INTERNATIONAL CIVIL AVIATION ORGANIZATION SAM/IG/9-WP/15
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Assistance for the implementation of a regional ATM system according to the ATM operational concept and the corresponding technological support for CNS
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Agenda Item 4: Standards and procedures for the approval of performance-based navigation operations

(Presented by Colombia)

SUMMARY

This working paper shows the process followed by the Civil Aviation Security Secretariat of Colombia *(Secretaría de Seguridad Aérea de la Aeronáutica Civil de Colombia)* for the approval of conventional procedures based on radio aids using approved RNP systems even when the radio aid is out of service.

References:

- Airbus A320 AFM
- Boeing B737-600 AFM
- Embraer 170 AFM

ICAO Strategic Objectives:	*A – Safety* *B - Security* *C – Environmental protection*

1. **Background**

1.1 RNAV routes and some RNAV arrival and departure procedures as well as RNP approach procedures have already been officially published for major airports and at airports lacking conventional aids in Colombia as of 20 October 2011.

1.2 However, although our main operators are already RNAV/RNP approved under the PBN concept, there is a large number of airports and aerodromes throughout the Colombian territory, and many of them only have procedures based on conventional aids such as NDB, VOR/DME.

2. **Discussion**

2.1 A technical study of aircraft operating in Colombia, specifically those FMS-equipped, revealed that some of these systems support procedures based on radio aids even if the such radio aids are out of service and even if the airborne equipment is inoperative.

2.2 For example, the Rionegro airport has a VOR arrival procedure for runway 36. The Avianca A320 FMS always flies "GPS Primary" by default, meaning that even if the VOR is inoperative, the FMS algorithm supported by the database knows the exact position of the VOR and, through the GPS, can plot radials from that position, just like the VOR would do if operative. The FMS retrieves the procedure from the database and executes it regardless of whether the VOR station is operative or not. Even if the VOR receiver is inoperative, the FMS executes the procedure provided the GPS is working properly with RAIM availability.

2.3 Let us see some examples of aircraft limitations in the AFM:

- AIRBUS A320

AIRBUS A320 AIRPLANE FLIGHT MANUAL	LIMITATIONS AUTO FLIGHT SYSTEM FLIGHT MANAGEMENT SYSTEM

- After takeoff provided FMGS runway updating has been checked
- In terminal area provided:
  - GPS PRIMARY is available, or
  - HIGH accuracy is displayed and the appropriate RNP is checked or entered on the MCDU, or
  - navaid raw data is monitored.

NAV, or NAV and APP NAV and FINAL APP mode may be used for VOR, VOR/DME, NDB, NDB/DME or RNAV (including GPS or RNAV(GNSS)) approach but not for ILS, LOC, LOC-BC, LDA, SDF, GLS or MLS final approach.

APPROACHES

Ident.: **LIM-22-FMS-00009571.0002001 / 23 NOV 09** **EASA APPROVED**
Criteria: ((A319 or A320 or A321) and (25205 or 26111 or 26485 or 26999 or 28382 or 30241 or 30631 or 30635))

The FINAL APP mode guidance capability with GPS PRIMARY has been demonstrated down to MDH/DH (barometric) 250 ft.

VOR, VOR/DME, NDB or NDB/DME approach procedures may be performed, in NAV, or NAV and APP NAV and FINAL APP mode, provided AP or FD is used and:
- GPS PRIMARY is available. In this case, the reference navaid may be unserviceable, or the airborne radio equipment may be inoperative, or not installed, provided an operational approval is obtained.

2.4 As may be seen, this AFM clearly and explicitly states that procedures based on radio aids may be executed even if the station or the airborne equipment is inoperative, and even if the equipment is not installed on board, except for procedures based on ILS or LOC alone.

- BOEING B737 NG

BOEING

737-600/-700/-800/-900
AIRPLANE FLIGHT MANUAL

F L I G H T M A N A G E M E N T C O M P U T E R S Y S T E M
(F M C S) Software update U10 and later versions.

The Flight Management Computer System has been demonstrated to meet the requirements of Advisory Circular 20-130A for a multi-sensor area navigation system when operated with radio or Global Position System (GPS) updating. When operated in this configuration, the FMCS may be used for enroute and terminal area operations and instrument approach navigation (excluding ILS, LOC, LOC-BC, LDA, SDF, GLS, and MLS).

One FMC, one CDU, one VOR, one IRU in NAV mode, and either one DME or GPS (if installed) operational at dispatch are required for RNAV operations (FAA AC20-130A, JAA AMJ 20X2), unless other appropriate procedures are used.

2.5 This AFM is not as explicit as the previous one, but a further analysis shows that it is equivalent, that is, it allows procedures based on radio aids even if such radio aids are inoperative, except for ILS or LOC procedures.

- EMBRAER 190

SUPPLEMENT 4
PRIMUS EPIC - FLIGHT MANAGEMENT SYSTEM

AIRPLANE FLIGHT MANUAL

EMBRAER 170

- The use of FMS Speed guidance is prohibited when the FD vertical mode is standby.
- The use of VNAV guidance is prohibited when the FD vertical mode is standby.
- The use of the VNAV guidance when the FD mode is other than VNAV is prohibited unless pilots set the ALT SEL to each waypoint altitude constraint required by the FMS entered procedure.
- The use of GPS is limited to areas where GPS is approved. De-selection of GPS should be performed in other non-approved areas.
- Prior to flight using the FMS for IFR navigation, a minimum of one VOR, DME, and IRS must be verified to be installed and operational. Also, any appropriate ground facilities (VOR, DME) that are utilized by the procedures to be flown must be verified as operational using an approved method (NOTAM, etc.).

2.6 For some unclear reason, Embraer limits the execution of procedures to when the station and airborne equipment are operative.

2.7 In view of the above, the Air Navigation Service Bureau (*Dirección de Servicios a la Navegación Aérea*) in coordination with the Secretariat of Air Security (*Secretaría de Seguridad Aérea*) issued circular AIC C09/12 (see the appendix to this working paper) to clarify the use of RNP systems in conventional SIDs, STARs and approach procedures.

2.8 **Suggested action**

a) If the States deem it advisable, use this paper as a reference for approving procedures based on radio aids for aircraft that have limitations, even if the radio aids are out of service.

b) It should be noted that in these cases the recommendation is to check RAIM availability at the airport of destination, since it is a pre-requisite in such cases, taking into account that FMS executes the procedure using GNSS information.

c) This procedure may not be used in lieu of the LOC.

- END -

APPENDIX

AIC C09/12 USE OF RNP SYSTEMS IN CONVENTIONAL DEPARTURE, ARRIVAL, AND APPROACH PROCEDURES

EFFECTIVE DATE: 28 FEBRUARY 2012

1. PURPOSE

1.1. The purpose of this circular (AIC) is to provide an operational and airworthiness guide on the suitability and use of RNP systems when applying conventional procedures based on radio aids within Colombian airspace, even if the radio aid or airborne equipment associated to the procedure is temporarily out of service, provided compliance with the MEL. This includes holding patterns, departure procedures (SIDs), arrival procedures (STARs), as well as approach procedures (NPA/PA), except for the final segment of the procedures if supported by a localiser, in which case this radio aid needs to be operative.

1.2. This AIC may be applied in two different scenarios: when the RNP system is used as a SUBSTITUTE MEANS of navigation and when it is used as ALTERNATE MEANS of navigation.

1.3. Use of the RNP system under any of the scenarios described in 1.2 DOES NOT turn the scenarios described in 1.1 into RNAV/RNP procedures; however, some operational procedures described below are similar.

1.4. This AIC allows greater precision when following conventional paths whose protection zones are more conservative as compared to RNAV/RNP procedures, thus attaining greater confinement of the path flown, which ensures the safety of operations, provided compliance with the procedures described in this AIC.

2. DEFINITIONS

2.1. RECEIVER AUTONOMOUS INTEGRITY MONITORING (RAIM): Technique whereby an airborne GPS receiver/processor autonomously checks the integrity of navigation signals from GPS satellites.

2.2. ALTERNATIVE MEANS OF NAVIGATION: It means using information from an RNP system in lieu of information from a serviceable operational radio aid (VOR, NDB, VOR/DME, NDB/DME, or COMPASS LOCATOR), whose signal is compatible with an airborne navigation equipment, which must be operational and where the pilot has no need to monitor the radio aid, provided it is thus specified in the aircraft flight manual (AFM).

2.3. SUBSTITUTE MEANS OF NAVIGATION: It means using information from an RNP system rather than from an operational radio aid (VOR, NDB, VOR/DME, NDB/DME or COMPASS LOCATOR) that is out of service, whose signal is compatible with an airborne navigation equipment and which may be out of service provided it is thus stipulated in the aircraft flight manual (AFM) and is in compliance with the MEL.

2.4. APPROPRIATE RNP SYSTEM: A system that provides on-board performance control and alert and that meets the performance requirements established for this type of operation, such as instrument flight rules, and that is suitable for the operation with the procedure to be flown in terms of the navigation performance criteria established by the UAEAC of Colombia, such as SIDs, STARs, and instrument approach procedures.

3. SCOPE

3.1. This AIC applies only to aircraft of an air operator that has been authorised by the Aviation Security Secretariat (*Secretaría de Seguridad Aérea* - SSA) of the UAEAC of Colombia, in its OPERATION SPECIFICATIONS, to conduct approach operations (RNP APPROACH) based on a GNSS sensor, using a multi-sensor system in accordance with circular 5102-082-008 or 009 or 010.

3.2. In order to use RNP systems as a SUBSTITUTE means of navigation pursuant to paragraph 3.1, air operators shall have a special approval from the UAEAC SSA in their OPERATION SPECIFICATIONS, in keeping with that specified in the aircraft flight manual (AFM) or its supplement.

3.3. The RNP system shall not be used as a substitute or alternative means of navigation when the AFM or AFM supplement specify radio aid monitoring as MANDATORY during the execution of the procedure.

4. USE OF THE RNP SYSTEM

4.1. Subject to the requirements prescribed in this AIC, flight crews may use their RNP system to determine the position or distance from a radio aid or a radio-aid defined fix, to navigate to/from a radio aid, perform a holding pattern or fly a DME arc, even when a radio aid or radio aids are required in the aeronautical chart for the execution of a procedure (for example: VOR/DME BOG REQUIRED).

4.2. The RNP system may NOT be used in lieu of an LOC signal.

4.3. The RNP system may NOT replace lateral guidance in the VOR or NDB final approach, unless the crew is completely assured, in real time, of GPS signal integrity.

5. FLIGHT PLANNING

5.1. Operators capable of using the RNP system as an alternative and/or substitute means of navigation shall report RNP capability, GPS equipment, and RNP APPROACH navigation specification in the FPL/RPL using the corresponding suffixes.

5.2. It will NOT be necessary to file a new FPL when a radio aid required to navigate a SID, STAR, or approach at the departure, destination, or destination alternate aerodrome has been declared as INOPERATIVE via NOTAM.

5.3. Operators planning to use the RNP system as a substitute means of navigation shall consult NANU NOTAMs as well as RAIM availability before flight departure, for which they may use a valid RAIM prediction programme, or the airborne equipment, or a GNSS NOTAM published by the UAEAC of Colombia.

5.4. For the purpose of flight planning, at least a take-off alternate or destination alternate aerodrome with an instrument approach procedure that does not require GNSS shall be available. For instance, if the airborne VOR equipment is out of service, an NDB, LOC, or ILS approach shall be available.

6. OPERATIONAL CONSIDERATIONS

6.1. The navigation database shall be current throughout the flight. If the AIRAC cycle changes during the flight, the flight crew shall ensure the precision of navigation data by comparing the electronic data with the information contained in the aeronautical charts.

6.2. The flight crew shall inform air traffic control of their intention and capability of using the RNP system as a substitute means of navigation of an out-of-service radio aid.

6.3. The flight crew shall retrieve the procedures to be flown from the navigation database. IT IS FORBIDDEN to enter routes or procedures manually using latitude/longitude, location/course or location/course/distance functionalities.

6.4. The flight crew shall deselect the radio aid that has been declared out of service via NOTAM from the flight management and guidance system (FMS) before starting the procedure.

6.5. The crew shall navigate the tracks defined in the procedure as precisely as possible with the help of the lateral deviation indicator and any other airborne display, unless authorised by ATC or in an emergency.

6.6. Whenever the crew uses the RNP system as a substitute means of navigation, it shall suspend the procedure upon losing GNSS signal integrity or in the event of any alarm indicating unacceptable degradation of the navigation system.

7. TRAINING

7.1. The ATC does not require specific training to issue a control clearance that includes a route, a departure procedure (SID), an arrival procedure (STAR), or an RNP-based conventional approach as a substitute or alternate means; however, it must be aware of that described in this AIC.

7.2. The flight crew shall be aware of both the information contained in this AIC and of the operational procedures approved for RNAV 1, 2 and RNP APPROACH navigation specifications.

8. PHRASEOLOGY

8.1. Air traffic control and the flight crew shall use the standard phraseology described in ICAO Doc 4444 (Air Traffic Management) applicable to area, approach, and aerodrome control services. This means that there is NO difference between control clearances, whether the route or authorised procedure is executed based on the area navigation equipment or on radio aid signals.

8.2. The flight crew shall inform ATC when capable of using the RNP system as a substitute means of navigation.