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CIVIL AVIATION AUTHORITY OF VANUATU

RNAV (GNSS) APPROACHES

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b. Rule References

- ICAO DOC 9613 , PBN Manual.
- ICAO ANNEX 8 , Airworthiness of Aircraft
- ICAO ANNEX 6 , Operation of Aircraft and PAN – OPS (DOC 8168) –Volume 1

c. Rules affected

- Nil

d. Amendments

- Nil

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:

- Sound theoretical knowledge;
- Operational proficiency with equipment;
- Awareness of vulnerabilities of the system and human operator, and;
- Standardisation of systems and procedures wherever possible.

d. The purpose of this document is to detail the current Authority policy relating to the use of GPS in the Vanuatu Domestic Airspace.

e. This Document is produced on the Directives of the Director of Civil Aviation Authority of Vanuatu under the Civil Aviation Act Consolidated Edition 2021 Section 30.

2. APPLICATION

a. This 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 PANSOPS, 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 approved stand alone GPS receivers meeting the requirements of TSO C-129 A1 equivalent or higher.

E. This Document should be read in conjunction with CAANZ AC 61-17 Appendix III.

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
- **Primary-Means Navigation System –** A navigation system approved for a given operation or phase of flight that must meet accuracy and integrity requirements, but need not meet full availability and continuity of service requirements. Safety is achieved by limiting flights to specific time periods, and through appropriate procedural restrictions.

- **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
- **Sole-Means Navigation System** – A sole means navigation system for a given phase of flight must enable the aircraft to meet, for that phase of flight, all four navigation system performance requirements: accuracy, integrity, availability, and continuity of service. ADF, VOR, DME and INS are approved sole means navigation systems.

- **Supplemental-Means Navigation System** – A navigation system that must be used in conjunction with a sole means navigation system.
  Approval for supplemental-means for a given phase of flight requires that a sole-means navigation system for that phase of flight must be on board and available.
  Amongst the navigation system performance for a given phase of flight, a supplemental-means navigation system must meet the same accuracy and integrity requirements as a sole-means system; there is no requirement for a supplemental-means navigation system to meet availability and continuity requirements.
  Operationally, while accuracy and integrity requirements are being met, a supplemental-means system can be used without any crosscheck against the sole-means system.
  Any navigation system approved for supplemental-means could involve one (stand-alone installation) or several sensors, possibly of different types (multi sensor installation).
  GPS may be used as a supplemental means en-route IFR navigation aid to provide navigation information for that part of the flight which is outside the rated coverage of conventional navigation aids and to which Dead Reckoning (DR) navigation techniques would otherwise be applied.
- **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.

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4. CERTIFICATION / AIRWORTHINESS

a. Navigation system integrity

- For the purpose of IFR navigation, general aviation GPS receivers must meet the requirements of FAA TSO C129 Class A1 ,TSO C145, TSO 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.
- Every aircraft that is planned to conduct RNAV (GNSS) APROACHES must
  - Have 2 approved similar GPS Receivers and are to be both operating simultaneously during the course of the approach and checked correct at every waypoints. Or
  - Have 1 GPS Receiver with a fully functional Conventional ground based navigation and to be checked at every waypoints for correct orientation. And
  - All TSO C129 A1 Receivers cannot be used as a stand alone receivers on single pilot operation.

- 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.
- The minimum equipment list (MEL) should identify the minimum equipment necessary to satisfy the navigation application.

5. RNAV(GNSS) TRAINING AND ENDORSMENTS

- Flight Crew wishing to include the GPS NPA INSTRUMENT Rating Endorsement in their License must complete an approved ground training syllabus for GPS before commencing Flight Training.
- 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.
- A Flight Test is required for an initial GPS endorsement. A CAAV Delegated Examiners shall conduct the flight test. Internal Examiners can conduct other regular renewals.

6. RECENCY REQUIRMENTS

- 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.

- 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

- Standard Operating Procedures (SOPs) detailing the conduct of the RNAV (GNSS) approach shall be included in the Company Operations Manual.
- The SOPs for the conduct of an RNAV (GNSS) approach should be generally consistent with the procedures used for other non ILS approaches.
- Air Operators Certificates specifications must show approval of operations by the Authority.
- Flight Crew before use of Receivers must ensure that the Necessary Databases are checked, current.

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

- The AFM must contain a statement that the aircraft is capable of meeting the requirements for RNP 0.3.
- The aircraft must be operated in accordance with the manufacturer's instructions.
- RNAV must not be used to satisfy any of the requirements for alternate aerodrome planning.
- 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

- Before commencing the approach, the PIC must ensure that:-
  - at least 1 of the aircraft's GPS receivers is operational;
  - the RNAV (GNSS) approach is loaded from the current approved navigation database, and;
  - RNP 0.3 is displayed or selected in the FMS.

- At all times during the approach, the PIC must ensure that:-
  - the approach is flown using a method of control that, in accordance with the AFM, permits RNP 0.3 operations to be conducted;
  - the approach is flown in accordance with the current approved navigation database setting out that approach;
  - an approved method is used to monitor cross track (XTK) error, and;
  - at least 1 pilot monitors the XTK error.

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

d. VNAV path assessment

- 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.
- The VNAV path is suitable for the approach if:-
  - it is at or above the path identified in the published chart for the approach, and;
  - the flight crew do not have to intervene by selecting an alternative mode of flight to the VNAV path.
  - Despite the assessment of the VNAV path as suitable, the flight crew must observe vertical limitations in the published chart.
  - 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.

➢ Operating Requirements

- A RNAV (GNSS) NPA may not be conducted unless that instrument approach procedure can be retrieved from the current approved navigation data base.
- The aircraft must be operated in accordance with the manufacturer's instructions.
- RNAV must not be used to satisfy any of the requirements for alternate aerodrome planning.
- RNAV must not be used as a navigation reference for flight below the LSALT/MSA, except in accordance with a published RNAV (GNSS) procedure.
- A pilot-in-command may use GPS as a navigation system for domestic en-route phase of flight when promulgated waypoint data is available from a data card or is promulgated data that is manually entered in the receiver database.

- Manually entered data may be used only if the data entries:

  - have been cross-checked for accuracy by at least 2 flight crew members and have been further checked by ensuring that sequential waypoints produce route track and distance segments corresponding to those on the promulgated route; or
  - for single pilot operations – have been checked independently against other aeronautical information, such as current maps and charts carried in the aircraft.

- Where aircraft are regularly flown over any particular route, the operator is expected to ensure that the aircraft's GPS database gives the pilot-in-command the capability of selecting the route to be flown instead of having to compile a route from waypoints. This process will further mitigate any risk from manual data entry.

- Both the pilot and the operator are responsible for ensuring compatibility of the ground aid and aircraft equipment and that the pilot is appropriately qualified and current

➢ **Procedures**

- 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 RAIM warning or other reason to doubt the validity of GPS derived information,or;
- RAIM loss.

- 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,

- 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.

➢ **VNAV path assessment**

- 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.
- The VNAV path is suitable for the approach if:-

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

- Despite the assessment of the VNAV path as suitable, the flight crew must observe vertical limitations in the published chart.
- The flight crew may alter the speed of the aircraft if it does not affect the VNAV path.

➢ **Navigation aid and procedure tolerances**

- +/- 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
- 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;
- DME or GNSS arc +/- 2 nautical miles.

10. RECOMMENDED GNSS TRAINING SYLLABUS

- **Introduction**

  This syllabus is guidance for developing a course for RNP and RNAV Instrument Rating privileges.

  Pilot training must include classroom training and examination, and practical training on the equipment to be used (in simulator, training device, or aircraft), covering the following matters with appropriate logbook endorsement.

- **Course concept**

  This course is a prerequisite for the issue of GNSS as a navigation aid endorsement to an instrument rating.

  Prior to undertaking the endorsement demonstration, the applicant must provide evidence to the holder of a current flight examiner rating with the examiner privilege of additional navigation aid GNSS that they have successfully completed a course in accordance with this syllabus.

  The flight examiner must be satisfied with the content of the course as delivered to the candidate by questioning the candidate appropriately on the content of the course syllabus.

- **Classroom training and examination**

- **Performance Based Navigation (PBN) Principles**
  a. State the principles of RNAV 1 and 2, RNP 1 and 2 and RNP APCH
  b. Describe in basic terms the principal GNSS systems – GPS, Galileo, GLONASS and BeiDou.
  c. Explain navigation database menus and sub menus.
  d. Explain how to confirm data validity and a verifiable source for current applicable software versions.
  e. Understand system software configuration management.
  f. Using the basic block diagram of an RNAV system explain the function and operation of each component.
  g. Describe the effects of RAIM outages, Fault Detection (FD), and Fault Detection and Exclusion (FDE) on PBN.
  h. Explain the difference between an almanac and ephemeris data on GNSS operations.
  i. Explain the effect of barometric altitude input.
  j. Explain the operating principle of RAIM.
  k. Explain the difference between Fly-by and Fly-over waypoints.
  l. List the required navigation and communication equipment for RNAV, RNP, and RNP APCH operations.
  m. Describe the basic differences between TSO C129 and C145/146 receivers, including scaling differences.
  n. State and apply the operational conditions required to support RNP 1 and 2 (no surveillance) operations and RNAV 1 and 2 operations (under surveillance).
  o. State the actions to be taken in the event of loss of integrity, system failure and system messages.
  p. List the effects on turn anticipation with consideration to speed and altitude.
  q. Explain the contingency procedures for RNAV/RNP failures.
  r. State the aviation documents required for PBN operations.

- **Charting**
  a. Demonstrate a working knowledge of definitions and abbreviations associated with RNP, RNAV and RNP APCH operations.
  b. Be familiar with the interpretation of chart legends including route depiction, flyover and fly-by waypoints.
  c. Explain the significance of the WGS-84 earth model.
- **Aircraft and equipment knowledge**
  a. Describe the use of navigation database menus and submenus.
  b. Describe system software configuration management.
  c. Describe annunciator message importance of warnings; both cautions and advisory, and their applicability.
- **Pilot operations**
  a. Discuss human factors in PBN.
  b. Demonstrate filing of ICAO flight plans in compliance with current flight planning requirements.
  c. Identify operator procedures, including methods to minimise cross track error.
  d. Explain monitoring procedures for each stage of flight.
  e. Explain turn anticipation with consideration of speed and altitude effects.
  f. Demonstrate appropriate RTF phraseology.
- **Equipment specific training**
  On ground
  a. Describe the capabilities and limitations of the installed system from the Aircraft Flight Manual or AFM Supplement.
  b. Explain levels of automation, mode annunciations, changes, alerts etc.
  c. Explain system software configuration management.
  d. Demonstrate removal and re-selection of navigation sensor input.
  e. Demonstrate confirmation of exclusion of sensor input.
  f. Describe functional integration with other aircraft systems.
  g. Interpret electronic displays and symbols.
  h. Identify where HDG, GS, TK, XTK,G/S etc. are displayed.
  i. Demonstrate RAIM prediction.
  j. Verify currency and integrity of the aircraft navigation data.
  k. Initialise navigation system self-tests.
  l. Verify the successful completion of the navigation system self-tests.
  m. Verify waypoints and flight plan programming.
  n. Edit or amend current flight plan with routing changes.
  o. Perform an FDE prediction for flights to a destination and alternate.

- **In aircraft, simulator, or training device**
  a. Initialise system position.
  b. Perform a manual or automatic update with take-off point shift if applicable.
  c. Verify waypoints and navigation system flight plan programming.
  d. Retrieve and fly a planned SID and reprogram with a subsequent runway change.
  e. Adhere to speed and/or altitude constraints associated with a SID.
  f. Vector off and re-join a route or procedure.
  g. Determine allowable deviation limits and maintain flight within those limits.
  h. Carry out contingency procedures for RNAV/RNP failures.
  i. Demonstrate how to change CDI scaling.
  j. Perform parallel track offset functions if capability exists.
  k. Perform gross navigation error checks with legacy aids.
  l. Perform RNAV/RNP holding functions.
  m. Change the planned destination and alternate airport.
  n. Select and fly the appropriate STAR and demonstrate and handle a runway change.
  o. Adhere to speed and/or altitude constraints associated with a STAR.
  p. Retrieve and fly, an RNAV (GNSS) approach.
  q. Adhere to speed and/or altitude constraints associated with an RNP APCH

11. Air Traffic Control Requirements

- Pilots intending to operate over GPS routes are to inform via the flight plan requirements.
- Pilots intending to use GPS on training or test flights utilising abbreviated flight planning or flights utilising Repetitive flight plans are to advise ATC when establishing RT contact prior to taxiing.
- Within controlled airspace, aircraft equipped with GPS may be cleared for a GPS step descent provided:

- the aircraft is on track
- traffic permits
  - GPS bearings and distances will be treated in the same way as VOR radials and DME distances by ATC for separation purposes.
  - Aircraft may be cleared by ATC for a GPS approach; however the onus is upon the pilot to fly the GPS approach procedure appropriate to the limitations of the GPS receiver installed on board. (Refer part 4 – Certification). And with the pilots currency requirements.