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North American, Central American and Caribbean Office

**Special Eastern Caribbean Communication, Navigation and Surveillance Meeting
(S-E/CAR CNS)**

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S-E/CAR CNS - WP/07

01/10/04

Agenda Item 3: Navigation Developments
3.1 GNSS Implementation

IMPLEMENTATION OF GNSS IN THE EASTERN CARIBBEAN

(Presented by the Secretariat)

SUMMARY
This working paper presents proposals to continue the implementation of the GNSS in the Eastern Caribbean.
References: <ul style="list-style-type: none">• Report of the AN-Conf/11. Montreal, October 2003.• Report of the GREPECAS/12. Havana, Cuba June 2004.• ICAO Annex 6.• Amendment 79 to Annex 10, Volume I.

1. Introduction

1.1 Some Eastern Caribbean States/Territories have been implementing the use of GNSS en-route and support for non-precision approach operation subject to conditions defined by appropriate national regulatory authority or service provider. The GNSS training available is ongoing.

1.2 The Eleventh Air Navigation Conference, 2003 (An-Conf/11) formulated Recommendation 6/1, encouraging inter alia, that:

- a) air navigation service providers move rapidly in coordination with airspace users, with a view to achieve, as soon as possible, worldwide capability to at least APV1 performance; and
- b) States and airspace users take note of the available and upcoming SBAS navigation services providing for APV operations, and take necessary steps towards installation and certification of SBAS capable avionics.

1.3 The GREPECAS/12 meeting, held in Havana, Cuba, on 3-7 June 2004, through Conclusion 12/45 recommended to CAR/SAM States/Territories/International Organizations take into account the new “*Regional guidelines for the transition to the global navigation satellite systems (GNSS)*” and the “*Regional strategy for the introduction and application of non visual aids to approach, landing and departure*”,

presented in Appendices S and T, respectively to the Agenda Item 3 of the GREPECAS/12 Report (shown in **Appendix A** and **Appendix B** respectively of this paper).

1.4 Based on AN-Conf/11 Recommendation 6/1 – *Transition to satellite based air navigation*, as well as Recommendation 6/9 – *Support and participation in SBAS preoperational implementation activities*, the Meeting considered that, the main activities should be routed towards the continuation of studies to mitigate the ionosphere effects in the Equatorial zone, as well as elaborate alternate proposals to define SBAS augmentation system's evolutionary architecture and the introduction of GBAS. Based on the regional strategy and guidance shown in Appendix W to the Agenda Item 3 of the GREPECAS/12 Report (shown in **Appendix C** of this paper). Consequently, the GREPECAS/12 Meeting also formulated Conclusion 11/46 – *CAR/SAM Regional Activities for the SBAS and GBAS Implementation*.

1.5 The Amendment 79 of the Annex 10, Volume I, describes that the date of applicability is 25 November 2004, presenting changes to GNSS SARPs and related guidance material concerning performance specifications for approach specifications for approach with vertical guidance (APV); global positioning system (GPS) selective availability (SA) discontinuation and clarification of signal power level; specifications for modernized Global Navigation Satellite System (GLONASS-M); frequency planning criteria for ground-based augmentation system (GBAS) and a number of other enhancements.

2. Discussion

2.1 In accordance to paragraph 3.7.2 of Annex 10, Volume I; the GNSS navigation services shall provide position and time data to the aircraft using various combinations of the following elements installed on the ground, on satellites and/or on board the aircraft: Global Positioning System (GPS) that provides the Standard Positioning Service (SPC), Global Navigation Satellite System (GLONASS) that provides the Channel of Standard Accuracy (CSA) navigation signal; aircraft-based augmentation system (ABAS); satellite-based augmentation system (GBAS) and aircraft GNSS receiver.

2.2 ICAO Annex 10, Volume I, Table 3.7.2.4-1 establishes the signal-in space performance requirements for the following typical operation:

- a) En-route (oceanic/continental low density).
- b) En route (continental).
- c) En route, Terminal.
- d) Non-precision approach (NPA), Departure.
- e) Approach operations with vertical guidance (APV-I).
- f) Approach operations with vertical guidance (APV-II).
- g) Category I precision approach (*Note*).

Note: GNSS performance requirements for Category II and III precision approach operations are under review and will be included in the Annex 10 at a later date.

2.3 ICAO annex 6 defines two types of APV operations:

- a) approaches using vertical guidance provided by processing of barometric information (baro-VNAV) by the flight management system (FMS); and
- b) approaches using guidance (horizontal plus vertical) provided by Satellite Based Augmentation Systems (SBAS).

2.4 In order to continue implementing the GNSS in the Eastern Caribbean, it is suggested that Meeting recommends actions to review and update the Eastern Caribbean GNSS implementation plan as part of the CNS/ATM implementation plan and the related national plan. Therefore, the following steps have to be undertaken:

- a) The new “*Regional guidelines for the transition to the global navigation satellite systems (GNSS)*” and the “*Regional strategy for the introduction and application of non visual aids to approach, landing and departure*”, that are shown in Appendix A and Appendix B of this paper; and
- b) the new SARPs on the GNSS containing in the ICAO Annex 6 and Annex 10, Volume I; and
- c) E/CAR States and Territories follow-up the CAR/SAM regional activities for the SBAS and GBAS trials and planning implementation.

3. Suggested Action

3.1 The Meeting is invited to:

- a) take note of the information in this working paper;
- b) take note of the need that the Eastern Caribbean States, Territories and International Organization will review and update Eastern Caribbean and National GNSS implementation plans, recommending relevant actions;
- c) take note of the need that the Eastern Caribbean States, Territories and International Organization follow-up the CAR/SAM regional activities for the SBAS and GBAS implementation;
- d) take into consideration the relevant GREPECAS conclusions and the ICAO SARPs; and
- e) formulate other considerations deemed appropriate.

APPENDIX A

(Appendix S to the Agenda Item 3 of the GREPECAS/12 Report)

GUIDELINES FOR TRANSITION TO SATELLITE NAVIGATION SYSTEMS IN THE CAR/SAM REGIONS

1. GNSS should be introduced in an evolutionary manner, with improvements in GNSS capability generating increasing benefits, and culminating in GNSS supporting all phases of flight. As GNSS evolves, the planning for the removal of ground-based navigation aids should take account of the issues described below:
2. The ground infrastructure for current navigation systems must remain available during the transition period.
3. States/regions can consider segregating traffic according to navigation capability and granting preferred routes to aircraft with better navigation performance where this can be done without reducing airspace capacity.
4. Before any existing ground infrastructure is considered for removal, users shall be given reasonable transition time to allow them to equip with GNSS to attain equivalent navigation service.
5. As GNSS is introduced for en-route operation, States/regions should coordinate to ensure that harmonized separation standards and procedures are developed and introduced concurrently in all flight information regions along major traffic flows to allow for a seamless transition to GNSS-based navigation
6. In planning the transition to GNSS, the following issues must be considered:
 - a) maintaining or improving the current level of safety;
 - b) schedule for provision and/or adoption of a GNSS service, including aircraft and operator approval processes;
 - c) extent of existing ground-based radio navigation services;
 - d) strategy for transition schedule to GNSS capability (i.e. benefits-driven or mandatory);
 - e) appropriate level of user equipage with GNSS capability;
 - f) provision of other air traffic services (i.e. surveillance and communications);
 - g) density of traffic/frequency of operations;
 - h) mitigation of risks associated with radio frequency interference failures and ionospheric issues;
 - i) design and implementation of procedures; and
 - j) over-all economics and lead times to introduce aircraft avionics requirements.

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APPENDIX B

(Appendix T to the Agenda Item 3 of the GREPECAS/12 Report)

STRATEGIES FOR THE INTRODUCTION AND APPLICATION OF NON VISUAL AIDS IN APPROACH, LANDING AND DEPARTURE IN THE CAR/SAM REGION

- a) Maintain the ILS as the ICAO standard precision approach and landing system as long as necessary and as long as it remains operationally acceptable and economically beneficial, doing everything possible to not deny access to airports to aircraft equipped only with ILS;
- b) implement GNSS with augmentation as required for APV and Category I operations where operationally required and technically feasible and economically beneficial, taking into account GNSS evolution;
- c) promote the development and use of a multi-modal airborne landing capability;
- d) promote the use of APV operations, particularly those using GNSS vertical guidance, to enhance safety and accessibility; and
- e) identify and resolve operational and technical feasibility issues for GNSS with ground-based augmentation system (GBAS) to support Category II and III operations; Implement GNSS for Category II and III operations where operationally required and economically beneficial.

APPENDIX C

(Appendix W to the Agenda Item 3 of the GREPECAS/12 Report)

CAR/SAM REGIONAL STRATEGIES AND RULES TO DEFINE THE SATELLITES BASED AUGMENTATION SYSTEM (SBAS) ARCHITECTURE AND THE INTRODUCTION OF GROUND BASED AUGMENTATION SYSTEM (GBAS) AND TO LEAD THEIR IMPLEMENTATIONS

1. Based on the AN-Conf/11, Recommendation 6/9 — *Support and participation in SBAS pre-operational implementation activities*, the States/International Organizations participating in SBAS pre-operational implementation activities including RLA/00/009 and RLA/03/902 projects, to study the feasibility of leading to the CAR/SAM Regions extension of the WASS and EGNOS augmentation systems respectively, CAR/SAM Regions own SBAS with an increment of the integrity functions and other estimated feasible alternatives.
2. To perform the above-mentioned studies, bear in mind the GNSS evolutionary development derive from the implementation phases of the new multiple signals and multiple constellations, as well as the SARPs, so that the implementation be gradual and progressive by two consecutive implementation stages, in which the required actions be defined, aim at satisfying the Table CNS 3 – *Radio navigations aids*, contained in the FASID, Part IV, according to the following Table:

Phases of the SBAS and GBAS -GNSS implementation		
Phase	Date	Minimal performance to be satisfied
Phase I: (Initial GNSS-SBAS introduction)	Current – 2010	<ul style="list-style-type: none"> • En-route Navigation and en-route terminal; • Capacity of non-precision approach (NPA); and • Approach capacity, which is not a precision with vertical guidance - APV-I (in equatorial areas this capacity may not be obtained).
Phase II: (Final GNSS-GBAS Introduction)	2010 - 2015	<ul style="list-style-type: none"> • APV II and Precision approach (PA) Category I. • PA Cat II and Cat III.

Note: These phases would be conditional to the come into service of different constellations and new GNSS signals, according to the AN-Conf/11 foreseen periods.

3. The SBAS and GBAS introduction would be in accordance with the CAR/SAM Regions guidelines for the transition of the navigations systems and the regional strategy for the system's implementation in support of the approach, landing and departure operations.
4. During Phase I, the SBAS-GNSS initial implementation should be aim at resolving problems on the air space and to increase the instrument flights, as well as to facilitate the improvement of the access, terminal area operations and the RNAV coverage flexibility, particularly in the mountainous areas (with a number of obstacles or with other limitations (e.g. noise reduction requirements) and to achieve the GNSS benefits in operations and safety matters, including the system's advanced capacities. This service should be achieved with small investments and with the coordinately States/International organizations participation. Also during this phase the system should satisfied APV-I performance requirements, with the exception of the equatorial areas. 5. Additionally, during Phase I conventional ground radio aids will be kept as a backup to the GNSS or integrated to it.

Resulting from the rapid and large ionosphere changes taking place at the equatorial zone, including the ionospheric scintillation, the GNSS signals interruption should be mitigated making a better use of the ground navigation radio aids, as well as with support from radar surveillance and other techniques, in conformity with AN-Conf/11, Recommendation 6/2 - *Guidelines on mitigation of GNSS vulnerabilities*.

6. During Phases II it is expected that the effects caused by the ionosphere quick and big changes be minimized due to the availability of the multiple new signals and constellations. The results should be observed on the studies carried out by Brazil, other States and the ICAO guidance texts. The final GNSS will essentially consist in the level of services increment to achieve APV-II performances and precision approach (PA) Category I. Moreover, the GBAS introduction should be carried out in order to contribute to obtain the Category I, II and III in general.