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Requirements for the use of GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) when flying in the Piarco Flight Information Region (FIR).

1. Introduction

1.1 This Circular sets out the airworthiness criteria and operational matters associated with the use of GPS when flying under IFR/VFR. The Circular considers the current status of GPS, the classes of airborne equipment, their use and the limitations prevailing. At present, these limitations restrict the use of GPS equipment only as a Supplemental Air Navigation System.

1.2 **Definitions**

a. Receiver Autonomous Integrity Monitoring (RAIM)

A technique whereby a GPS receiver/processor determines the integrity of the GPS navigation signals using only GPS signals augmented with barometric altitude.

b. Sole Means Air Navigation System

An approved navigation system that can be used for specified phases of operations without the need for any other navigation system.

c. Stand-Alone GPS Navigation System

A GPS navigation system that is not combined with other navigation sensors or navigation systems.

d. Supplemental Air Navigation System

An approved navigation system that can be used in conjunction with a sole means air navigation system.

e. CAA

Civil Aviation Authority of State of Registry

f. GLONASS

Global Orbiting Navigation Satellite System (USSR)

g. EGNOS

European Geostationary Navigation Overlay Service

h. MTST

Mulit-functional Transport Satellite System (Japan)

i. GNSS

Global Navigation Satellite System (generic term)

j. GPS

Global Positioning System

k. WGS84

World Geodetic System (1984) Datum

l. RAIM

Receiver Autonomous Integrity Monitoring

2. Description of GPS

2.1 The Navstar Global Positioning System (GPS) of the United States Department of Defense (DOD) is a satellite based radio navigation system. Today, twenty-four satellites are in various orbits approximately 11,000 nautical miles above the surface of the earth. Each satellite broadcasts a timing signal and data message. A portion of the data message gives a GPS receiver the orbital details of each satellite. The receiver measures the time taken for the signal to arrive from the satellites in view and from this information computes a position and velocity.

2.2 Three satellites are needed to determine a two dimensional position, and four for a three dimensional position. The elevation and geometry of each satellite relative to the receiver must satisfy certain criteria before the designed system accuracy can be achieved. Accuracy in predictable horizontal positions of 100 metres or better should be available on 95% of occasions and 300 metres or better on 99.99% of occasions.

2.3 The figures quoted for accuracy are based on the assumption that the position given is referenced to the World Geodetic System 1984 (WGS 84) Datum. This datum relates position on the Earth's surface or in space to a mathematically defined ellipsoid that approximates the complex shape of the earth. The point of origin of the WGS 84 Datum is the Earth's centre of mass. This allows position information to be derived for the world from one reference. ICAO has adopted WGS 84 as a World Standard.

2.4 Currently, position information throughout the world is derived from local or regional datums; for example, European Datum 1950 and Nouvelle Triangulations de France (NTF) 1970. These datums use different ellipsoids that approximate the shape of the earth over a selected area, but are not valid on a global scale. Conversion between datums is possible, but inherent inaccuracies present in National datums can result in large residual errors.

2.5 Consequently, a given position today could be referenced to one of many datums and that position may be significantly displaced from the coordinates of the same position when measured against WGS 84. Differences of several hundred metres are not uncommon. With the accuracy provided by today's ground based navigation aids – other than precision approach aids – these discrepancies in position between datums are of little importance. The introduction of position information provided by satellites for more precise navigation, changes this situation, but only when all positions worldwide are based on one datum, can the full potential of satellite navigation be realized. Until this stage is reached it is necessary to place some restrictions on the airborne use of the Navstar GPS constellation.

3. Limitations of GPS Constellation and Equipment.

3.1 In January 1994, the US DOD had declared Initial Operational Capability (IOC) for the constellation. This declaration has not yet been formally endorsed by the US Department of Transportation (DOT)/Federal Aviation Administration (FAA). Currently, the interim policy stated in this Circular parallels the use of GPS as authorized by the FAA. Following the endorsement of IOC by the DOT/FAA, the FAA proposes extending the conditions of use of GPS for certain phases of flight.

3.2 Most existing ground based navigation aids are flight calibrated and can signal an alarm if erroneous signals are being radiated. For example, VOR signal characteristics are monitored and where the set tolerances are not met, the VOR automatically stops transmitting. The GPS constellation is monitored from the ground and it may take some considerable time before users become aware of a malfunction within the system. Several possibilities for providing signal integrity equivalent to that obtained from conventional navigation aids are under consideration, but it will be some years before these possibilities are realized. At present, two methods exist within airborne equipment to provide the integrity of navigation when using GPS signals. Receiver Autonomous Integrity Monitoring RAIM and that given by an integrated navigation system where other sensors are used in addition to GPS.

3.3 In airborne equipment incorporating both the GPS sensor and navigation capability, determination of a 3D position requires four satellites with adequate elevation and suitable geometry. An additional satellite is needed to perform the RAIM function. A sixth satellite is required to isolate any faulty satellite and remove it from contribution to the navigation solution. Where a GPS receiver uses barometric altitude as an augmentation to RAIM, the number of satellites needed for the receiver to perform the RAIM function may be reduced by one, given appropriate geometry. Not all GPS receivers possess RAIM but in stand-alone GPS equipment this function is essential for airborne use when flying under IFR.

3.4 In airborne equipment where a GPS sensor provides data to an integrated navigation system e.g. FMS or a mutli-sensor navigation system, either the GPS sensor is required to provide RAIM or the mutli-sensor navigation system should possess a level of integrity equivalent to that provided by RAIM. This level of integrity is required when flying under IFR.

3.5 The availability of six satellites is less than 100% of all occasions. Consequently, the RAIM function may be interrupted.

4. Use of GPS

4.1 When the airborne navigation equipment using GPS is DCA approved as satisfying the relevant technical criteria, then operators may be approved to conduct flights when flying under IFR in oceanic, domestic en-route and terminal airspace subject to the conditions detailed below and in paragraph 7.

4.2 A stand-alone GPS-based Supplemental Air Navigation System may not be used for any GPS non-precision approach procedure until the database for the navigation system contains those procedures as depicted in the relevant published approach plates and referenced to WGS 84.

4.3 The use of GPS in any form for any type or part of any precision approach is not permitted.

4.4 The criteria presently specified may be superseded by Airworthiness and Operational Standards promulgated by the Director of Civil Aviation.

5. Composition and Approval of a Supplemental Air Navigation System using GPS.

5.1 A GPS Supplemental Air Navigation System may comprise:-

(a) a stand-alone GPS EQUIPMENT; or

(b) a multi-sensor system where at least one sensor is GPS.

6. Airworthiness Approval

6.1 To gain airworthiness approval for a GPS Supplemental Air Navigation System, the equipment and its installation will need to satisfy the following criteria.

(a) Stand- Alone equipment:

(i) Complying with FAA TSO-C129, Class A, or equivalent, and meeting the intent of the associated FAA Notice N8110.47, as revised. Copies of this information should be provided.

(ii) An approved sole means navigation system suitable for the route to be flown is fitted to the aircraft.

(b) Multi-Sensor equipment using GPS:

(i) Complying with FAA TSO-C 129, Classes B or C, or equivalent, and meeting the intent of the associated FAA Notice N8110.48, copies of this information should be provided, as revised; and

(ii) An approved sole means navigation system suitable for the route to be flown is fitted to the aircraft.

(c) Existing GPS installations:

Where a GPS sensor has been approved and installed in an aircraft as one component of an integrated navigation system on a "no-credit" basis, that system may be classed as a Supplemental Air Navigation System where it can be shown that a level of integrity to that given by RAIM is provided.

6.2 Approvals for the installation and use of this type of equipment should be in accordance with Civil Aviation Authority Regulations, as applicable, and must be obtained using the current certification procedures.

7. Operational Matters

7.1 Operation of GPS Equipment will require use in accordance with the limitations stated in the approved Flight Manual or Flight Manual Supplement. Furthermore, multi-sensor navigation systems employing GPS may be used for Standard Instrument Departures (SIDs) and Standard Terminal Arrivals (STARs) only when the operator has an operational approval to fly such procedures using an FMS. The following conditions also apply.

(a) Stand-Alone Equipment

(i) The approved sole means navigation system not using GPS to determine position must be serviceable and continuously displayed to and monitored by the flight crew when the GPS equipment is in use;

(ii) The GPS equipment is used during a non precision approach only where an approved procedure has been published by the Director of Civil Aviation and

(iii) The criteria stated in Attachment A are met.

(b) Multi-sensor equipment using GPS

The criteria stated in Attachment A must be met for flying a non-precision approach.

(c) Existing GPS Installations

Where these systems have received airworthiness approval for use as a Supplemental Air Navigation System they may be used for flying a non-precision approach provided the criteria stated in Attachment A are met.

7.2 Due to satellite coverage and their elevation and geometry relative to the receiver, the RAIM function will not always be available and may be lost for significant periods of time. Where this occurs, then the primary means of navigation must be by reference to the other approved navigation systems.

7.3 **Training**

GPS avionics require more pilot attention than traditional VOR and ADF receivers, particularly during approach. GPS units are essential navigation management computers, within many features, modes and controls. Before flying a stand-alone approach in instrument conditions, a pilot must be completely familiar with GPS fundamentals, avionics operation and the approach procedure to be flown.

8. The Future

8.1 At present, GPS, the most widely used satellite based system is not yet fully operational. GLONASS, the Russian Global Navigation Satellite System, is some way from reaching an operational capability. In the future, combinations of GPS and GLONASS plus other civil satellites and augmentation systems, are possible components for a civil Global Navigation Satellite System (GNSS).

This circular is issued for information, guidance and necessary action.

ATTACHMENT A

USE OF APPROVED GPS-BASED EQUIPMENT FOR NON-PRECISION APPROACHES

1. The use of GPS-based navigation equipment as a Supplemental Air Navigation System to fly any part of any instrument non-precision approach will be permitted when the following general and specific conditions are satisfied.

1.1 General

(a) The GPS equipment must be approved by the DCA as complying with FAA TSO-C129, Classes A1, B1, B3, C1, C3, or equivalent, and be installed to meet the intent of the applicable FAA Notice (N8110.47 or 8110.48, as revised)

(b) The navigation databases must contain current information on the non-precision approach to be flown; and

(c) All approach plates and databases must have position information in WGS84 coordinates, or equivalent; and

(d) The approach to be flown must be retrievable from the database, which must have stored:

(i) The location of all navigation aids required to define the approach; and

(ii) The location of all waypoints and intersections; and

(iii) Present the information in the order depicted on the published non-precision approach plate.

(e) If required, the nominated alternate airfield must have an approved non-GPS instrument approach procedure expected to be available at ETA; and

(f) The use of GPS equipment to fly non-precision approaches is initially restricted to approaches based on VOR, VOR/DME, NDB, NDB/DME and RNAV let-downs.

1.2 Specific

1.2.1 For the approach used:

(a) The operator must be authorized by the national authority in whose airspace the approach procedure is promulgated; and

(b) The appropriate navigation equipment, in addition to the GPS equipment, must be installed and operational in the aircraft; and

(c) The appropriate ground based navigation aid (s) must be serviceable.