CIVIL AVIATION AUTHORITY OF FIJI

STANDARDS DOCUMENT

RNAV (GNSS) Approaches

SD-RNAV (GNSS)

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Civil Aviation Authority of Fiji
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PREFACE

General

Fiji's National Aviation Law consists of a three tier or triple system regulatory system, comprising Acts, Regulations and Standards Documents; the purpose of which is to ensure, where deemed appropriate, compliance and conformance with ICAO Standards and Recommended Practices (SARPS).

The 'three tier' or 'triple system' regulatory system represents Fiji's Primary Legislation System and Specific Operating Regulations to meet Critical Elements CE1 and CE2 of ICAO's Eight Critical Element of a safety oversight system.

Standards Documents (SD) are issued by the Civil Aviation Authority of Fiji under the provision of Section 14 (3) (b) of the Civil Aviation Authority Act 1979 (CAP 174A)

Where appropriate, the SD also contains technical guidance (Critical Element CE5) on standards, practices, and procedures that are acceptable to the Authority.

Notwithstanding the above, and where specifically indicated in this Standards Document that such a provision is available, consideration may be given to other methods of compliance that may be presented to the Authority provided they have compensating factors that can demonstrate a level of safety equivalent to or better than those prescribed herein. Accordingly, the Authority will consider each case based on its own merits holistically in the context of and relevancy of the alternative methods to the individual applicant.

When new standards, practices, or procedures are determined to be acceptable, they will be added to this document.

Purpose

This Standards Document RNAV GNSS APPROACHES is issued by the Civil Aviation Authority of Fiji pursuant to Regulation 118 – (1) of the Air Navigation Regulations 1981 (as amended). The Document is intended for Operators and Pilots who are intending to carry out RNAV (GNSS) approaches. It has been developed regarding the operator's obligation to comply with standards notified by the Authority and is the means by which such notification is given.

Change Notice

This Standards Document has been developed pursuant to the Authority's obligation to provide oversight on certified operators and their personnel, as well as the operator's obligation to comply with standards notified by the Authority and is the means by which such notification is given.

THERESA LEVESTAM
CHIEF EXECUTIVE

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1 INTRODUCTION

a. The International Civil Aviation Organisation (ICAO) has adopted “Global Navigation Satellite Systems” (GNSS) as a generic term to identify all satellite navigation systems where the user performs on-board position determination from satellite information.

b. GNSS is an Area Navigation (RNAV) system substantially different in design philosophy from the conventional azimuthal systems like NDB, VOR, and Localizer. GNSS measures distance differently to DME or TACAN and is also quite different from inertial RNAV systems in terms of initialisation, updating and accuracy. As such, GNSS introduces new variables to the navigation problem. The potential for human error is real and the complexity of aviation operations provides the potential for even small errors to cause serious occurrences. For pilots transitioning from IFR flying using conventional ground based navigation to an RNAV environment the display of distance to the next waypoint, cross track error measured in distance rather than degrees and absence of slant range, scalloping and other errors mean that some rule of thumb and situational awareness techniques cannot be applied.

c. The keys to the safe use of GNSS in aviation operations are:

(i) Sound theoretical knowledge;
(ii) Operational proficiency with equipment;
(iii) Awareness of vulnerabilities of the system and human operator, and;
(iv) Standardisation of systems and procedures wherever possible.

2 APPLICATION

a. This Standards Document applies to the conduct of RNAV (GNSS) approaches using the flight procedures designed in accordance with International Civil Aviation Organization design rules (ICAO Document 8168, commonly referred to as PANS-OPS). Under PANS- OPS, RNAV (GNSS) procedures may be flown by RNP 0.30 (multi-sensor) capable aircraft [RNP 0.30 being the maximum estimated deviation from the aircraft’s track when using its Flight Management System (FMS)].

b. With the advent of multi sensor Flight Management Computer (FMC) navigation and the ability to code glide-paths into FMC databases for instrument approaches, it is now possible to conduct NPAs using the auto flight system modes of LNAV and VNAV. In this case, both the pitch and roll axis of an aircraft are controlled by signals received from the FMC. This serves to cross the boundaries of our conventional definitions, thus Boeing has adopted the new definitions of ILS and non-ILS approaches.

c. A non-ILS approach is defined as an RNAV approach, VOR approach, NDB approach, LOC approach or GPS or DME arrival. RNAV approaches are further broken down into RNAV (GNSS) approaches and RNAV (RNP) approaches. In the past, RNAV (GNSS) approaches were called GPS approaches.

d. This document also includes procedures for stand alone GPS receivers meeting the requirements of TSO C-129 A1 or equivalent.

e. This Standards Document should be read in conjunction with AIC 03/04 and any subsequent replacement for that AIC.

3 DEFINITIONS

AFM means the aircraft flight manual

ANP means actual navigation performance

Approved navigation database means a navigation database on a medium approved by the manufacturer of the aircraft as suitable for use with the aircraft.

FMC means flight management computer.

FMS means the aircraft's flight management system

GNSS means the Global Navigation Satellite System, a satellite navigation system used by a pilot on board an aircraft to determine position from satellite data.

GPS means the United States Government satellite navigation system known as the Global Positioning System.

Method of control means autopilot or flight director **MCDU** means multi function cockpit display unit **NPA** means non-precision approach

NPS means navigation performance scales

RNAV (GNSS) approach means an area navigation system, fitted to an aircraft, for which the AFM for the aircraft states that it is capable of meeting RNP 0.3 requirements.

RNP means required navigation performance

XTK error means the cross-track difference between the indicated position of the aircraft and the planned position, as displayed to the flight crew by the FMS.

4 CERTIFICATION

Navigation system integrity.

a. For the purpose of IFR navigation, general aviation GPS receivers must meet the requirements of FAA TSO C129, C145, C146 or later versions of these standards. These TSOs require that an integrity monitoring system known as Receiver Autonomous Integrity Monitoring (RAIM) be incorporated into the receiver. Where a satellite signal is suspect, the RAIM warning advises the crew that the receiver has detected a problem with a satellite signal after comparing it with other satellite signals.

b. For multi sensor RNAV systems such as the Smiths Industries FMC as installed in the B737 NG, the system must meet the requirements of specific FAA Advisory Circulars regarding flight management systems that use multiple sensors for navigation purposes. The multiple sensor navigation systems have no RAIM warning like that used in a TSO approved GPS system, but the Smiths FMC does incorporate RAIM algorithms and other navigation accuracy warning systems.

5 INSTRUMENT RATING ENDORSMENTS

The Pilot in Command (PIC) shall ensure that an aircraft does not carry out an RNAV (GNSS) approach unless that type of approach is endorsed in the Instrument Rating of the active operating pilot flight crew members. Refer to the Standards Document – *Flight Crew Licensing* for endorsement requirements.

6 RECENCY REQUIRMENTS

a. The holder of a command instrument rating must not carry out an RNAV (GNSS) approach as pilot in command (PIC) unless in the preceding six months the holder has carried out an RNAV (GNSS) approach using a system that is the same (stand alone or multi-sensor FMC) as that fitted in the aircraft.

b. Prior to conducting an RNAV (GNSS) approach in IMC the PIC must have carried out not less than 3 RNAV (GNSS) approaches in flight or in a synthetic trainer using the same (stand alone or multi-sensor FMC) type of equipment.

7 OPERATING PROCEDURES

a. Standard Operating Procedures (SOPs) detailing the conduct of the RNAV (GNSS) approach shall be included in the Company Operations Manual.

b. The SOPs for the conduct of an RNAV (GNSS) approach should be generally consistent with the procedures used for other non ILS approaches.

8 INSTRUCTIONS FOR FMS (MULTI SENSOR) EQUIPPED AIRCRAFT

a. Use of RNP capability for RNAV (GNSS) approaches

The auto pilot is normally used for the approach.

The flight crew of an aircraft operating under the Instrument Flight Rules (I.F.R.) may use an RNP- capable RNAV system in accordance with these instructions as a non-precision approach I.F.R. navigation aid for a published RNAV (GNSS) approach procedure, including a related missed approach procedure.

b. Operating Requirements

(i) The AFM must contain a statement that the aircraft is capable of meeting the requirements for RNP 0.3.

(ii) The aircraft must be operated in accordance with the manufacturer's instructions.

(iii) RNAV must not be used to satisfy any of the requirements for alternate aerodrome planning.

(iv) RNAV must not be used as a navigation reference for flight below the LSALT/MSA, except in accordance with a published RNAV (GNSS) procedure.

c. Procedures

(i) Before commencing the approach, the PIC must ensure that:-

(a) at least 1 of the aircraft's GPS receivers is operational;
(b) the RNAV (GNSS) approach is loaded from the current approved navigation database, and;
(c) RNP 0.3 is displayed or selected in the FMS.

(ii) At all times during the approach, the PIC must ensure that:-

(a) the approach is flown using a method of control that, in accordance with the AFM, permits RNP 0.3 operations to be conducted;
(b) the approach is flown in accordance with the current approved navigation database setting out that approach;
(c) an approved method is used to monitor cross track (XTK) error, and;

(d) at least 1 pilot monitors the XTK error.

(iii) A pilot who is carrying out a RNAV (GNSS) non-precision approach procedure in IMC and has passed the initial approach fix but has not arrived at the final approach fix must carry out a missed approach procedure if:

(a) the navigation of the aircraft exceeds the manufacturer's stated limits for the RNP 0.3 capability;
(b) an alert is displayed indicating that the navigation system cannot meet the manufacturer's stated limits for the RNP 0.3 capability;
(c) a XTK error alert is annunciated, or;
(d) the manufacturer does not provide a means of XTK error alerting – the XTK error is 0.2NM or more;
(e) Loss of LNAV or VNAV;
(f) ANP exceeds RNP, MCDU message VERIFY POSITION or FMC DISAGREE, or;
(g) Unable to maintain the lateral NPS limit inside the initial or intermediate approach waypoints.

d. **VNAV path assessment**

(i) For a planned approach, the flight crew may use a vertical navigation path that is derived from the FMS ***(VNAV path)*** only if the PIC has assessed the VNAV path as suitable for the approach.

(ii) The VNAV path is suitable for the approach if:-

(a) it is at or above the path identified in the published chart for the approach, and;
(b) the flight crew do not have to intervene by selecting an alternative mode of flight to the VNAV path.

(iii) Despite the assessment of the VNAV path as suitable, the flight crew must observe vertical limitations in the published chart.

(iv) The flight crew may alter the speed of the aircraft if it does not affect the VNAV path.

9 INSTRUCTIONS FOR NON-FMS RAIM EQUIPPED AIRCRAFT

Use of RAIM TSO C-129 A1 or equivalent navigation systems

The flight crew of an aircraft operating under the Instrument Flight Rules (I.F.R.) may use an approved TSO C-129 A1 or equivalent RNAV system in accordance with these instructions as a non-precision approach I.F.R. navigation aid for a published RNAV (GNSS) approach procedure, including a related missed approach procedure.

RAIM Prediction

Flight crew who are operating aircraft with stand alone GPS receivers with RAIM incorporated may choose to review the predicted GPS accuracy for the route and/ or the destination around the estimated time of arrival. This is called GPS RAIM Prediction and maybe obtained from the Airservices Australia internet briefing service. This prediction is based on the geometry of the satellites (in their known orbits) and serves to inform the crew of the risk of a RAIM warning being received during the approach.

a **Operating Requirements**

(i) A RNAV (GNSS) NPA may not be conducted unless that instrument approach procedure can be retrieved from the current approved navigation data base.

(ii) The aircraft must be operated in accordance with the manufacturer's instructions.

(iii) RNAV must not be used to satisfy any of the requirements for alternate aerodrome planning.

(iv) RNAV must not be used as a navigation reference for flight below the LSALT/MSA, except in accordance with a published RNAV (GNSS) procedure.

b **Procedures**

(i) A pilot who is carrying out a RNAV (GNSS) non-precision approach procedure in IMC and has passed the initial approach fix but has not arrived at the final approach fix, must carry out a missed approach procedure if there is:

(a) A RAIM warning or other reason to doubt the validity of GPS derived information, or;
(b) RAIM loss.

(ii) If there is reason to doubt the validity of GPS arrival derived information, the PIC must adopt procedures for a loss of GPS as a navigation aid,

(iii) If a RAIM warning or RAIM loss ends before the pilot commences a missed approach procedure, GPS derived information may be used during the missed approach.

c **VNAV path assessment**

(i) For a planned approach, the flight crew may use a vertical navigation path that is derived from the FMS ***(VNAV path)*** only if the PIC has assessed the VNAV path as suitable for the approach.

(ii) The VNAV path is suitable for the approach if:-

(a) it is at or above the path identified in the published chart for the approach, and;
(b) the flight crew do not have to intervene by selecting an alternative mode of flight to the VNAV path.

(iii) Despite the assessment of the VNAV path as suitable, the flight crew must observe vertical limitations in the published chart.

(iv) The flight crew may alter the speed of the aircraft if it does not affect the VNAV path. d **Navigation aid and procedure tolerances**

(i) +/- ½ scale deflection at each waypoint passage and on final approach, descent must not be started unless established within this tolerance; GNSS approach mode must be activated during final approach, and;

(ii) Descent below LSALT or limiting altitude for a step – not before the distance specified in the arrival procedure for commencement of descent to the next step, and;

(ii) DME or GNSS arc +/- 2 nautical miles.

9. RECOMMENDED GNSS TRAINING SYLLABUS

This chapter provides a suggested syllabus for GNSS ground training. It is intended to cover the mandatory syllabus for IFR training applicable to the en-route navigation approvals. Part A comprises modules common to both IFR and VFR pilots; Part B applies only to IFR operations.

The training must cover general information and procedures applicable to all types of GNSS equipment, as well as the essential operating procedures for a specific type of aircraft equipment. Pilots who have completed the training and who wish to use a different type of GPS aircraft equipment must ensure that they are familiar with and competent in the operating procedures required for that type of equipment, before using it in operations. Pilots are reminded of the need to have suitable type-specific recency for GPS approach operations.

PART A - EN-ROUTE NAVIGATION USING GNSS

System Components and Principles of Operation

Demonstrate an understanding of the GPS system and its principles of operations:

- GPS system components, space, control and user
- Aircraft equipment requirements
- GPS satellite signal and pseudo random code
- Principle of position fixing
- Geocentric altitude
- Method of minimizing receiver clock error
- Minimum satellites required for navigation functions
- Masking function
- Performance limitations of various equipment types
- GNSS use of the WGS84 coordinate system

Navigation System Performance Requirements

Define the following terms in relation to a navigational system and recall to what extent the GPS system meets the associated requirements:

- Accuracy
- Integrity:
  - Means of providing GNSS integrity
  - RAIM, procedural, systems integration
- Availability
- Continuity

Authorisation and Documentation

- Recall the requirements applicable to pilots and equipment for operations using GNSS.
- Pilot training requirements
- Logbook certification
- Ratings and Endorsements
- Aircraft equipment requirements
- GNSS NOTAMs

Errors and Limitations

Recall the cause and magnitude of typical errors:

- Ephemeris
- Clock
- Receiver
- Atmospheric/Ionospheric
- Multipath
- SA
- Typical Total error
- Effect of PDOP/GDOP on position accuracy
- Susceptibility to interference
- Comparison of vertical and horizontal errors
- Tracking accuracy and collision avoidance

Human Factors and GNSS

Be aware of the human factors limitations associated with the use of GNSS equipment. Apply GNSS operating procedures which provide safeguards against navigational errors and loss of situational awareness because of the following:

- Mode errors
- Data entry errors
- Data validation and checking including independent cross checking procedures
- Automation induced complacency
- Non-standardization of the human-machine interface
- Human information processing and situational awareness

Equipment-specific Navigation Procedures

Recall and apply knowledge of appropriate operating procedures to typical navigational tasks using a specific type of GNSS aircraft equipment, including:

- Select appropriate operational modes
- Recall categories of information contained in the navigational database
- Predict RAIM availability
- Enter and check user defied waypoints
- Enter/retrieve and check flight plan data
- Interpret typical GNSS navigational displays Lat/Long, distance and bearing to waypoint, CDI, HSI, ND
- Intercept and maintain GNSS defined tracks
- Determine TMG, GS, ETA, time and distance to WPT, WV in flight
- Indications of waypoint passage
- Use of direct to function
- Use of nearest airport function

GNSS Equipment Checks

For the specific type of aircraft equipment, carry out the following GNSS operational and serviceability checks at appropriate times:

- Loss of RAIM
- 2D navigation
- In Dead Reckoning mode
- Database out of date
- Database missing
- GPS fail
- Barometric input fail
- Power/battery fail
- Parallel offset on
- Satellite fail

PART B – GNSS APPROACH AND ARRIVAL PROCEDURES

1. Human Factors in GPS Arrival and GPS NPA Operations

(i) Syllabus requirements

(a) Criteria to be met by application:

- Be able to describe how the following factors may adversely affect the conduct of a GPS approach and describe suitable pilot procedures to minimize such effects:

  - Data imput
  - Functions selection logic
  - Automation effects
  - Fixation
  - Mode awareness
  - Alert modes
  - The control loop
  - Situational awareness

(ii) Competence to be shown

(a) Applicant to demonstrate:

- Knowledge of operating procedures for GPS equipment that eliminate, as far as possible, errors due to any of the factors specified.
- Methods of RAIM Prediction

(iii) Syllabus requirements

(a) Criteria to be satisfied by applicant:

- Know the parameters applicable to RAIM warnings in the en-route, terminal and approach modes.
- Know the effect of availability or otherwise of baro-aiding on RAIM availability and prediction
- Be able to predict RAIM availability at destination and ETA using:

- aircraft GPS receiver;
- if available, an external RAIM prediction service

- Know the effect of satellite unserviceability on the reliability of each type of prediction
- Know the effect of each type of RAIM prediction on operational requirements

(iv) Competence to be shown

(a) Applicant to demonstrate:

- The ability to accurately predict, within a period of 1 hour before departure, the availability of approach RAIM at the destination or alternate aerodrome within ± 15 minutes of ETA
- Knowledge of any limitations which apply to the prediction.

2. GPS Arrival Operational Requirements

(i) Syllabus requirements

(a) Criteria to be met by applicant:

- Know the appropriate alternate requirements and operational procedures that apply to the conduct of a GPS arrival
- State the indications requiring a missed approach to be initiated.

(ii) Competence to be shown

(a) Applicant to demonstrate:

- The ability, in a given operational situation and using a specific type of GNSS aircraft equipment, to correctly apply the operational requirements which apply to alternate aerodrome provision, GPS reference points, azimuthal tracking and RAIM availability for GPS arrival procedures.
- GPS NPA Operational Modes

(iii) Syllabus requirements

(a) Criteria to be met by applicant:

- Know the conditions and actions that allow the GPS receiver to function in the appropriate mode for the successful conduct of a GPS NPA. Know the parameters applicable to tracking tolerances, automatic waypoint sequencing, CDI sensitivity and RAIM availability in each of the following segments:

  - entry
  - RAIM available
  - initial approach
  - intermediate approach
  - final approach
  - missed approach
  - state the indications requiring a missed approach to be initiated

(iv) Competence to be shown

(a) Applicant to demonstrate:

- The ability to correctly state the mode of operation required during each segment of a GPS NPA, the conditions required to transition to and operate in that mode, and the associated CDI sensitivity and RAIM protection provided. GPS NPA Operational Requirements.

(v) Syllabus requirements

(a) Criteria to be met by applicant:

- Know the operational requirements which apply to planning a flight on the basis of conducting a GPS NPA at destination.

(vi) Competence to be shown

(a) Applicant to demonstrate:

- The ability, in a given operational situation, to correctly state the alternate and/or holding requirements which apply at a destination served by a GPS NPA procedure.