International Civil Aviation Organization
CAR/SAM Regional Planning and Implementation Group (GREPECAS)
Sixteenth Meeting of the CAR/SAM Regional Planning and Implementation Group (GREPECAS/16)
Punta Cana, Dominican Republic, 28 March – 1 April 2011

Agenda Item 3: Performance framework for Regional Air Navigation Planning and Implementation

3.1 Global, inter-regional and intra-regional activities concerning air navigation systems in the CAR/SAM Regions

FLIGHT INSPECTION ACTIVITIES IN BRAZIL

(Note presented by Brazil)

SUMMARY

This working paper aims to introduce participants to the methods of flight inspection for new RNAV and GBAS procedures being implemented in Brazil.

References:
- Brazilian Flight Inspection Manual – MANINV
- Annex 10, ICAO Vol I
- Doc 8168, Vol II, ICAO

1. Introduction

1.1 In recent years, Brazil has created RNAV GNSS procedures to be used in most of its airports. Such procedures include, besides the approach phase, the arrival and departure phases, thus becoming an important alternative to those based on ground aids.

1.2 Due to greater flexibility in establishing fixes, an aircraft using RNAV GNSS procedures executes optimized routes, improving the standard of air navigation and helping to minimize the impact of the constant increases in air traffic flow nationwide.

1.3 All this required the establishment of very specific flight inspection rules for each type of procedure. These parameters, based on Brazil's extensive experience in flight inspection, the Brazilian Flight Inspection Manual and the international legislation (ICAO and FAA), will be discussed below.

2. Analysis

2.1. The possibilities arising from RNAV GNSS procedures are numerous, including aircraft vertical guidance during approaches. In this area, DECEA is in the process of approving 240 APV/Baro-VNAV procedures in major airports, of which some 30 procedures have already been published. Concomitantly, a GBAS station in the Rio de Janeiro International Airport is in final stage of installation.

2.2. The implementation of new types of procedures, the importance of which is justified by safety requirements (as is the case of the APV procedures) or by an operating gain (as is the case of ILS procedures with RNAV transition and SID RNAV procedures), led DECEA to draft these new procedures for about 140 public airports operating under instruments in Brazil, totaling 640 new charts, which are currently in a publication schedule sorted by priority, taking into account the user needs and the objectives of Resolution A37-1 of the 37^{th} ICAO Assembly.

2.3. The inclusion of these new procedures and new navigation aids in the Annual Flight Inspection Programme (PROINV) led to a significant increase in the activities of the Special Flight Inspection Group (GEIV).

2.4. The procedures based on Performance-Based Navigation and on GBAS required reformulation of the criteria applied in flight inspection, the summary of which is presented in Appendix “A” to this working paper.

3. Action Suggested

3.1. The Group is invited to:

a) Take note of the information provided in this working paper;

b) Discuss means for exchanging flight inspection rules and methods, with a view to ensure the harmonization of the air navigation procedures in the CAR/SAM Regions.

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Summary of Flight Inspection Criteria Applicable to PBN and GBAS

1. LNAV Flight Inspection Procedures

1.1. In the inspections of RNAV procedures of lateral guidance only (LNAV), the following items are observed:

a. Waypoint Accuracy

The accuracy and representation of the waypoints established in the procedure should be checked. The applicability and correct representation of fly-by and fly-over waypoints established in the procedure should be checked.

NOTE: Except for specific operational needs, IAF, IF and FAF will be defined by "fly-by waypoints" and MAPt will be defined by "fly-over waypoint."

b. Bearing Accuracy

Where applicable, the bearings, as shown in the instrument approach procedures, should have their accuracy assessed.

c. Distance Accuracy

The distances should have their accuracy verified by means of the Aircraft Positioning System (SPA). The information contained in the system database should be previously validated so as to ensure the accuracy of the distances inserted in the procedure.

d. Checks before Take-off

New procedures must be assessed before the flight inspection, by inserting the waypoints in the aircraft system and comparing the information about distances, bearings and vertical profiles between the waypoints and the information contained in the charts.

e. Aid Coverage

The air traffic control expert should provide the flight inspection crew with the analysis used in drawing up the procedures. The Check Pilot (PI) shall confirm the coverage of the different aids and identify any interferences or multipath effects, in the case of GNSS navigation.

1.2. In case of procedures based on DME/DME position information, an assessment shall be made of the impact on the navigation solution of all the DME signals received during the course established. The assessment must determine:

- Which DME provide coverage (considering proper signal strength) over the route proposed – the purpose is to confirm the coverage defined when the procedure was prepared;
- If the position accuracy is suitable for all the waypoints along the route, using the DME stations available - the purpose is to confirm that the navigation system errors, assumed by the air traffic controller expert, are within the tolerance ranges;
- If any DME is critical for ensuring proper coverage;

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- If a DME has a negative effect on the accuracy of the position information;
- If there is any electromagnetic interference with a negative effect in signal reception; and
- If there is any false information for any reason (**ex.:** multipaths).

1.3. In case of GNSS procedures, the coverage is monitored during operation by means of the Receiver Autonomous Integrity Monitoring (RAIM) System. The assessment must determine whether:

- Suitable horizontal positioning accuracy is achieved with RAIM availability;
- There is any electromagnetic interference with a negative effect in signal reception; and
- There is a minimum masking angle due to topographical aspects associated with the procedure.

2. APV BARO/VNAV Approach Procedures

2.1. The APV/Baro-VNAV procedure adds the possibility of approaches with vertical guidance to the lateral guidance procedures (RNAV) without meeting the requirements defined for precision approach operations.

2.2. A Baro-VNAV navigation system has a computed vertical guidance, with a vertical path angle (VPA), normally at 3º. The parameters of a vertical guidance approach using the pressure type altimeter are based on the performance criteria of the aircraft, wherein the Navigation System Error (NSE) and the Flight Technical Tolerance Error (FTE) are calculated, and the Total Error (TSE) is the root sum square of these errors.

2.3. Although the optimal descent angle for Baro-VNAV approaches is 3º, when, for technical and/or operational reasons, it is not possible to use an optimum slope, such angle may be elevated up to a maximum of 3.5º. Once the vertical approach angle is determined, the maximum variation allowed will be approximately 0.1º.

2.4. With vertical navigation based on barometric pressure, the minimum obstacle clearance (MOC) is directly influenced by the atmospheric temperature, because of the proximity of isobaric lines at low temperatures. At very low temperatures, the nominal slope of 3ºcan suffer a reduction, resulting in the decrease of minimum heights. For this reason, the flight inspection teams shall observe the minimum temperature for executing Baro-VNAV procedures, published in the corresponding IAC.

2.5. Flight inspection of Baro-VNAV procedure is divided into 2 (two) stages, the first one referring to the verification of the accuracy of the information contained in the chart and the flyability of the procedure, and the second one, which will assess the clearance of the procedure.

2.6. In the first stage of the inspection flight of the Baro-VNAV procedure, the following aspects should be considered:

- the approach procedure should be preferably flown with the information already stored on the aircraft navigation system database, by means of a the Flight Management System (FMS) update card;

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- If such information is not available, data must be entered manually into the FMS by the Check Pilot;
- Preference should be given to the flight using the autopilot in order to evaluate the transition to the final segment with vertical guidance;
- For verifying the Baro-VNAV procedure, there will be no need to set up the Aircraft Positioning System (SPA) nor to store/print data by the Flight Inspection System Operator (OSIV); and
- During the flight, the "RAIM PREDICTION" on the APPR configuration should also be verified, as well as if the APPROACH mode of the FMS is enabled.

2.7. In the second stage of the inspection flight of the Baro-VNAV procedure for checking clearance, only the final approach segment should be evaluated, since the initial and intermediate segments are common to the LNAV (RNAV GNSS) procedure. To this end, the Check Pilot should follow the steps below:

- The Check Pilot must plan the flight point to point on the FMS, according to the file concerning the procedure. This flight will also be performed with approach precision on the FMS of the aircraft;
- The flight begins, remains on the final approach course on FAF (FAP), at an altitude of 100 ft above the FAS (Final Approach Segment), which is the obstacle limiting assessment surface of the Baro-VNAV procedure, as prescribed in ICAO Doc 8168-Vol II, Construction of Visual and Instrument Flight Procedures;
- Maintain a constant descent rate for a set point at the final approach of the procedure, coded by the distance from the threshold or coordinates, which should be overhead 100 ft below the DA;
- Then, the aircraft will maintain the flight on the level (100 ft below the DA) until intercepting the assessment surface of the missed approach segment, which will be defined by a point, coded by the distance from the threshold or coordinates;
- Over the point described in the previous item, the aircraft should begin its climb maintaining standard gradient of 2.5%, or the gradient published on the file concerning the procedure (Fig. 2); and
- During the flight over the segment described above, there should be no obstacles at the same altitude of the aircraft.

2.8. Besides these characteristics inherent to the procedures with vertical guidance, all other items common to a RNAV approach procedure must be inspected as prescribed in Section 214 of the Brazilian Flight Inspection Manual (MANINV), including the tolerances.

3. GLS (GBAS) Approach Procedures

3.1. To meet the requirements of the CAT I precision approach operations, the use of GBAS was chosen for improving the GNSS signal.

3.2. GBAS is a critical safety system consisting of hardware and software that improves the GPS Standard Positioning Service (SPS) and, potentially, any constellation in the future, providing improved service levels and supporting the CAT I approach in the system’s coverage area. GBAS operates in the frequency range from 108 to 117.95 MHz, enabling an increase in accuracy and setting the reference

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point of the precision approach, according to the requirements of Annex 10.

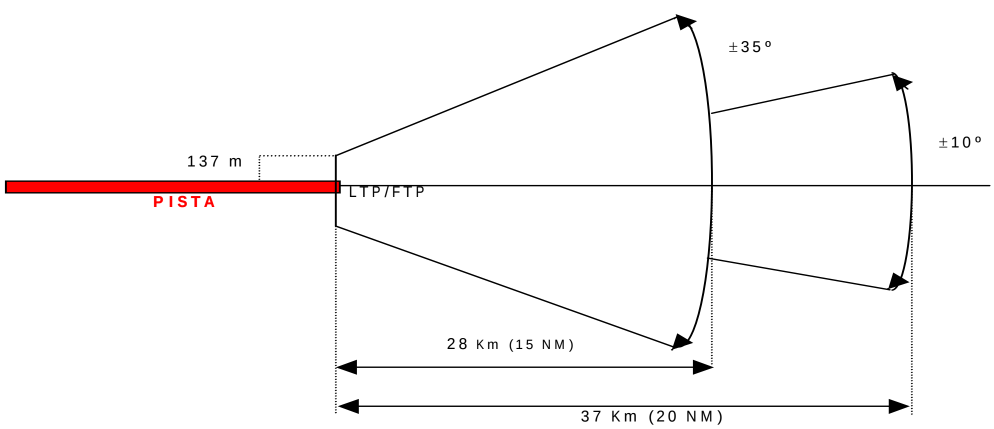
3.3. GBAS initially will be used according to the ILS "*look alike*" concept, in order to minimize the differences in precision approaches for pilots, airlines and air traffic controllers, as well as reduce deployment, operation and maintenance costs. Thus, current onboard architecture is harnessed, for example, making the information generated by the GBAS receiver to be the same as those generated by the ILS receiver.

3.4. Brazil is developing flight inspection procedures for the GBAS system. To execute them, it counts on EMB-110 and H-800XP aircraft equipped with the Flight Inspection System UNIFIS3000, which uses a Rockwell Collins MMR (Multi Mode Receiver) receiver.

3.5. The following items will be checked in the inspection, namely:

- Interference in frequency – the inspection must ensure that the frequency range of the VDL (VHF Data Link) is free from interference, and that there is no interference in the GPS frequency;
- VDB Coverage – inspection must demonstrate that the system meets all the procedure coverage volume;
- Approach procedure – inspection should ensure the procedure's fly ability, clearance of obstacles and consistency with the approach chart,
- Data from the final approach segment (FAS) – the inspection should ensure that information from the FAS data block is correct,
- Accuracy of the procedure – the accuracy of the procedure can be verified using a DGPS system for comparison.

3.6. To check the VDB (VHF Data Broadcast) Coverage, two arcs should be made (35 to 15 NM and 10 to 20 NM), in which the minimum height will be established by the field strength achieved.



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NOTES: **1 -** The LTP is a point over which the FAS path passes at a relative height specified by the TCH. LTP is normally located at the intersection of the runway centerline and the threshold.
2 - A single arc of ± 35° to 20 NM may be filed instead of two arcs of ± 10° to 20 NM and ± 35° to 15 NM.
3 - The arcs for multiple or parallel runways can be combined to minimize the flight inspection time.
4 - The minimum field strength requisites shall be confirmed at the lower vertical coverage limit (0.9° or 0.3/0.45) of the angle of the glide path. If the field strength is not satisfactory, the altitudes should be gradually raised in increments of 500 ft until the altitude that matches the lower limit of the coverage volume.

3.7. To verify the final approach path the maximum and minimum field strength requirements should be confirmed along all final approach segments (FAS) served by the ground subsystem. The inbound course should be followed along the final approach course in accordance with the procedure, intercepting the glide path, descending to 100 ft below the specified Decision Altitude (DA), up to the Missed Approach Point (MAPT). When necessary, coverage up to 3.7 m (12 ft) should extend above the runway surface, and the maximum and minimum field strength should be confirmed up to the touchdown point. If the signal strength is not satisfactory before the interception of the glide path, the altitudes should be gradually raised in increments until they match the lower limit of the coverage volume.

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