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ORGANIZATION OF EASTERN CARIBBEAN STATES (OECS):-

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Policy for use of Global Position System (GPS) Navigation Equipment in the OECS

For the organization of Eastern Caribbean States (OECS):- Antigua and Barbuda, Anguilla, Commonwealth of Dominica, Grenada, Monsterrat, St. Christopher (St. Kitts) and Nevis, St. Lucia and St. Vincent and the Grenadines.

1. Introduction

1.1 This circular sets out the airworthiness criteria and operational matters associated with the use of GPS when flying under IFR. 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. The Director of Civil Aviation, Organization of Eastern Caribbean States regulates air navigation in the following countries:-

Antigua and Barbuda
St. Christopher (St. Kitts) and Nevis
Anguilla
Montserrat
Commonwealth of Dominica
St. Lucia
St. Vincent and the Grenadines
Grenada

1.2 Definitions of terms used and reference documents are at Annex A.

2 Description of GPS

2.1 The NAVSTAR Global Positioning System (GPS) of the United States Department of Defence (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 dimensiona1 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 meters or better should be available on 95% of occasions and 300 meters 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 is proposing to adopt was 84 as a world standard, to be in use by 1998.

2.4 Currently, positioning information throughout the world is derived from local or regional datums; for example, European Datum 1950 and Nouvelle Triangulation de France (NFT) 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 co-ordinates of the same position when measured against WGS 84. Differences of several hundred meters 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 world-wide 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 the GPS Constellation and Equipment

3.1 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 integrated navigation system where other sensors are used in addition to GPS.

3.2 In airborne equipment incorporating both the GPS sensor and navigation capability, determining 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 contributing 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.

3.3 In airborne equipment where a GPS sensor provides data to an integrated navigation system e.g. FMS or a multi-sensor navigation system, either the GPS sensor is required to provide RAIM or the multi-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.

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

3.5 The limitations discussed above make GPS suitable for use only as a Supplemental Air Navigation System for certain phases of flight.

4. Use of GPS

4.1 When the airborne navigation equipment using GPS is DCA/OECS 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 plate 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 may be superseded by Airworthiness and Operational Standards promulgated by this Directorate.

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) Approved by the DCA/OECS as complying with FAA TSO-C129, Class A, or equivalent, and meeting the intent of the associated FAA Notice N8110.47; and

(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) Approved by the DCA/OECS as complying with FAA TSO-C129, Classes B or C, or equivalent, and meeting the intent of the associated FAA Notice N110.48; 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 as required by the applicable legislation must be obtained using the current certification procedures of British Civil Airworthiness Requirements (BCAR) which for the time being have been adopted by the DCA/OECS.

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; and

(ii) the GPS equipment is used during a non precision approach only where an approved procedure has been published by the national regulatory authority; and

(iii) the criteria stated in Annex B are met

(b) Multi-Sensor equipment using GPS

The criteria stated in Annex B 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 Annex B are met

7.2 Due to satellite coverage and their elevation and geometry re1ative 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 other approved navigation systems.

8. The Future

8.1 At present, GPS is the only satellite-based system capable of giving a usable service to aviation. GLONASS, the Russian Global Navigation Satellite System, is some way from reaching an operational capability. Combinations of GPS and GLONASS plus other civil satellites and ground augmentation facilities are possible components for a civil Global Navigation Satellite System (GNSS). ICAO has established working groups to develop the principles governing the operation of GNSS.

8.2 It is evident that a GPS based system is potentially capable of achieving aeronautical navigation performance requirements for en-route, terminal area and precision landing. Many technical and institutional issues require resolution before GPS can be used in other than a supplemental role.

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

ANNEX A

1 Definitions

1.1 Receiver Autonomous Integrity Monitoring (RAIM)

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

1.2 Sole Means Air Navigation System

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

1.3 Stand –alone GPS Navigation System

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

1.4 Supplemental Air Navigation System

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

2. References

EUROCAE Edition 58
Minimum Operational Performance Specification for Area Navigation Equipment using Multi-sensor Inputs.

EUROCAE Edition 58
Minimum Operational Performance Specification for Airborne GPS Receiving Equipment.

FAA TSO-C115 a
Airborne Area Navigation Equipment using Multi-sensor Inputs

FAA TSO-C129
Airborne Supplemental Navigation Equipment using the Global Positioning System. (GPS)

RTCA DO 208
Minimum Operational Performance Standards for Airborne Supplemental Navigation Equipment using Global Positioning System (GPS)

FAA NOTICE N8110.47
Airworthiness Approval of Global Positioning System (GPS) Navigation Equipment for use as a VFR and IFR Supplemental Navigation System

FAA NOTICE N8110.48
Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors.

Note: The two FAA Notices are time limited. They were due to expire in April 1994, by which time the FAA had intended to replace them with Advisory Circular Material

ANNEX B

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 OECS as complying with FAA FAA TSO-C129, Classes A1, B1, B3, C1, or C3 or equivalent and be installed to meet the intent of the applicable FAA Notices; and

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

(c) all approach plates and databases as of the 1st January 1998 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 flu non-precision approaches is initially restricted to approaches based on VOR, VOR/DME, NDB, NDB/DME and RNAV let-downs.

1.1.1 Specific

1.2.1 For the approach used:

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

(b) the appropriate ground based navigation aid(s) must be serviceable; and

(c) the appropriate navigation equipment, in addition to the GPS equipment, must be installed and operational in the aircraft.