigational error of at least 15 NM; or
  - (b) a longitudinal navigational error of at least 10 NM; or
  - (c) a longitudinal navigational error of at least 3 minutes variation between the aircraft's estimated time of arrival at a reporting point and its actual time of arrival; or
  - (d) a navigation system failure.

- 3.2.3.5 For CASR 91.5010 (e), the Navigation Error Investigation Form is the approved form for reporting a navigation error or an equipment failure.
- 3.2.3.6 For CASR 91.5010 (e), if a navigation error has occurred, CASA and the operator may determine the reasons for the apparent deviation from track or altitude and the steps to be taken to prevent a recurrence.
- 3.2.3.7 Under CASR 91.5015 (1), and for CASR 91.5010, CASA may cancel the RNP 10 operational authorisation if a repeated navigation error may be attributed to a specific piece of navigation equipment.
- 3.2.3.8 Under CASR 91.5015 (1), and for CASR 91.5010, CASA may cancel a flight crew member's licence if continued errors are being made after remedial action has been completed.

## **Section 3.3 RNP 10 requirements and definitions for CASR 91.5010**

### **3.3.1 Cross-track and along-track requirements**

- 3.3.1.1 An aircraft operating in RNP 10 airspace must have a maximum cross-track TSE of  $\pm 10$  NM for 95% of the flight time. This includes positioning error, FTE, PDE and display system error.
- 3.3.1.2 The maximum along-track TSE is  $\pm 10$  NM for 95% of the flight time.

*Note* For RNP 10 operational authorisation of aircraft capable of coupling the RNAV system to the flight director or autopilot, navigational positioning error is considered to be the dominant contributor to cross-track and along-track error. FTE, PDE and display system errors are considered to be insignificant for the purposes of authorisation.

### **3.3.2 Types of errors**

- 3.3.2.1 In this MOS:

***display system error*** includes any of the following:

- (a) error components contributed by any input, output or signal conversion equipment used by the display as it presents either position or guidance commands (eg course deviation or command heading);
- (b) errors in a course definition entry device;
- (c) errors in systems in which charts are incorporated as integral parts of the display.

*Note* 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 ground. To be consistent, for symbolic displays not using integral charts, any errors in waypoint definition, directly attributable to errors in the reference chart used in determining waypoint positions, are included as a component of this error.

***FTE*** (flight technical error):

- (a) means the accuracy with which an aircraft is controlled, measured by the indicated aircraft position in relation to the indicated command or desired position; and
- (b) does not include blunder or gross navigation errors (***GNEs***).



*NSE* (navigation system error) means the square root of the sum of the squares of the ground station error contribution, the airborne receiver error and the display system error.

*PDE* (path definition error) mean the difference between the defined path and the desired path at a specific point and time.

*PEE* (position estimation error) means the difference between true position and estimated position.

*TSE* means the total system error, worked out by:

$$\sqrt{(\text{NSE})^2 + (\text{FTE})^2}$$

- 3.3.2.2 For an aircraft that is not capable of autopilot or flight director coupling, the FTE value to be taken into account in determining any limitations for oceanic or remote area operations is 2 NM.

*Note* When using the method described in AC 91.U-2(0) Appendix 1 as the basis for RNP 10 approval, the error types noted in clause 3.3.1 are included. For the data collection method described in AC 91.U-2(0) Appendix 6, they are not included because the Appendix 6 method is more conservative. The Appendix 6 method uses radial error instead of cross-track and along-track error.

### 3.3.3 Navigation systems

- 3.3.3.1 For an RNP 10 operation in oceanic or remote airspace, there must be at least 2 independent and serviceable LRNSs, comprising INS, IRS/FMS or GNSS, that ensure the navigation system does not provide misleading information with an unacceptable probability.

## Section 3.4 Aircraft groups (fleets of aircraft) for CASR 91.5010

### 3.4.1 Definition of an aircraft group

- 3.4.1.1 For an aircraft to be considered as a member of an aircraft group for RNP 10 operations, the following conditions must be satisfied:

- (a) the aircraft must have been manufactured to a nominally identical design and approved by the same type certificate, type certificate amendment or supplemental type certificate;

*Note* For derivative aircraft, it may be possible to use the database from the parent configuration to minimise the amount of additional data required to show compliance. The extent of the additional data required will depend on the nature of the changes between the parent aircraft and the derivative aircraft when INS/IRU is used to meet RNP 10 navigational requirements.

- (b) the navigation system installed must have been manufactured to the manufacturer's specifications and have the same part numbers;

*Note* Aircraft that have INSs/IRUs that are of a different manufacturer or part number may be considered as part of the group, if it is demonstrated that this navigation equipment provides equivalent navigational performance.

- (c) if authorisation is sought for an aircraft group, the data package must contain:
- (i) a list of the aircraft group to which the data package applies; and

- (ii) a list of the routes to be flown and the maximum estimated time from alignment to the time when the flight will leave Class II Navigation; and

*Note* Class II navigation is an en route operation conducted outside the operational service volumes of ICAO standard NAVAIDS (VOR, NDB, VOR/NDB). Class I operations are those conducted within the operational service volumes of ICAO standard NAVAIDS.

- (iii) the compliance procedures to be used to ensure that all aircraft submitted for approval meet RNP 10 navigational capabilities for the RNP 10 approved time duration; and
- (iv) engineering data to be used to ensure continued in-service RNP 10 capability for the RNP 10 approved time duration.

### **3.4.2 Non-group aircraft**

- 3.4.2.1 A non-group aircraft is an aircraft for which an operator applies for authorisation on the basis of the characteristics of the unique airframe and the navigation system used rather than because the aircraft is a member of a group.
- 3.4.2.2 For a non-group aircraft, if airworthiness approval has been based on data collection, the continuing integrity and accuracy of the navigation system must be demonstrated by meeting the data collection requirement for group aircraft.

*Note* Data collected by 1 or more operators is acceptable as the basis for authorisation by another operator. An approved data collection procedure is described in AC 91.U-2(0) Appendix 6.

## **Section 3.5 Determination of aircraft equipment eligibility for CASR 91.5010**

### **3.5.1 Introduction**

- 3.5.1.1 The following groupings are different to the groupings described in section 3.4.
- 3.5.1.2 These eligibility groups are meant to assist in determining the approval method that may be used to approve specific aircraft and navigation systems.

*Note* Doppler systems are not approved for RNP 10 operations.

### **3.5.2 Aircraft eligibility through prior navigation system certification — Group 1 for CASR 91.5010**

- 3.5.2.1 Group 1 aircraft are those that have obtained formal certification and approval of RNP integration in the aircraft.
- 3.5.2.2 RNP compliance is documented in the AFM, and may not be limited to RNP 10. The AFM addresses RNP levels that have been demonstrated and any related provisions applicable to its use (eg navaid sensor requirements). Operational authorisation of Group 1 aircraft is based upon the performance stated in the AFM.
- 3.5.2.3 An airworthiness approval may specifically address RNP 10 performance. The approval includes approval of an appropriate AFM supplement containing the system limitations and referring to the manufacturer's operating procedures applicable to the equipment installed. The AFM supplement may be approved

under regulation 138 of the *Civil Aviation Regulations 1988 (CAR)* with a layout that follows the format for an approved flight manual.

*Note* It is proposed to replace CAR 138 with regulations in CASR Part 91.

### **3.5.3 Aircraft eligibility through prior navigation system certification — Group 2 for CASR 91.5010**

3.5.3.1 Group 2 aircraft are those that can equate their certified level of performance, under previous standards, to the RNP 10 criteria.

3.5.3.2 The standards in this subsection may be used to qualify an aircraft under Group 2.

#### **3.5.3.3 *Transport category aircraft equipped with dual FMSs and other equipment***

3.5.3.3.1 Aircraft having INSs or IRUs, radio navigation positioning updating and electronic map displays that qualify for the /E equipment suffix meet all of the RNP 10 requirements for up to 6.2 hours of flight time.

3.5.3.3.2 For 3.5.3.3.1, the flight time starts at the later of when the systems are placed in the navigation mode or the last time the systems are updated.

3.5.3.3.3 If systems are updated during en-route, the effect that the accuracy of the update has on the time limit must be included in the operator's application (see subclause 3.5.6).

*Note* The 6.2 hours of flight time is based on an inertial system with a 95% Radial Position Error Rate (circular error rate) of 2.0 NM/hr which is statistically equivalent to individual 95% cross-track and 95% along-track position error rates (orthogonal error rates) of 1.6015 NM/hr each, and 95% cross-track and 95% along-track position error limits of 10 NM each (eg  $10 \text{ NM} / 1.6015 \text{ NM/hr} = 6.2 \text{ hours}$ ).

3.5.3.3.4 The aircraft must have the following equipment:

- (a) dual FMSs that meet the specifications of:
  - (i) FAA AC 25-15 Approval of Flight Management Systems in Transport Category Airplanes, FAA AC 20-129 Airworthiness Approval of Vertical Navigation (VNAV) Systems for use in the US National Airspace System (NAS) and Alaska and FAA AC 20-130A Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors; or
  - (ii) equivalent criteria as approved by CASA;
- (b) a flight director and autopilot control system capable of following the lateral and vertical FMS flight path;
- (c) at least dual inertial reference units (*IRUs*);
- (d) a database, containing the waypoints and speed and altitude constraints for the route and procedure to be flown, that is automatically loaded into the FMS flight plan;
- (e) an electronic map.

*Note* These requirements are set out in the US Aeronautical Information Manual (*AIM*), Table 5-1-2, Aircraft Equipment Suffixes - Area Navigation Systems. Under the US system, these aircraft qualify for the /E suffix.

**3.5.3.4**      *Aircraft equipped with INSs or IRUs that have been approved under CFR Part 121*

- 3.5.3.4.1 INSs or IRUs approved under Appendix G of FAR Part 121 meet RNP 10 requirements for up to 6.2 hours of flight time.
- 3.5.3.4.2 For 3.5.3.4.1, the flight time starts at the later of when the system is placed in the navigation mode or the last time the systems are updated.
- 3.5.3.4.3 If systems are updated during en route, the effect that the accuracy of the update has on the time limit must be included in the operator's application (see subclause 3.5.6).
- 3.5.3.4.4 The requirements of FAR 121.355 and FAR Part 121 Appendix G for INS accuracy, reliability, flight crew training and maintenance, and any requirements associated with Class II navigation, apply to RNP 10 operational authorisation.

**3.5.3.5**      *Aircraft equipped with dual INSs or IRUs approved Minimum Navigation Performance Specification (MNPS) or approved for RNAV operations in Australia*

- 3.5.3.5.1 Aircraft equipped with dual INSs or IRUs approved to MNPS or approved for RNAV operations in Australia meet RNP 10 requirements for up to 6.2 hours after the system is placed in the navigation (*NAV*) mode or following an en-route update.
- 3.5.3.5.2 For 3.5.3.5.1, if systems are updated during en-route, the effect that the accuracy of the update has on the time limit must be included in the operator's application (see subclause 3.5.6).

**3.5.3.6**      *Aircraft equipped with a single INS or IRU and a single GPS approved for primary means navigation*

- 3.5.3.6.1 Aircraft equipped with a single INS or IRU and a single Global Positioning System (*GPS*), approved under FAR Part 121 Appendix G for primary means of navigation in oceanic and remote areas, meet the RNP 10 requirements without time limitations.
- 3.5.3.6.2 The minimum standard for a GPS receiver is TSO-C129a with an approved dispatch Fault Detection and Exclusion (*FDE*) availability prediction program.
- 3.5.3.6.3 RNP 10 operational authorisation is subject to the following conditions:
  - (a) the maximum allowable time for which the FDE capability is projected to be unavailable is 34 minutes;
  - (b) a statement that the particular INS or GPS installation meets the appropriate CASA requirements is in the AFM.

**3.5.3.7**      *Aircraft equipped with dual GPS approved for primary means of navigation*

- 3.5.3.7.1 Aircraft equipped with dual GPS approved for primary means of navigation in oceanic and remote areas under Appendix 1 of FAA AC20-138A meet the requirement for RNP without time limitations.

3.5.3.7.2 For 3.5.3.7.1, the minimum standard for the GPS receivers is dual TSO authorised equipment and an approved dispatch FDE availability prediction program for use with operations.

3.5.3.7.3 RNP 10 approval is subject to the following conditions:

- (a) the maximum allowable time for which the FDE capability is projected to be unavailable is 34 minutes;
- (b) a statement that the particular GPS installations meet the appropriate CASA requirements must be included in the AFM.

*Note* If predictions indicate that the maximum FDE outage time for the intended RNP 10 operation will be exceeded, RNP 10 operations are to be rescheduled when FDE is available, or RNP 10 predicated on an alternate means of navigation.

### **3.5.3.8 *Multi-sensor systems integrating GPS (with GPS integrity provided by Receiver Autonomous Integrity Monitoring (RAIM))***

3.5.3.8.1 Multi-sensor systems integrating GPS with RAIM and FDE that are approved using the guidance of FAA AC 20-130A Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors, or equivalent, meet RNP 10 requirements without time limitations.

*Note* FAR Part 121 Appendix G is the basis for the approval of INS or IRU.

## **3.5.4 Aircraft eligibility through data collection — Group 3 for CASR 91.5010**

3.5.4.1 Group 3 aircraft are those that use a data collection program to address the appropriate navigational accuracy requirements for RNP 10. The 2 main requirements of a data collection program are:

- (a) the applicant must demonstrate that the aircraft and the navigation system give the flight crew navigation situational awareness of the intended RNP 10 route: and
- (b) the applicant must demonstrate that the flight crew has a clear understanding of the status of the navigation system, and that failure indications and procedures are consistent with maintaining the required navigation performance.

3.5.4.2 There are 2 methods approved by CASA for data collection:

- (a) the sequential method — the operator collects data and plots it against the ‘Pass-Fail’ graphs to determine if the operator’s aircraft system will meet the RNP 10 requirements for the length of time needed by the operator; and

*Note* This data collection program meets the provisions of AC 91.U-2(0) Appendix 1.

- (b) the periodic method — a hand-held GPS receiver is used as a base line for collected INS data and data collected is analysed in accordance with the procedures set out in the AC to determine if the system is capable of maintaining RNP 10 for the length of time needed by the operator.

*Note* An approved process is described in AC 91.U-2(0) Appendix 6.

### **3.5.5 Obtaining authorisation for an extended time limit for INS or IRU systems**

3.5.5.1 The baseline RNP 10 time limit of 6.2 hours for INS and IRU systems after the system is placed in the navigation mode may be extended by 1 of the following methods:

- (a) integration of the RNP into the aircraft navigation system through a formal certification process (as described in subsection 3.5.2);
- (b) if INS or IRU has been approved using an existing approval standard (as detailed in 3.5.3.3, 3.5.3.4 and 3.5.3.5) — presentation of justifying data by an applicant;

*Note 1* Data collected by 1 or more operators may be used as the basis for a group approval.

*Note 2* An approved means of analysing the certification of IRU performance and amending the existing approval in aircraft documentation is described in AC 91.U-2(0) Appendix 2.

- (c) showing that the carriage of multiple navigation sensors, that mix or average navigation position error, justifies the extension (eg triple mixed INSs);

*Note 1* If a time limit based on mixing is used, the mixing capability must be operational at take-off for RNP 10 operations.

*Note 2* If the mixing or averaging function is not available at take-off, a time limit that does not depend on mixing must be used.

- (d) if INS or IRU has been approved using an existing approval standard — conducting a data collection program in accordance with AC 91.U-2(0) Appendices 1 or 6.

### **3.5.6 Effect of en-route updates**

3.5.6.1 An operator may extend RNP 10 navigation capability time by using updating.

3.5.6.2 The updating procedures are based upon the baseline for which they have been approved minus the following times:

- (a) automatic updating DME/DME — 0.3 hours (eg an aircraft that has been approved for 6.2 hours can gain 5.9 hours following an automatic DME/DME update);
- (b) automatic updating using DME/VOR — 0.5 hours;
- (c) manual updating using the approved methods described in AC 91.U-2(0) Appendix 7 or another method approved by CASA — 1 hour.

### **3.5.7 Conditions under which automatic radio position updating is acceptable for flight in airspace where RNP 10 is applied**

3.5.7.1 Automatic updating (i.e. that does not require flight crew to manually insert coordinates) is acceptable if:

- (a) the procedures for automatic updating are included in an operator's training program; and
- (b) the flight crews have knowledge of the updating procedures and of the effect of the update on the navigation solution; and

- (c) if it is to be used as the basis for an extended time limit — the data presented must give a clear indication of the accuracy of the update and the effect of the update on the navigation capabilities for the remainder of the flight.

### **3.5.8 Conditions under which manual radio position updating may be acceptable for flight in airspace where RNP 10 is applied**

3.5.8.1 Manual radio position updating may be acceptable for RNP 10 operations if:

- (a) the procedures for manual radio position updating are reviewed by CASA on a case-by-case basis; and

*Note* An approved procedure for manual updating is described in AC 91.U-2(0) Appendix 7 and may be used as the basis for an RNP 10 approval for an extended time when supported by acceptable data.

- (b) the operator shows that updating procedures and training contain measures and cross checking to prevent human factor errors; and
- (c) the operator provides data that establishes the accuracy with which the aircraft navigation system can be updated using manual procedures and representative navigation aids; and

*Note* The data to demonstrate update accuracy come from in-service operations and will be considered when establishing the RNP 10 time limit for INSs or IRUs (see subclause 3.5.6).

- (d) the flight crew qualification syllabus is found by CASA to provide effective pilot training.

## **Section 3.6 Minimum Equipment List (MEL) for CASR 91.5010 (a)**

### **3.6.1 Specific operational procedures and adjustments to the MEL**

3.6.1.1 If an RNP 10 operational authorisation is granted on the basis of a specific operational procedure (eg credit for triple-mix navigation systems), the MEL must be adjusted to reflect the basis of the approval and any required dispatch conditions.

## **Section 3.7 Continuing airworthiness (maintenance requirements) for CASR 91.5010 (c)**

### **3.7.1 Required documentation**

3.7.1.1 The holder of the design approval, including the type certificate or supplemental type certificate, for each individual navigation system installation must provide at least 1 set of complete instructions for continued airworthiness, in accordance with Section 1529 of Parts 23, 25, 27 and 29 of the FAR, for the maintenance requirements for operations conducted in accordance with this MOS.

## **Section 3.8 Operational requirements for CASR 91.5010 (d)**

### **3.8.1 Flight plan**

3.8.1.1 An operator is identified as authorised for RNP 10 operations by the letter 'R' written in Item 10 (Equipment) of the ICAO Flight Plan.

- 3.8.1.2 The method to be used to indicate the RNP type (***RNP 10***) is set out in the relevant State AIPs.
- 3.8.1.3 The use of the letter “R” indicates that the pilot has:
- (a) reviewed the planned route of flight, including any routes to alternate aerodromes, to identify the types of RNP involved; and
  - (b) confirmed that the operator and the aircraft have been authorised by CASA for RNP operations; and
  - (c) confirmed that the aircraft can be operated in accordance with the RNP requirements for the planned route of flight, including any routes to alternate aerodromes.

### **3.8.2 Availability of nav aids**

- 3.8.2.1 At dispatch or during the flight planning phase, adequate navigation aids must be available en-route to enable the aircraft to navigate to RNP 10.

### **3.8.3 Route evaluation for RNP 10 time limits for aircraft equipped with only INSs or IRUs**

- 3.8.3.1 An RNP 10 time limit applies to aircraft equipped only with INSs or IRUs (see subclause 3.5.6).
- 3.8.3.2 An operator who plans operations in areas where RNP 10 is applied must ensure that it is able to meet the time limitation.
- 3.8.3.3 For 3.8.3.2, the operator must take into account the effect of headwinds and, for aircraft not capable of coupling the navigation system or flight director to the autopilot, FTE.
- 3.8.3.4 A route may be evaluated:
- (a) once only; or
  - (b) for each flight.
- 3.8.3.5 In carrying out the evaluation, the operator must consider the following:
- (a) a route evaluation that establishes the aircraft’s capability to satisfy the RNP 10 time limit established for dispatch or departure into airspace where RNP 10 is applied;
  - (b) the start point for calculation, being the point where the system is placed in the navigation mode or the last point at which the system is expected to be updated;
  - (c) the stop point for calculation, being:
    - (i) the point where the aircraft will begin to navigate by reference to ICAO Standard Nav aids (VOR, DME, NDB) or will come under radar surveillance from ATC; or
    - (ii) the first point where the navigation system is expected to be updated;
  - (d) the following sources of wind component data:
    - (i) the Bureau of Meteorology;
    - (ii) National Weather Service;



(iii) Bracknell;

(v) industry sources, eg Boeing Winds on World Air Routes and historical data supplied by the operator;

(e) a one-time calculation based on 75% probability wind components;

*Note* Some sources of wind data establish the probability of experiencing a given wind component on routes between city pairs annually.

(f) a calculation of time limit for each specific flight.

*Note* The operator may choose to evaluate each individual flight using flight planned winds to determine if the aircraft will comply with the specified time limit.

3.8.3.6 If a one-time calculation of RNP 10 time limit compliance is chosen, the annual 75% probability level to calculate the effect of headwinds can be used.

3.8.3.7 If it is determined that the time limit will be exceeded, the aircraft must fly an alternate route or delay the flight until the time limit can be met.

*Note* This evaluation is a flight planning or dispatch task.

## **Section 3.9 Certification actions related to RNP 10 for CASR 91.5010**

### **3.9.1 Improved performance**

3.9.1.1 Aircraft navigation performance may be certified to a new standard to take advantage of the aircraft capability.

3.9.1.2 Improved navigation performance demonstrated through operational data collection does not require the aircraft to be re-certified.

3.9.1.3 For aircraft with INS certified under the US CFR Part 121, Appendix G, additional certification is only necessary for an operator who chooses to certify INS accuracy to better than 2 NM per hour radial error. However, the application to CASA for additional certification must:

(a) address all standards associated with maintaining the required accuracy and training programs, including accuracy and reliability, acceptance test procedures and maintenance procedures; and

(b) identify the standard against which INS performance is to be demonstrated.

*Note* This standard may be a regulatory (i.e. CFR Part 121, Appendix G), industry or applicant unique specification. An amendment to the AFM identifies the accuracy standard used for certification (see paragraph 3.5.2.3).

3.9.1.4 FAA AC 20-138A also provides an acceptable means of complying with installation requirements for an aircraft that uses GPS but does not integrate it with other sensors.

3.9.1.5 FAA AC 20-130A describes an acceptable means of compliance for multi-sensor navigation systems that incorporate GPS.

3.9.1.6 An operator who intends to use GPS as the only navigation system (eg no INS or IRS) for RNP 10 operations must comply with Australian and other State requirements, other than specific GPS requirements mentioned in this MOS.

### **3.9.2 Equipment configuration — MEL**

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

### **3.9.3 Equipment configuration — accuracy**

- 3.9.3.1 The equipment configuration used to demonstrate the required accuracy must be supportable in RNP 10 oceanic and remote airspace.
- 3.9.3.2 For example, the statistical benefit of estimating position using INS position data filtered with DME data will not be considered by CASA as part of its review of the application for RNP 10 operational authorisation.

### **3.9.4 Equipment installation — regulations**

- 3.9.4.1 The design of the installation must comply with the design standards that apply to the aircraft being modified.
- 3.9.4.2 The installation in an Australian registered aircraft must be performed in accordance with the applicable regulations.

## **Section 3.10 Training programs, operating practices and procedures for CASR 91.5010**

### **3.10.1 Introduction**

- 3.10.1.1 Standardised RNP 10 training programs and operating practices and procedures must be incorporated into existing operator programs and procedures.
- 3.10.1.2 This section sets out items that the programs, practices and procedures must cover.
- 3.10.1.3 Some items may already be covered adequately in existing operator programs and procedures.
- 3.10.1.4 If a new technology eliminates the need for a crew action that this MOS would otherwise require, the MOS may be taken to be complied with in relation to that action.

### **3.10.2 Flight planning**

- 3.10.2.1 During flight planning, flight crew must pay particular attention to conditions that may affect RNP 10 operations, including:
- (a) verifying that the aircraft is authorised for RNP 10 operations; and
  - (b) verifying that the RNP 10 time limit has been accounted for; and
  - (c) verifying that the ICAO Flight Plan has been correctly annotated (see subclause 3.8.1); and
  - (d) confirming the requirements for GPS, 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 10 operational authorisation.

### **3.10.3 Pre-flight procedures**

3.10.3.1 The flight crew must:

- (a) review the maintenance logs and forms to ascertain the condition of equipment required for RNP 10 operations, and clear that maintenance action has been taken to correct defects to required equipment; and
- (b) during the external inspection of aircraft, if possible, check the condition of the navigation antennae and the fuselage skin in their vicinity (this check may be done by a qualified and authorised person other than the pilot, eg a flight engineer or a maintenance person); and
- (c) ensure that they can recognise when the aircraft is no longer capable of navigating in accordance with its RNP 10 approval requirements.

### **3.10.4 En-route**

3.10.4.1 En-route flight crew must:

- (a) check that at least 2 long range navigation systems capable of navigating to RNP 10 are operating normally at entry to the airspace where RNP 10 operations are to be conducted; and
- (b) check the aircraft's position as accurately as possible by using external nav aids before entering oceanic or remote airspace; and

*Note* This may require DME/DME and DME/VOR checks to determine navigation system errors through displayed and actual positions.

- (c) conduct in-flight operating drills and crosschecking procedures to identify navigation errors in sufficient time to prevent aircraft from deviating inadvertently from ATC cleared routes; and
- (d) tell ATC of any deterioration or failure of the navigation equipment below the navigation performance requirements or of any deviations required for a contingency procedure.

### **3.10.5 Flight crew knowledge**

3.10.5.1 An AOC holder must ensure that flight crew members have been trained and have appropriate knowledge of:

- (a) this MOS; and
- (b) the limits of their RNP 10 navigation capabilities; and
- (c) the effects of updating navigation systems; and
- (d) RNP 10 contingency procedures.

3.10.5.2 A private operator must show CASA that the operator's pilots have appropriate knowledge of RNP 10 operations.

## **Chapter 4 Required Navigation Performance 4 (RNP 4)**

### **Section 4.1 Overview**

#### **4.1.1 Background**

- 4.1.1.1 ICAO Annex 6 — Operation of Aircraft requires 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 Applicability**

- 4.1.2.1 Under CASR 91.005, the standards in this chapter apply to Australian operators of Australian or foreign registered civil aircraft, and flight crew, seeking approval to undertake RNP 4 operations.
- 4.1.2.2 Australian registered aircraft, when operating outside Australian territorial airspace (i.e. beyond the 12 NM territorial limit), must comply with:
- (a) when over the high seas — ICAO Annex 2; or
  - (b) when operating within another State's airspace — the applicable regulations of that State.

#### **4.1.3 Approval to undertake RNP 4 operations**

- 4.2.3.1 Under CASR Division 91.U.4, CASA may grant an approval in the form of an RNP 4 operational authorisation to an operator to undertake RNP 4 operations.

### **Section 4.2 Operational authorisation process**

#### **4.2.1 General**

- 4.2.1.1 Under CASR 91.5155 (3), 91.5160 and 91.5170, the steps that must be completed before an RNP 4 operational authorisation is issued to an operator are:
- (a) CASA reviews the existing certification of the aircraft navigation equipment and makes a determination that it is eligible for RNP 4 operational authorisation;
  - (b) the operator identifies the flight crew training and operating procedures for the navigation systems to be used for RNP 4 operations;
  - (c) CASA evaluates the operator's database use, flight crew training and operating procedures.

#### **4.2.2 Limitations**

- 4.2.2.1 For CASR 91.5010, authorisation for RNP 4 operations is only given for an aircraft that has received airworthiness certification indicating that the installed navigation systems meet the performance requirements for RNP 4.

- 4.2.2.2 The authorisation may have been issued at the time of manufacture or if the aircraft has been retrofitted in order to meet the requirements for RNP 4, by the granting of an appropriate supplemental type certificate.
- 4.2.2.3 For CASR 91.5010, authorisation may be given only for aircraft for which the certification of RNP 4 navigation capability (see section 4.3) is based on the use of GNSS or equivalent systems as stand-alone navigation systems or as 1 of the navigation inputs to a multi-sensor system.
- 4.2.2.4 There is no navigation time limit for RNP 4 operations.

### **4.2.3 Contents of application for RNP 4 operational authorisation**

4.2.3.1 Under CASR 91.5155 (3) and for CASR 91.5010, an application for an RNP 4 operational authorisation must include the following information:

- (a) aircraft airworthiness eligibility documents (eg the flight manual and the flight manual supplement) that establish that the aircraft is equipped with Long Range Navigation Systems (*LRNSs*) that meet the requirements of RNP 4;
- (b) a description of aircraft equipment and components, including a configuration list that details the components and equipment that the operator will use for long-range navigation and RNP 4 operations;

*Note* The installed equipment must be identical to that certified in the flight manual and operational authorisation before entering RNP 4 airspace other than exceptions listed in the MEL for specific non-standard conditions.

- (c) a description of operational training programs and operating practices and procedures that:
  - (i) for an AOC holder — includes training syllabi and material to show that the operational practices and procedures and training items related to RNP 4 operations are incorporated in the relevant training programs (eg initial, upgrade, recurrent training for flight crew, dispatchers or maintenance personnel); and

*Note* The practices and procedures to be covered are detailed in section 4.5.

- (ii) for a private operator — includes evidence that the operator accepts responsibility for training flight crew and demonstrates the operator will operate using the practices and procedures identified in section 4.5;
- (d) operations manuals and checklists that:
  - (i) for an AOC holder — show any revisions made to the operations manual and checklists to include standard operating procedures detailed in section 4.5 and navigation system operating instructions and contingency procedures; and
  - (ii) for a private operator — shows revisions to the operations manual or pilot operating handbook, as appropriate, and includes navigation operating instructions and contingency procedures;

*Note* These manuals and the aircraft navigation equipment manufacturer's checklist, as appropriate, form part of the package to be submitted as part of the application process.

- (e) an operating history that addresses any events or incidents related to navigation errors for the operator (eg as reported in a CASA Navigation Error Investigation Form) that have been covered by training, procedures, maintenance or the aircraft navigation system modifications that are to be used;
- (f) a revised MEL or flight manual that addresses the standards listed in this MOS and approved by CASA;
- (g) a description of the maintenance program that includes a reliability program for monitoring equipment.

*Note* The holder of the design approval, including the type certificate or supplementary type certificate for each individual navigation system installed, must submit a complete set of instructions for continuing airworthiness.

#### **4.2.4 Evaluation, investigation and cancellation**

- 4.2.4.1 Under CASR 91.5155 (3) and 91.5160, if an application is submitted, CASA may begin the following evaluation, investigation and cancellation process:
  - (a) an examination of each element mentioned in clause 4.2.3; and
  - (b) a decision on whether or not the material presented can be approved (eg revisions to the MEL, operating history).
- 4.2.4.2 Under CASR 91.5160 (b), the RNP 4 operational authorisation may be issued subject to conditions or limitations on operations.
- 4.2.4.3 For CASR 91.5010, navigation accuracy must be determined by:
  - (a) radar observations of an aircraft's proximity to track and altitude before the aircraft comes into range of short range nav aids; and
  - (b) pilot or operator reports that provide the basis for determining the lateral route spacing and separation minima; and
  - (c) Automatic Dependant Surveillance — Contract (**ADS-C**) observations.
- 4.2.4.4 For CASR 91.5010 (e), the pilot in command must report navigation errors to CASA if there is:
  - (a) a lateral navigational error of at least 15 NM; or
  - (b) a longitudinal navigational error of at least 10 NM; or
  - (c) a longitudinal navigational error of at least 3 minutes variation between the aircraft's estimated time of arrival at a reporting point and its actual time of arrival; or
  - (d) a navigation system failure.
- 4.2.4.5 For CASR 91.5010 (e), the Navigation Error Investigation Form is the approved form for reporting navigation errors and equipment failures.
- 4.2.4.6 For CASR 91.5010 (e), if a navigation error has occurred, CASA and the operator may determine the reasons for the apparent deviation from track or altitude and the steps to be taken to prevent a recurrence.
- 4.2.4.7 Under CASR 91.5015 (1), and for CASR 91.5010, CASA may cancel an RNP 4 operational authorisation if a repeated navigation error may be attributed to a specific piece of navigation equipment.

- 4.2.4.8 Under CASR 91.5015 (1), and for CASR 91.5010, CASA may cancel a flight crew member's license if continued errors are being made after remedial action has been completed.

## **Section 4.3 Aircraft eligibility groups, technical requirements and explanation of terms for CASR 91.5010**

### **4.3.1 Aircraft eligibility groups**

4.3.1.1 Group 1 aircraft have the following characteristics:

- (a) the aircraft have obtained formal certification and approval of RNP integration in the aircraft;
- (b) RNP compliance is documented in the flight manual and may not be limited to a single RNP type;
- (b) the flight manual addresses the RNP levels that have been demonstrated and any related provisions applicable to their use (eg navaid sensor requirements);
- (c) operational approval is based on the performance stated in the flight manual;
- (d) a supplementary type certificate may be 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.

4.3.1.2 Group 2 aircraft are those that can equate their certified level of performance, given under previous standards, to RNP 4 criteria.

4.3.1.3 Group 2 aircraft include aircraft fitted with:

- (a) Global Navigation Satellite Systems (**GNSS**) as an approved long-range navigation system for oceanic and remote airspace operations that meet the technical requirements mentioned in clause 4.3.2, if:
  - (i) the AFM states that the dual GNSS equipment is approved under FAA Technical Standard Orders (**TSO**) C129a or C146a, or JAA Joint Technical Standard Orders (**JTSO**) C129a or C146a; and
  - (ii) there is an approved dispatch fault detection and exclusion (**FDE**) availability prediction program; and
  - (iii) the maximum allowable time for which FDE capability is projected to be unavailable is 25 minutes; and
  - (iv) if predictions indicate that the maximum allowable FDE outage will be exceeded, a rescheduling of the operation is required for a time when FDE is available; or
- (b) multi sensor systems integrating GNSS with integrity provided by RAIM, and multi-sensor systems integrating GNSS with RAIM and FDE, that are approved under FAA AC 20-130A or other equivalent documents; or
- (c) multi sensor systems integrating GNSS:
  - (i) with integrity provided by Aircraft Autonomous Integrity Monitoring (**AAIM**) that uses the redundancy of position estimates from multiple

sensors, including GNSS, to provide integrity performance that is at least equivalent to RAIM; and

- (ii) if certified in accordance with TSO C-115b, JTSO C-115b or other equivalent documents (eg the use of an inertial navigation system (*INS*) or other navigation sensors as an integrity check on GNSS data when RAIM is unavailable but GNSS positioning information continues to be valid; and
- (iii) for which the INS or inertial reference unit (*IRU*) is approved in accordance with FAA Part 21 Appendix G).

#### **4.3.2 Technical requirements**

4.3.2.1 Navigation accuracy has the following characteristics:

- (a) it is defined relative to a geodesic path along a route or defined procedure;
- (b) for RNP 4 operations, the maximum cross-track TSE, including PEE, FTE, PDE and display system error, is  $\pm 4$  NM for 95% of the total flight time;
- (c) the maximum along-track TSE is  $\pm 4$  NM for 95% of the flight time.

4.3.2.2 GNSS monitoring has the following requirements:

- (a) a GNSS navigation system must detect satellite failures before they cause the aircraft to exceed the defined airspace limits;
- (b) this applies to all navigational uses of GNSS and is derived from overall effect of a GNSS failure;
- (c) the standard for the probability of missed detection of satellite failures must be not more than 1 in 1000;
- (d) for these failures of the navigation solution (or the horizontal alert limit (*HAL*)), the effective monitor limit must take into account:
  - (i) other normal errors that may exist during the satellite fault; and
  - (ii) the latency of the alert; and
  - (iii) the crew reaction time to an alert; and
  - (iv) the aircraft response;
- (e) A HAL of 4 NM may be used to monitor GNSS failure for oceanic RNP 4 operations.

4.3.2.3 The following are mandatory functionalities:

- (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.

4.3.2.4 The following additional functionalities are recommended:

- (a) display cross-track error on the CDU;
- (b) display present position in distance or 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 or VOR, or both;
- (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.

4.3.2.5 Automatic radio position updating is the only method acceptable for the update of an aircraft's position.

### 4.3.3 Explanation of terms and standards

4.3.3.1 The *display of navigation data* must use a lateral deviation display or a navigation map display.

4.3.3.2 A non-numeric lateral deviation display (eg course deviation indicator (**CDI**)), electronic horizontal-situation indicator (**(E)HSI**) with a To/From indication and a failure annunciation, for use as primary instruments for the navigation of aircraft, for manoeuvre anticipation and for failure or status or integrity indication, must:

- (a) be visible to the pilot and located in the primary field of view ( $\pm 15^\circ$  from the pilot's normal line of sight) when looking forward along the flight path; and
- (b) if implemented, have lateral scaling that agrees with any alerting and annunciation limits; and

- (c) either:
  - (i) be automatically slaved to the RNAV computed path, have a full-scale deflection suitable for the current phase of flight and be based on the required track-keeping accuracy; or
  - (ii) allow the pilot to change the CDI or HSI selected course to the computed desired track; and
- (d) have display scaling:
  - (i) that is set automatically by default logic or set to a value obtained from the navigation database; and
  - (ii) for which the full-scale deflection is known or available for display to the pilot and commensurate with the en-route, terminal or approach phase of flight values.

4.3.3.3 A navigation map display must:

- (a) be readily visible to the pilot; and
- (b) have appropriate map scales (scaling may be set manually by the pilot); and
- (c) give equivalent functionality to a lateral deviation display.

4.3.3.4 The **track to fix (TF)** leg is a geodesic path between 2 fixes:

- (a) the first fix is the previous leg termination or an IF leg; and
- (b) the termination fix is normally provided by the navigation database, but may also be a user-defined fix.

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

4.3.3.6 The **Direct-To** function must:

- (a) be able to be activated by the crew at any time; and
- (b) be available to any fix; and
- (c) be capable of generating a geodesic path to the designated To fix; and
- (d) enable the aircraft to capture this path without S-turning or undue delay.

4.3.3.7 The **course to fix (CF)** leg is a geodesic path terminating at a fix with a specified course at that fix.

4.3.3.8 The inbound course at the termination fix and the fix are provided by the navigation database.

4.3.3.9 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.

4.3.3.10 The system requirements for a **parallel offset** are:

- (a) the capability to fly parallel tracks at a selected offset distance; and
- (b) when executing a parallel offset, the RNP type and all performance requirements of the original route in the active flight plan are applicable to the offset route; and

- (c) provision for entry of offset distances in increments of 1 NM, left or right of course; and
- (d) capability for offsets of at least 20 NM; and
- (e) a clear indication to the flight crew that the system offset mode is in use; and
- (f) when in offset mode, the provision of reference parameters (eg cross-track deviation, distance-to-go, time-to-go) relative to the offset path and offset reference points; and
- (g) prevention of an offset being propagated through route discontinuities, unreasonable path geometries or beyond the initial approach fix; and
- (h) the flight crew must be given an annunciation before the end of the offset path, with sufficient time to return to the original path; and
- (i) when a parallel offset is activated, the offset must remain active for all flight plan route segments until removed automatically, the flight crew enters a Direct-To routing or manually cancelled by the flight crew; and
- (j) the parallel offset function must be available for en-route TF and geodesic portion of DF leg types.

4.3.3.11 The ***fly-by transition*** criteria are:

- (a) no predictable and repeatable path is specified, because the optimum path varies with airspeed and bank angle; and
- (b) predictable and repeatable boundaries of the transition area are defined; and
- (c) if the path lies within the transition area, there is no PDE; and
- (d) a fly-by transition is the default transition when the transition type is not specified; and
- (e) the theoretical transition area requirements are applicable for the following assumptions:
  - (i) course changes do not exceed 120° for low altitude transitions (when the aircraft barometric altitude is less than FL 195); and
  - (ii) course changes do not exceed 70° for high altitude transitions (when the aircraft barometric altitude is at least FL 195).

4.3.3.12 A ***user interface display*** must provide for the presentation of information and situational awareness and be designed and implemented to accommodate human factors considerations.

4.3.3.13 The following matters must be considered in user interface display design:

- (a) minimising reliance on flight crew memory for any system operating procedure or task;
- (b) developing a clear and unambiguous display of system modes or 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 (eg 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 ATS clearances, holding procedures, runway and instrument approach changes, missed approaches and diversions to alternate destinations;
  - (f) minimizing the number of nuisance alerts so the flight crew will recognise and react appropriately when required.
- 4.3.3.14 Each display element that is used as a primary flight instrument in the guidance and control of the aircraft, for manoeuvre anticipation, or for failure or status or integrity annunciation must:
- (a) 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; and
  - (b) be readable under normal cockpit conditions and expected ambient light conditions; and
  - (c) under night lighting conditions — be compatible with other cockpit lighting; and
  - (d) be arranged to facilitate flight crew accessibility and usage; and
  - (e) if controls are normally adjusted in flight — be readily accessible with standardised labelling as to their function; and
  - (f) be designed to maximise operational suitability and minimise pilot workload; and
  - (g) if intended for use during flight — be designed to minimise errors; and
  - (h) if operated in all possible combinations and sequences — result in a condition whose presence or continuation would not be detrimental to the continued performance of the system; and
  - (i) be arranged to provide adequate protection against inadvertent system shutdown.
- 4.3.3.15 For ***flight planning path selection***, the navigation system must provide:
- (a) the capability for the crew to create, review and activate a flight plan; and
  - (b) the capability for modification (eg deletion and addition of fixes and creation of along-track fixes), review and user acceptance of changes to the flight plans; and
  - (c) if the capability mentioned in paragraph (b) is exercised, that guidance outputs are not affected until modifications are activated; and
  - (d) activation of any flight plan modification that require positive action by the flight crew after input and verification by the flight crew.
- 4.3.3.16 The navigation system must provide the capability for ***automatic sequencing of fixes***.
- 4.3.3.17 The navigation system must provide the capability to define a ***user-defined course to a fix*** and the pilot must be able to intercept the user-defined course.
- 4.3.3.18 The requirements for ***path steering*** are:

- (a) the system must provide data to enable the generation of command signals for autopilot, flight director or CDI, as applicable; and
- (b) in all cases a Path Steering Error (*PSE*) must be defined at the time of certification, and must meet the requirements of the desired RNP operation in combination with the other system errors; and
- (c) during the certification process, crews must demonstrate their ability to operate the aircraft within the specified PSE; and
- (d) aircraft type, operating envelope, displays, autopilot performance, and leg transitioning guidance (specifically between arc legs) must be accounted for in the demonstration of PSE compliance; and
- (e) a measured value of PSE may be used to monitor system compliance to RNP requirements. For operation on all leg types, this value is the distance to the defined path; and
- (f) when assessing cross-track containment compliance, any inaccuracies in the cross-track error computation (for example, resolution) must be included in the Total System Error (TSE) calculation.

4.3.3.19 The navigation system must provide the following *alerting functions*:

- (a) 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;
- (b) the reinstatement of this annunciation with any subsequent reduction of the RNP type;
- (c) if approaching RNP airspace from non-RNP airspace — alerting must be enabled when the cross-track to the desired path is not more than half the RNP value and the aircraft has passed the first fix in the RNP airspace.

4.3.3.20 The *navigation database* must:

- (a) provide access to navigation information in support of the navigation systems reference and flight planning features; and
- (b) not be able to be manually modified; and

*Note* This requirement does not preclude the storage of user defined data within the equipment.

- (c) allow for data to be recalled from storage and also retain those data in storage; and
- (d) provide a means of identifying the navigation database version and valid operating period.

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

## **Section 4.4 Operational requirements for CASR 91.5010**

### **4.4.1 Navigation equipage**

4.4.1.1 The minimum navigation equipage for RNP 4 operations in oceanic or remote airspace is 2 fully serviceable independent LRNSs, with integrity such that the navigation system does not provide misleading information.

4.4.1.2 For aircraft incorporating GNSS, FAA Advisory Circular AC 20-138 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.

*Note* FAA AC 20-130A describes an acceptable means of compliance for multi-sensor navigation systems that incorporate GNSS.

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

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

### **4.4.2 Flight plan designation**

4.4.2.1 The method of indicating that an operator is approved to undertake RNP 4 operations is to have the letter 'R' written in Item 10 (Equipment) of the ICAO flight plan.

4.4.2.2 The method to be used to indicate the RNP type (**RNP 4**) is set out in the relevant State AIPs.

4.4.2.3 The insertion of the letter "R" indicates that the pilot has:

- (a) reviewed the planned route of flight, including the routes to any alternate aerodromes, to identify the types of RNP involved; and
- (b) confirmed that the aircraft and the operator have been authorised by CASA for RNP 4 operations; and
- (c) confirmed that the aircraft can comply with all conditions of the approval for the planned route of flight, within airspace or on routes requiring RNP 4.

### **4.4.3 Availability of GNSS**

4.4.3.1 Before the commencement of a flight, the operator must ensure that the GNSS availability requirements, on which the operator's approval is based, will be met for the whole of the flight.

### **4.4.4 Navigation database**

4.4.4.1 The standards for navigation databases are set out in RTCA document DO-200A and EUROCAE document DO-76.

4.4.4.2 An operator who uses a navigation database supplier that does not meet these standards must implement navigation database integrity checks using appropriate software tools or approved manual procedures to verify data relating

to all waypoints in RNP 4 airspace or routes. These checks are in addition to any checks performed by the Aeronautical Information Services, unapproved navigation database suppliers or navigation equipment manufacturers.

- 4.4.4.3 The integrity checks must identify any discrepancies between the navigation database and the published charts and procedures.
- 4.4.4.4 If an approved third party performs integrity checks:
  - (a) discrepancies that invalidate a procedure must be reported to the navigation database supplier; and
  - (b) affected procedures must be prohibited by an operator's notice to its flight crew.

## **Section 4.5 Training programs and operating practices and procedures for CASR 91.5010**

### **4.5.1 Introduction**

- 4.5.1.1 Standardised RNP 4 training programs and operating practices and procedures must be incorporated into existing operator programs and procedures.
- 4.5.1.2 This section sets out items that the programs, practices and procedures must cover.
- 4.5.1.3 Some items may already be covered adequately in existing operator programs and procedures.
- 4.5.1.4 If a new technology eliminates the need for a crew action that this MOS would otherwise require, the MOS may be taken to be complied with in relation to that action.

### **4.5.2 Flight planning**

- 4.5.2.1 During flight planning, flight crew must pay particular attention to conditions that may affect RNP 4 operations, including:
  - (a) verifying that the aircraft is authorised for RNP 4 operations; and
  - (b) verifying that the ICAO Flight Plan has been correctly annotated (see clause 4.4.2); and
  - (c) verifying that any additional flight planning requirements specified in ICAO Regional Supplementary Procedures (Doc 7030) or State AIP have been met; and
  - (d) confirming the requirements for GNSS, such as FDE, for the operation; and
  - (e) if required for a specific navigation system, accounting for any operating restriction related to the RNP 4 operational authorisation.

### **4.5.3 Pre-flight procedures**

- 4.5.3.1 The flight crew must:
  - (a) review maintenance logs and forms to ascertain the condition of equipment required for RNP 4 operations, and clear that maintenance action has been taken to correct defects to required equipment; and

- (b) review contingency procedures for RNP 4 operations; and
- (c) be able to recognise when the aircraft is no longer capable of navigating in accordance with its RNP 4 operational authorisation.

#### **4.5.4 En-route**

4.5.4.1 En-route flight crew must:

- (a) check that at least 2 independent long-range navigation systems capable of navigating to RNP 4 are operating normally at entry to the airspace where RNP 4 operations are to be conducted; and
- (b) conduct in-flight operating drills and crosschecking procedures to identify navigation errors in sufficient time to prevent aircraft from deviating inadvertently from ATC cleared routes; and
- (c) tell ATC of any deterioration or failure of the navigation equipment below the navigation performance requirements or of any deviations required for a contingency procedure.

#### **4.5.5 Flight crew knowledge**

4.5.5.1 An AOC holder must ensure that flight crew members have been trained and have knowledge of:

- (a) this MOS; and
- (b) the limits of their RNP 4 navigation capabilities; and
- (c) the effects of updating navigation systems; and
- (d) RNP 10 contingency procedures.

4.5.5.2 A private operator must provide evidence to CASA that the operator's pilots have appropriate knowledge of RNP 4 operations.

### **Chapter 5 Basic Area Navigation (B-RNAV) (reserved)**

### **Chapter 6 Precision Area Navigation (P-RNAV) (reserved)**

### **Chapter 7 Minimum Navigation Performance Specification (MNPS) (reserved)**

### **Chapter 8 Australian RNAV Approval (AUSEP) (reserved)**

### **Chapter 9 Navigation Trials (reserved)**

### **Chapter 10 Area Navigation (RNAV) (reserved)**