

INTERNATIONAL CIVIL AVIATION ORGANIZATION

**RLA/00/009 PROJECT SECOND COORDINATION MEETING ON GNSS AUGMENTATION
TRIALS**

(Río de Janeiro, Brazil, 28 to 30 August 2002)

**Agenda Item 3: Report on activities carried out to date regarding execution of the project
GNSS AUGMENTATION TRIALS IN THE CAR/SAM REGION (CSTB)**

(Presented by the Secretariat)

Summary

This working paper informs the meeting on the activities carried out for the execution of the GNSS Augmentation Regional trials and on the forthcoming activities.

References:

- RLA/00/009 Project Document; and
- Report of the RLA/00/009 Project Coordination Meeting on GNSS augmentation trials (Santiago, Chile, 1 to 3 August 2001).

1. Background

1.1 A chronogram of activities for the execution of the project activities was established during the RLA/00/009 project coordination meeting on GNSS augmentation trials carried out in Santiago, Chile, from 1 to 3 August 2002.

1.2 The execution of the chronogram was divided into three phases; phase one corresponding to the installation of the TRS reference stations, phase two, the execution of the training programme and phase three, the trials execution.

1.3 The dates indicated in the chronogram had to be modified due to the tragedy of 11 September 2001. To date, all TRS have been installed, some communications circuits between the TRS and the master stations have been implemented and the remaining will be implemented through the SAM Digital Network (REDDIG), once it becomes operational.

1.4 Two courses were held within the training programme, one related with the installation of a reference station and the other, on data analysis of WAAS augmentation signals.

1.5 With respect to the execution of the trials, recordings of the GPS satellite signal were made, as well as of the Inmarsat geostationary satellites in the WAAS console installed on board the flight inspection aircraft of the Chilean civil aviation, and of the information registered on ground at the reference stations. The trials were carried out in Argentina, Bolivia, Chile and Peru.

2. Activities carried out

2.1 The GNSS augmentation trials, as formulated during the RLA/00/009 project (Santiago, Chile, 1 to 3 August 2002), are mainly oriented towards en route and non precision approach operations. As a first phase of implementation, the project considered the holding of flight trials in Argentina, Bolivia and Peru with the aim of validating the integrity, precision, continuity, availability and coverage for the above indicated operations.

2.2 Between the FAA specialists in GNSS augmentation systems and the Brazilian aeronautical personnel in charge of the GNSS augmentation trials, it has been verified that, as result of the GNSS augmentation trials, the behaviour of the ionosphere in this area is completely different to the ionosphere behaviour over the United States, therefore, the ionosphere model implemented in the Rio de Janeiro master station, which is the same as the master station implemented in United States, is not applicable for the mentioned area, becoming the establishment of a new ionospheric model necessary.

2.3 During the conclusions formulated at the end of the course on WAAS augmentation signal data analysis, held in Atlantic City from 18 to 22 February 2002, it was considered that, to complete the study initiated in Brazil, it had become necessary that the main objective of the trials to be executed in Argentina, Bolivia, Chile and Peru consist in the acquisition and storage of GPS data in the WAAS console of the flight inspection aircraft, and in the TRS reference stations. All this with the aim of analysing the errors generated in the GPS signals due to the ionosphere.

2.4 The trials were carried out from 12 to 24 May 2002. The recordings of the flight data were made from the Millenium GPS receiver installed in the WAAS trial console of the Chilean flight inspection aircraft. The recording of the data collected from the Chile, Argentina and Peru reference stations were carried out at the data banks of the FAA WAAS Trial Centre in Atlantic City. This was possible due to the existing communications links among the Chile, Argentina and Peru reference Stations with the Chile Master Station, and, at the same time, the circuit between the Chile Master Station and the FAA WAAS Trial Centre in Atlantic City. Since during the trial, the circuit between the Bolivia and Chile master stations had not been implemented, part of the TRS data was recorded in a portable computer and later recorded in a CD.

2.5 The recording of the ground data is constantly effected; the recording of on board data, only during the execution of the flight trials. All flight trials were carried out two to three hours after sunset, since major ionospheric activity presents itself at that time.

2.6 The aircraft departed Arturo Merino airport in Santiago, Chile, at 01:00 UTC of 12 May 2002, arriving to Ezeiza airport at 03:05 UTC. The aircraft stayed in Argentina until 15 May. Due to bad weather in the area, the collection of data during non precision approach procedures was only made on 15 May, with the participation of local personnel.

2.7 The Chilean aircraft departs Ezeiza on 15 May at 22:00 UTC towards La Paz, with a stop in Tarija. The recording of the flight data starts at 22:00 UTC until arrival to El Alto/La Paz international airport at 02:50 UTC. The aircraft remains in Bolivia until 21 May. During the stay in Bolivia, many non precision approach operations were made, with the participation of local personnel for data collection.

2.8 On 21 May at 01:00 UTC, the Chilean aircraft departs La Paz en route to Lima, arriving at 02:50 UTC. During this flight all data collected was recorded by the WAAS trial console Millenium receiver. The aircraft remained in Lima until 25 May. During that time, many non precision approach operations were made, with the participation of local personnel for data collection.

2.9 The aircraft left Lima at 02:00 UTC of 25 May via Antofagasta, arriving at 04:00 UTC. During this flight all data collected was recorded by the WAAS trial console Millenium receiver.

2.10 All data collected in flight was recorded in a CD and sent to the FAA Technical Centre in Atlantic City for analysis. The data from the Chile, Argentina and Peru TRS was recorded at the FAA data bank in Atlantic City at the time when the communications circuits were working. The data from the Bolivia TRS was recorded in a CD because during the trial the communications line between La Paz and Santiago had not been implemented.

2.11 The results of the analysis elaborated by the FAA are presented in another working paper. **Appendix A** to this paper describes the activities carried out to date at participating States.

3. **Extension of GNSS augmentation trials in the CAR/SAM Regions**

3.1 The trials for en route and non precision approach operations to verify the integrity, precision, continuity, availability and coverage for the afore indicated operations will be carried out once all reference stations are installed and operational, all required communications circuits are established, satellite ground station is implemented and augmentation is disseminated through the geostationary satellite. This will form part of the final phase of the project's execution. It has been foreseen that these final trials start at the end of 2002 and continue up to 2004.

3.2 Many of the States participating in the project have indicated their interest for the project to cover other operational phases, such as 1000 ft minimum vertical separation for en route navigation, as well as approaches requiring certain vertical precision, such as vertical guidance.

3.3 The afore mentioned operations need certain vertical precision not required for en route and NPA navigation. To carry out SBAS trials in the CAR/SAM Regions requiring vertical precision, which includes the Equator line between +/- 20°, a ionospheric model study of all the Region is required.

3.4 Through the ionospheric model, the level of possible air operations will be verified, as well as establish appropriate corrections to the GPS signals affecting operations by this phenomenon. Some CAR/SAM States have investigated the existence of national scientific organizations in charge of studying the ionosphere and how it affects radiofrequency signals, to get orientation permitting to obtain a ionosphere model that will aid in the planning of domestic air navigation.

3.5 To not duplicate efforts and work in a standardized manner, ICAO, together with States of the Region, could start studies regarding the requirements necessary that will help to elaborate air operation trials requiring vertical precision. During the seventh meeting of Directors of Civil Aviation (RAAC/7)

(Bahia, Brazil, 1 to 3 July 2002), Conclusión 7/9 was formulated, which proposes the need to reformulate the objectives of the project.

3.6 RLA/00/009 project does not have the necessary resources to carry out these studies, therefore, to extend the reach of GNSS augmentation trials in aeronautical procedures requiring vertical precision, the meeting is submitted the following draft conclusion, for approval:

CONCLUSION 2/X - STUDY FOR THE EXTENSION OF TRIALS UNDER RLA/OO/009 PROJECT

That the Project take into consideration and study the viability of extending the satellite based augmentation trials, such as for those requiring vertical precision.

4. **Actions suggested**

4.1 The meeting is invited to:

- a) take note of the information contained in this working paper; and
- b) consider the draft Conclusion in paragraph 3.5 above for analysis and approval.

APPENDIX A

ACTIVITIES CARRIED OUT AT STATES PARTICIPATING IN THE PROJECT

Argentina

The TRS is installed and operational since December 2001 and the communication with the Master Station in Chile was completed in March 2002. From 12 to 15 May trials consisting in the obtainment and storage of GPS data and of Inmarsat geostationary satellites through the WAAS console installed on board the Chilean flight inspection aircraft, and recording of data from the TRS.

The trials were held two to three hours after sunset. En route data was registered during the Santiago de Chile/Buenos Aires and Buenos Aires/La Paz flights. In addition, flight trials on non precision approach procedures were made at Ezeiza airport. During these last trials, personnel from the Argentinean civil aviation administration had the opportunity of active participation.

The data obtained and processed by the TRS during the flight trials were recorded in the FAA Atlantic City WAAS Trial Unit data bank (NTSB). All of it could not be recorded for there were interruptions in the circuit between the Buenos Aires TRS and the Chile TMS.

Bolivia

The equipment for the reference station was sent to Bolivia in two parts and the last part was shipped in mid-April 2002. The TRS was installed by the first week of May 2002, when it also became operational. The circuit between the La Paz TRS and the Chile TMS has not been installed. The recording of the information received by the TRS was done locally. The information was copied to a CD and sent to the Lima ICAO Office for further remittance to the NTSB trial centre of the FAA in Atlantic City.

Flight trials were held from 15 to 21 May and consisted in the obtainment and storage of GPS data and of Inmarsat geostationary satellites in the WAAS console at the Chilean flight inspection aircraft during enroute operation phase over Bolivian territory during Buenos Aires/La Paz and La Paz/Lima flights, as well as non precision approach operations at El Alto international airport in La Paz. All these trials were effected two to three hours after sunset. Bolivian civil aviation personnel had the opportunity to actively participate in the non precision approach trials.

Brazil

The five TRS stations, as well as the TMS station foreseen for Brazil are installed and operational since September 2001. Likewise, all of the communication links between the reference stations and the master station have been implemented. In-flight trials were conducted in January 2002 with the collaboration of FAA technical personnel for the purpose of collecting GPS data in order to analyse the behaviour of said data in the ionosphere. In March 2002, a seminar on the ionosphere was conducted, at which the results of the trial were presented.

To complete the regional trial platform, the implementation of the communications circuits between the Rio de Janeiro master station and the Colombia and Honduras reference stations is pending, as well as the circuit with the Chile Master Station. For the establishment of these circuits, the installation of a VSAT station from the Colombian satellite network has been foreseen in Rio de Janeiro, Brazil, and Tegucigalpa, Honduras; the latter has already been installed. The implementation of the communications circuit between the Chile and Rio de Janeiro master stations will be through the REDDIG.

Chile

The reference stations in Chile, as well as its master station, are installed and operational since 1998. As for the topology of the regional trial platform, the communication circuit between the La Paz reference station and the master station in Chile is still lacking, as is the connection between the Santiago master station and that of Rio. The implementation date for these circuits is described in sections on Bolivia and Brazil in this working paper.

The Chilean flight inspection aircraft carried out flight trials for the collection of GPS data and of Inmarsat geostationary satellites for enroute and non precision approach in Argentina, Bolivia, Chile and Peru between 13 and 24 May.

Colombia

The reference stations was installed by the end of May 2002, pending the communications circuit with the Brazil master station. To be able to analyze the data stored in the light trials and in the reference stations, Colombia is proceeding with the installation of an application software for the processing and presentation of the trials results. This software is being installed with the collaboration of the FAA. The same software is installed in Río de Janeiro.

COCESNA

The installation of the reference station was ready by the end of May 2002, still pending the implementation of the circuit with the Brazil master station.

Panamá

The reference station is installed and operational, and is connected to the FAA master station in Atlantic City, making it part of the United States satellite-augmentation trial platform (NTSB). The information from the Panama reference station will also be interconnected with the Rio master station once the circuit between Rio de Janeiro and Atlantic City has been implemented.

Perú

The reference station of Peru is installed and operational since December 2001, as is the communication circuit between the Lima reference station and the Santiago master station. Trials regarding obtainment and storage of GPS data and of the Inmarsat geostationary satellites through the WAAS console installed on board the Chilean flight inspection aircraft, and recording of data from the TRS were carried out from 21 to 24 May.

Trials were carried out two to three hours after sunst. En route data was registered during the flight over Peruvian territory in the La Paz/Lima and Lima/Santiago de Chile routes. Likewise, flight trials were carried out using non precision approach procedures at the Jorge Chavez International airport in Lima. During these last trials, Peruvian civil aviation administration personnel had the opportunity of actively participating.

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