PAPUA NEW GUINEA

AERONAUTICAL INFORMATION SERVICE

AIP SUPPLEMENT

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REQUIREMENTS FOR USE OF GLOBAL POSITIONING SYSTEM (GPS) AS AN APPROVED PRIMARY MEANS IFR NAVIGATION AID

1. PURPOSE

1.1 The purpose of this AIP Supplement is to detail the Office of Civil Aviation=s requirements for the use of GPS as:

a. an approved enroute and area IFR primary means navigation aid;

b. a navigation aid approved to provide distance information for "GPS Arrivals", "GPS Departures", and for "DME or GPS Arrivals" and "DME or GPS Departures" when DME is not available.

1.2 This AIP Supplement constitutes the Office of Civil Aviation (OCA) approval for the use of GPS equipment, fitted and operated in accordance with the provisions contained herein, within Papua New Guinea domestic airspace, for the purpose of:

a. enroute position fixing, as specified in Civil Aviation Order section 20.8 sub-paragraph 3.2.2(c) and described in paragraph 8.1, herein;

b. deriving distance information for enroute navigation, traffic information and ATC separation;

c. enroute IFR descent below the applicable safety altitude -- GPS Arrivals and DME or GPS Arrivals (substituting GPS-derived distance for DME distance);

d. enroute IFR climb to the applicable safety altitude -- GPS Departures and DME or GPS Departures (substituting GPS-derived distance for DME distance);

e. Application of RNAV-based separation.

Note 1: The effect of the approval contained in this AIP Supplement is that GPS satisfies the Civil Aviation Order section 20.8 Appendix 2 requirement for aircraft to be equipped with DME for operations within controlled airspace. However, GPS is not to be used in connection with instrument approach procedures that require DME.

Note 2: This AIP Supplement does not constitute approval to use GPS Arrival procedures published by other ICAO contracting States. Operators who wish to use such procedures must obtain approval from the aviation authority in the particular State.

1.3 GPS must not be used as a sole means navigation system, or for instrument approaches other than "GPS Arrivals", "DME/GPS Arrival" "GPS Departures" or "DME/GPS Departures" until further authorisation is issued.

1.4 This AIP Supplement supersedes AIP Supplement 3/96, dated 7 November 1996, which is hereby cancelled. This significant extension of authorised GPS usage dictates the necessity to review all aspects of GPS and requires further system integrity reports.

2. BACKGROUND

2.1 GPS was approved for use in Australian airspace for Australian registered aircraft under the authority of Australian AIP Supplement H50/95 dated 7 December 1995. While OCA is yet to finalise site surveys to the WGS84 datum, it has been decided that sufficient system integrity is now available to implement a modified and adapted form of the Australian approval.

2.2 AIC 4/1995 advised the replacement of 200 MHZ DME (DMEA) equipment with 1000 MHZ (International) DME (DMEI). Subsequently, all DME Arrival and Departure procedures based on DMEA were approved for use with DMEI. It has now been determined that GPS-derived distance information may be used for all DME Arrival and DME Departure procedures which indicate a DMEA channel number. These procedures were all issued prior to 7 December 1997.

2.3 DME Arrival and DME Departure procedures issued on or after 7 December 1997 have been designed using DMEI tolerances only and GPS-derived distance information may **not** be substituted for DME distance.

2.4 Instrument arrival and departure procedures titled "DME or GPS Arrival" or "DME or GPS Departure" are being designed. GPS-derived distance may be substituted for DME distance in all these procedures when DME equipment is unserviceable.

Note: Due to available space, the procedure titles may substitute an oblique stroke for the word "or"; e.g. "DME/GPS Arrival".

2.5 Instrument arrival and departure procedures that use a ground-based azimuth aid and GPS-derived distance are being designed for locations at which DME is not installed. These procedures are titled "GPS Arrival" and "GPS Departure".

3. DEFINITIONS

3.1 **Sole Means Navigation System**: A navigation system that, for a given phase of flight, must allow the aircraft to meet all four navigation system performance requirements – accuracy, integrity, availability and continuity of service.

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

3.3 **Supplemental Means Navigation System**: A navigation system that must be used in conjunction with a sole means navigation system.

3.4 **Integrity**: That quality which relates to the trust which can be placed in the correctness of information supplied by a system. It includes the ability of a system to provide timely warnings to users when the system should not be used for navigation.

3.5 **Receiver Autonomous Integrity Monitoring (RAIM)**: A technique whereby an airborne GPS receiver/processor independently examines the integrity of the navigation signals from GPS satellites.

Note: Systems for providing integrity, other than RAIM, may be approved for use. Where reference to RAIM occurs in this AIP Supplement, it includes other approved equivalent integrity monitoring systems.

4. GPS SIGNAL INTEGRITY

4.1 System integrity is an essential element of the approval for use of GPS as a primary means navigation system. GPS receivers certified to US FAA Technical Standard Order (TSO) C-129 provide integrity through the use of RAIM, or an approved equivalent integrity system. When RAIM is lost or not available, the accuracy of the system cannot be assumed to meet the required standard for navigation, or for the application of ATC separation standards.

4.2 GPS integrity is also dependent on the number of operational satellites in view, or available for use. Loss of one or more satellites can result in degraded system availability (refer para 5).

4.3 RAIM availability is greatly improved through the use of barometric aiding.

4.4 Except as provided in this AIP Supplement, GPS **must not** be used to fix position, provide distance information or provide primary navigation, unless RAIM is available.

5. GPS SATELLITE CONSTELLATION

5.1 The approvals contained in this AIP Supplement are based on the availability of the US DoD GPS Standard Positioning Service (SPS) operating to its= defined Full Operational Capability (FOC). This service does not meet the requirements of a sole means navigation system.

5.2 Disruption to the SPS may result in degradations in GPS service to such a level that some or all of the operational approvals for the IFR primary use of GPS contained in this AIP Supplement may need to be withdrawn. When known, these changes or restrictions will be advised by NOTAM.

5.3 Prior knowledge of RAIM availability will enable operators to use the system more efficiently, by allowing operations to be planned around gaps in RAIM coverage (RAIM holes). To achieve these efficiencies, OCA recommends that appropriate RAIM prediction capabilities be available at despatch locations. Flights should be planned to ensure the safe completion of flight in the event of loss of GPS integrity.

6. AIRWORTHINESS REQUIREMENTS

6.1 The following airworthiness requirements must be satisfied:

a. GPS navigation equipment must have TSO C-129 (or OCA approved equivalent) authorisation; and

b. GPS receivers must be installed in PNG civil registered aircraft in accordance with AAC 6-26; and

c. Automatic barometric aiding function, as provided by TSO C-129, need not be connected, for domestic operations.

Note 1 : Operators should be aware that not all TSO C-129 receivers will meet the requirements for non-precision approaches, other than "GPS Arrivals" and "DME or GPS Arrivals".

Note 2 : Operators should also be aware that TSO C-129 receivers may not be able to take advantage of future enhanced GPS capabilities, such as Wide Area or Local Area Augmentation Systems (WAAS or LAAS).

*Note 3 : Future approval of GPS for international operations **will** require fitment of the barometric aiding function.*

7. PILOT TRAINING

7.1 The following pilot training requirements must be satisfied:

a. Prior to using GPS in IFR operations for any of the purposes specified herein, the holder of an instrument rating must, unless exempted by OCA, have completed a course of ground training based on the syllabus contained in Annex A. The course must be conducted by, or on behalf of, an approved IFR check and training organisation or approved instrument training school.

b. Satisfactory completion of the course and demonstration of competence in operation must be certified in the pilot's log book by either a Flying Operations Inspector (FOI), or by the Chief Pilot or the Chief Flying Instructor (or their nominated representative) of an organisation approved to conduct such a course. The certification entered in the pilot's personal log book shall be in the form specified below:

> XY Jones has satisfactorily completed a course of ground instruction in GPS principles and operation in accordance with the syllabus contained in Annex A of AIP Supplement Nr. 3/97 and I consider him/her competent in the operation of ..... type of GPS equipment for the purposes specified.
> .....
> AB Smith (ARN.....) 7 December, 1995

c. The course must cover both general information and procedures applicable to all types of GPS equipment, as well as the essential operating procedures for a specific type of aircraft equipment. Pilots who have completed the course 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 flight for any of the purposes approved herein.

d. From 1 July 1998, all pilots who wish to use GPS in accordance with this AIP Supplement will be required to demonstrate proficiency in the use of the equipment and have their instrument rating endorsed "GPS Arrival".

Note: An AIC will be issued detailing the requirement for DME and GPS Arrival endorsement.

8. OPERATIONAL REQUIREMENTS

8.1 The following operational requirements must be satisfied:

a. Operating instructions for GPS navigation equipment must be:

(i) on board the aircraft; and

(ii) incorporated into the Company Operations Manual.

b. GPS navigation equipment must be operated in accordance with the operating instructions and any additional requirements specified in the approved aircraft flight manual or flight manual supplement.

c. In addition to GPS, aircraft must be equipped with serviceable radio navigation systems as specified at AIP RAC 1.9, para 3.3 or the Minimum Equipment List (MEL).

d. GPS must not be used to satisfy any of the alternate requirements of RAC 1.9 para 3.2.6.

e. When within rated coverage of ground-based navigation aids, pilots must monitor the ground-based system and maintain track as defined by the most accurate ground-based radio navigation aid (VOR or NDB) available. If there is any discrepancy between the GPS and ground-based system information, pilots must use the information provided by the ground-based navigation system.

f. ATC may require GPS-equipped aircraft to establish on, and track with reference to, a particular VOR radial or NDB track for the application of separation.

g. GPS must not be used as a navigation reference for flight below the lower of AMA, LSALT or MSA, except as provided in para 11 of this AIP Supplement, or as otherwise authorised by OCA.

9. OPERATIONS WITHOUT RAIM

9.1 GPS systems normally provide three modes of operation:

a. Navigation (Nav) Solution with RAIM;

b. 2D or 3D Nav Solution without RAIM; and

c. Dead Reckoning (DR), or Loss of Nav Solution.

9.2 ATS services and, in particular, ATC separation standards, are predicated on accurate navigation and position fixing. If RAIM is lost, the accuracy of the system is assumed not to meet the required standard for both navigation and application of ATC separation. Accordingly, when RAIM is lost, the following procedures must be adopted:

a. Aircraft tracking must be closely monitored against other onboard systems.

b. In controlled airspace, ATC **must** be advised if:

(i) RAIM is lost for periods greater than ten minutes, even if GPS is still providing positional information; or

ii) RAIM is not available when ATC request GPS distance, or if an ATC clearance or requirement based on GPS distance is imposed; or

(iii) the GPS receiver is in DR mode, or experiences loss of navigation function for more than one minute; or

(iv) indicated displacement from track centreline is found to exceed 2NM. ATC may then adjust separation.

c. If valid position information is lost (2D and DR mode), or non-RAIM operation exceeds 10 minutes, the GPS information is to be considered unreliable and another means of navigation should be used until RAIM is restored and the aircraft is re-established on track.

d. Following re-establishment of RAIM, the appropriate ATS unit should be notified of RAIM restoration, prior to using GPS information. This will allow ATC to reassess the appropriate separation standards.

e. When advising ATS of the status of GPS, the phrases **"RAIM FAILURE"** or **"RAIM RESTORED"** must be used.

10. GPS DISTANCE INFORMATION TO ATS UNITS

10.1 When a DME distance is requested by an ATS unit, DME-derived distance information should normally be provided. Alternatively, GPS-derived distance information may be provided to an ATS unit, unless RAIM is currently unavailable and has been unavailable for the preceding ten minutes.

10.2 Notwithstanding para 10.1, if an ATC unit has issued a clearance or requirement based upon GPS distance (e.g. a requirement to reach a certain level by a GPS distance), pilots must inform ATC if RAIM is not available.

10.3 When a DME distance is not specifically requested, or when the provision of a DME distance is not possible, GPS-derived distance information may be provided. When providing GPS distance, the transmission must include the source and point of reference -- e.g. 115 GPS PY VOR, 80 GPS KIK NDB, 267 GPS KAPSO, etc.

10.4 If a GPS distance is provided to an ATC unit, and RAIM is not currently available -- but has been available in the preceding 10 minutes, the distance report should be suffixed **"NEGATIVE RAIM"** -- e.g. 26 GPS DAU NEGATIVE RAIM.

10.5 Databases sometimes contain waypoint information which is not shown on published AIP charts and maps. Distance information must only be provided in relation to published waypoints unless specifically requested by an ATS unit.

10.6 Where GPS information is requested or provided from an NDB, VOR, DME or published waypoint, the latitude and longitude of the navigation aid or waypoint must be derived from a validated database that cannot be modified by the operator or crew (refer paras 11 and 12).

11. GPS ARRIVALS AND DEPARTURES

11.1 Provided that azimuth guidance is obtained from the designated NDB or VOR and subject to the restrictions in para 11.3, GPS meeting the requirements of this AIP Supplement may be used to conduct enroute IFR climb and descent below the applicable safety altitude in accordance with the "GPS Arrival", "DME or GPS Arrival", "GPS Departure" or "DME or GPS Departure" procedures to be published in the IAL section of the AIP Flight Supplement.

11.2 In the event of DME failure, GPS-derived distance may be used for all valid DME Arrival and Departure procedures issued before 7 December 1997.

11.3 In addition to the general limitations and restrictions in this AIP Supplement, the following specific limitations apply to the use of GPS-derived distance for arrival and departure procedures:

a. The coordinates of the destination VOR or NDB, to which the descent procedure relates, must not be capable of modification by the operator or crew.

b. The database medium (card, chip, etc.) must be current and of a kind endorsed by the receiver manufacturer.

c. In the case of a departure procedure, RAIM must be available before take-off; in the case of an arrival procedure, RAIM must be available before descending below the applicable safety altitude.

d. The azimuth aid (VOR or NDB) nominated in the procedure must be used to provide track guidance.

e. In the event of a significant disparity between the NDB (greater than ±5deg) or VOR (greater than half-scale deflection) track and the GPS track indication, the pilot must discontinue the arrival procedure.

Note: Significant disparity may be caused by:
(a) incorrect waypoint selection, and/or
(b) navaid coordinates that are not based on the WGS84 datum.

f. If, at any time during an arrival procedure, there is cause to doubt the validity of the GPS information (e.g. RAIM warning), or if RAIM is lost, the pilot must:

(i) maintain flight to the Missed Approach Point (MAPt) at the last level at which the pilot was satisfied with the accuracy of the GPS information; or

(ii) climb to the LSALT/MSA and use an alternative approach, hold or divert.

g. If, at any time during a departure procedure, there is cause to doubt the validity of the GPS information (e.g. RAIM warning), or if RAIM is lost, and the aircraft is in IMC, the pilot must manoeuvre the aircraft by DR to ensure terrain clearance until reaching the appropriate safety altitude.

Note: Where significant aberrations in GPS information are observed, pilots are requested to advise ATS of any suspected errors. If interference is suspected, an interference report should be submitted (refer Annex B).

12. DATA INTEGRITY

12.1 As a significant number of data errors, in general applications, occur as a result of manual data entry errors, navigation aid and waypoint latitude and longitude data should be derived from a database, if available, that cannot be modified by the operator or crew.

12.2 When data is entered manually, data entries must be cross-checked by at least two crew members for accuracy and Areasonableness@ (confidence check), or, for single crew operations, an independent check (e.g. GPS-computer tracks and distance against current chart data) must be made.

12.3 Both manually-entered and database-derived position and tracking information should be checked for reasonableness in the following cases:

a. prior to each compulsory reporting point;

b. at or prior to arrival at each enroute waypoint;

c. at hourly intervals during area type operations, when operating off established routes; and

d. after insertion of new data -- e.g. creation of new flight plan.

12.4 Only data from a validated database may be used for navigation below AMA, LSALT or MSA. Manually entered data must not be used for navigation by civil aircraft below AMA, LSALT or MSA, unless authorised by OCA.

13. INTEGRITY AND INTERFERENCE DATA SHEETS

13.1 Coincident with the approvals contained in this AIP Supplement, and in order to build up data on GPS integrity below AMA, LSALT and MSA in Papua New Guinea, a system validation period has been established to operationally verify the availability of RAIM and the quality of navigation provided by GPS at other times.

13.2 The validation period will be reviewed prior to 1 July 1998, with a view to possibly extending GPS use approvals and revising ATC separation minima.

13.3 Operators or pilots using GPS for the purposes stated at para 1.2 of this AIP Supplement are requested to provide system information, as detailed below:

a. **Private Operators**: Private operators are requested to submit information on GPS interference as it occurs.

b. **Commercial Operators**: Commercial operators are requested to submit integrity reports for the first 30 operations below AMA, LSALT or MSA using approved GPS equipment. After this period, operators are requested to monitor and record the performance of GPS, and provide details of the system accuracies and reliabilities from time to time. In addition to these reports, operators are requested to submit information on GPS interference as it occurs.

13.4 Pilots should particularly note cases of GPS degradation/interference around airports, over populated areas, near radio, television or mobile phone towers, and during radio or SATCOM transmit operations.

13.5 Information about the additional types of data required is detailed on the data sheet. This data will be used to verify the predicted integrity of GPS in PNG airspace and will, in part, form the basis for future extension of GPS approvals and revisions to ATC separation minima.

13.6 Data should be entered on System Validation Data Sheets, copies of which are available from the Aeronautical Information Service, all ATS units, or may be copied from the sample format attached at Annex B.

14. FLIGHT PLAN NOTIFICATION

14.1 Pilots of aircraft equipped with GPS that complies with the requirements of this AIP Supplement should insert the following in flight plans:

a. Domestic Flight Plan and Standard IFR Flight Plan: A**N**@ in the NAV section, and **NAV/GPSRNAV** in the OTHER INFORMATION section.

b. ICAO Flight Plan: A**Z**@ in field 10, and **NAV/GPSRNAV** in field 18.

15. FUTURE DEVELOPMENTS

15.1 DME or GPS arrivals will require a flight test for endorsement on the instrument rating. Flight tests will not be required for renewal of this endorsement. Recency requirements will be the same as those for NDB or VOR.

15.2 GPS approach capability is expected during 1998 and will require flight test for endorsement and renewal.

15.3 Approval of GPS as a primary means navigation system for international and Oceanic routes will require compliance with United States Federal Aviation Administration Notice 8110.60 GPS as Primary Means for Oceanic/Remote Area Operations, which includes satellite fault detection and exclusion.

16. CANCELLATION

16.1 This AIP Supplement remains valid until its provisions are incorporated into the AIP.

DISTRIBUTION: Normal

CURRENT AIP SUPPLEMENTS: 1996: 2, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14
1997: 1, 2, 3

Annex:

A. Syllabus of Training -- GPS as Primary Means Navigation
B. System Verification Data Sheet

ANNEX A

SYLLABUS OF TRAINING -- GPS AS A PRIMARY MEANS NAVIGATION SYSTEM

1 - System Components And Principle of Operation

Demonstrate an understanding of the Global Positioning System and its= principles of operation:

* System components, constellation, control and use.
* Aircraft equipment requirements.
* GPS satellite signal and pseudo random code
* Principle of position fixing.
* Method of minimising receiver clock error.
* Minimum satellites required for navigation functions.
* Masking function
* Performance limitations for various equipment types.
* GPS use of WGS84 coordinate system.

2 - Navigation System Performance Requirements

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

* Accuracy.
* Integrity
* Means of providing GPS integrity.
* RAIM.
* Procedural systems integration.
* Availability
* Continuity of service

3 - Authorisation and Documentation

Recall the requirements applicable to pilots and equipment for GPS operations:

* Pilot training requirements.
* Log book certification.
* Aircraft equipment requirements.
* GPS NOTAM.

4 - GPS Errors and Limitations

Recall the cause and magnitude of typical GPS errors:

* Ephemeris
* Clock.
* Receiver.
* Atmospheric/ionospheric.
* Multipath.
* SA.
* Typical total error associated with C/A code.
* Effect of PDOP/GDOP on position accuracy.

* Susceptibility to interference.
* Comparison of vertical and horizontal errors.
* Tracking accuracy and collision avoidance.

5 - Human Factors and GPS

Be aware of the human factors limitations associated with the use of GPS equipment. Apply GPS operating procedures that provide safeguards against navigational errors and loss of situational awareness due to these causes:

* Mode errors.
* Data entry errors.
* Data validation and checking, including independent cross-checking procedures.
* Automation-induced complacency.
* Non-standardisation of the GPS-pilot interface.
* Human information processing and situational awareness.

6 - GPS Equipment -- Specific Navigation Procedures

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

* Select appropriate operational modes.
* Recall categories of information contained in the navigational database.
* Predict RAIM availability.
* Enter and check user-defined waypoints.
* Enter, retrieve and check flight plan data
* Interpret typical GPS navigational displays:
    * LAT/LONG.
    * Distance and bearing to waypoint.
    * CDI.
* Intercept and maintain GPS-defined tracks.
* Determine TMG, GS, ETA, time and distance to waypoint, WV in flight.
* Indications of waypoint passage.
* Use of Adirect@ function.
* Use of Anearest airport@ function
* Use of GPS in Arrival and Departure procedures, with emphasis on correct waypoint selection, RAIM availability, current database and pilot qualification requirements.

7 - GPS Equipment Checks

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

* TSO status.
* Satellites required.
* RAIM status.
* PDOP/GDOP status.
* IFR database currency.
* Receiver serviceability.
* CDI sensitivity.
* Position indication.

8 - GPS Warnings and Messages

For the specific type of aircraft equipment, recognise and take appropriate action for GPS warnings and messages, including the following:

* 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.

ANNEX B

Global Positioning System (GPS)
System Verification Data Sheet

A. GENERAL

Name:..... Company:.....

Address:.....

Telephone/Fax Nr.: .....
(Address is only used in the event of clarification. Please report each occurrence separately)

Make and type of receiver and any special features in use at the time that may have affected its= performance:

.....

B. INTERFERENCE REPORT

Purpose for which GPS was being used (survey, navigation, arrival, departure, etc.) and its= mode of use (e.g. stationary vehicle, at sea, aircraft in flight, etc.):

.....

.....

Location of receiver antenna (e.g. remote mounted on vehicle):

.....

Date, time and nature of GPS malfunction and variation with time/distance travelled:

.....

Location of receiver antenna (e.g. remote mounted on vehicle):

.....

Description of location (e.g. town, airfield) noting any potential sources of interference (e.g. satellite signals shadowed from rising ground, reflections from other sources, etc.):

.....

Did you try to establish a cause for the malfunction? If so, what did you do and what were your conclusions?:

.....

C. INTEGRITY/RAIM LOSS REPORT			
RAIM Mode : Enroute, Terminal or Approach	**Date and Time**	**Period of Loss**	**Location**

Comments:

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Please forward completed forms to:

Flight Safety Regulation Section
Office of Civil Aviation
P.O. Box 684
BOROKO
National Capital District
Papua New Guinea

Attention: Airways Surveyor

(Fax Nr.: 324 4485)