International Civil Aviation Organization

THE SIXTH MEETING OF IONOSPHERIC STUDIES TASK FORCE (ISTF/6)

Bangkok, Thailand, 19 – 21 January 2016

Agenda Item 2: Review of outcome of relevant Meetings/Conferences

OUTCOME OF THE NSP/2 MEETING

(Presented by Chairman of ISTF)

SUMMARY

This paper presents the outcome of the 2nd meeting of the Navigation Systems Panel (NSP/2) related to ISTF work which was held from 1 to 11 December 2015 in Montreal.

1. Introduction

1.1 The 2nd meeting of the Navigation Systems Panel (NSP/2) was held from 1 to 11 December 2015 at the ICAO Headquarter in Montreal, Canada.

1.2 After the 1st NSP meeting, the working groups and subgroups of the panel were renamed as summarized in Table 1.

Previous name	New name
Working group 1	-
Conventional navaids and testing subgroup (CNTSG)	Conventional navaids and testing working group (CNTWG)
Category-II/III subgroup (CSG)	GBAS working group (GWG)
GNSS SARPs subgroup (GSSG)	GNSS SARPs working group (GSWG)
Spectrum subgroup (SSG)	Spectrum working group (SWG)
Validation subgroup (VSG)	Validation working group (VWG)
Working group 2	Navigation operations working group (NOWG)

1.3 CNTWG, GWG, and VWG were held in the first week, and GSWG, SWG and the panel plenary meeting were held in the 2nd week of the NSP/2.

2. Discussion

2.1 In GWG, the validation of the ionospheric gradient monitoring (IGM) was one of the two issues left before the validation of the draft SARPs of GBAS service type-D (GAST-D). Another issue was the validation of compatibility and frequency coordination criteria of the VHF data broadcast (VDB) with ILS localizer, VOR, and VHF COM.

2.2 The major issue of IGM was that the tropospheric delay gradient may be a noise to degrade the delectability of the IGM. This was not found until the operational validation of the draft SARPs of the GAST-D were conducted in the world after technical validation was completed.

2.3 It was also discussed how to incorporate the plasma bubbles which were shown to have large ionospheric gradients exceeding the threat space which were used for the technical validation.

2.4 An ad hoc group on IGM has working on these issues with weekly teleconferences, and presented possible approaches to address these issues. GWG was of the view that these issues could be addressed, although the validation may require some more time.

2.5 According to the general rule of the Air Navigation Commission (ANC) to amend SARPs in even years, the draft SARPs of GAST-D will be finalized for approval of NSP in 2016 for applicability date of November 2018. The GWG and its IGM ad hoc group continue working on addressing the issue by continuing hard work with weekly teleconferences.

2.6 The meeting report of NSP/2 on Agenda Item 3 - SARPs for GNSS elements and signals (GBAS) is attached to this paper.

3. ACTION REQUIRED BY THE MEETING

3.1 The meeting is invited to do the following:

a) note the information included in this paper; and

b) discuss any relevant topics as appropriate.

4. ATTACHMENT

4.1 Meeting report of NSP/2, Agenda Item3, SARPs for GNSS elements and signals (GBAS)

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NSP/2-WP/37
11/12/15

NAVIGATION SYSTEMS PANEL (NSP)

SECOND MEETING

Headquarters, 1 to 11 December 2015

AGENDA ITEM 3

The attached constitutes the report on Agenda Item 3 and should be inserted at the appropriate place in the yellow folder.

Agenda Item 3: SARPs for GNSS elements and signals (GBAS) (Ref: Job card NSP005.01)

3.1 INTRODUCTION

3.1.1 Agenda item 3 was mainly addressed by the GBAS Working Group (GWG), which is responsible for the development of SARPs and guidance material for GBAS, and by a joint meeting of the GWG and the Spectrum Working Group (SWG).

3.1.2 The report of the GWG to the full panel meeting was provided in Flimsy 9, available on the NSP website. The report to the full panel meeting from the joint meeting of the GWG and SWG was provided in Flimsy 20, also available on the NSP website. The present report compiles and summarizes the relevant elements of the working group and joint working group meeting reports contained in those flimsies and reflects the agreement of the full panel meeting.

3.1.3 The main focus of the work on this agenda item was the review of validation materials for a substantial package of changes to Annex 10, Volume I, containing the provisions enabling GBAS to support CAT II/III operations (GBAS approach service type D (GAST-D).

3.2 STATUS OF GBAS RESEARCH AND IMPLEMENTATION

3.2.1 IP/1 reported on the completion of the FAA's planned GAST-D SARPs validation work program with the successful development and testing of commercial ground station and avionics. The FAA's work now focuses on support of Honeywell's GAST-D System Design Approval (SDA) for an approved GAST-D capable GBAS ground station by mid-2019.

3.2.2 IP/15 summarized the status of GBAS research and development activities in Japan. The operational validation program performed in support of the GAST-D validation is expected to reach completion at the end of 2016. The program includes the development of advanced GNSS-based procedures. A new research project focused on multi-constellation, multi-frequency (MCMF) GBAS has been started.

3.2.3 Oral reports on the status of GBAS activities were received from Australia, China, France, Germany, the United Kingdom, EUROCONTROL, Airbus, Boeing, Honeywell and Indra Navia. A brief summary of the reports is provided below. Additional details are available in Flimsy 9.

3.2.3.1 Australia has a SLS-4000 GBAS in service at Sydney providing CAT-I service to all six runway ends. Any aircraft with State of Registration GLS approval may use the Sydney GBAS. Approximately 24 percents of flights into Sydney are GLS equipped.

3.2.3.2 China has completed two demonstration projects at Shanghai airport using Boeing and Airbus aircraft and at Tianjin Binhai airport using flight inspection aircraft. A team has been established to produce regulations and standards aimed at validation and operational approval.

3.2.3.3 France has two GBAS stations located at Toulouse Airport. The first one is a CAT-I experimental facility used to certify Airbus GBAS installations. The second one is a GAST-D prototype.

Phase 2 of the GAST-D implementation was completed last year, and Phase 3 (extended verification) is progressing well.

3.2.3.4 The German air navigation service provider (DFS) is working on GBAS CAT I implementation and supporting GBAS CAT II/III development in the framework of European projects (SESAR 15.3.6). A GBAS CAT-I station is operating in Frankfurt and is used by several German and international airlines operating Airbus and Boeing aircraft.

3.2.3.5 The United Kingdom has a number of on-going activities, including operational benefit workshops, various technical programs, interference monitoring at Heathrow, development of flight inspection and ground testing procedures, and research into ionospheric effects on GBAS.

3.2.3.6 EUROCONTROL is contributing to GBAS development through European (SESAR) projects, including an increased research effort on multi-constellation, multi-frequency (MC/MF) GBAS. EUROCONTROL is also involved in large scale demonstrations within the framework of the Advanced Approaches to Land (AAL) SESAR project. GBAS advanced operations (adaptive glide path, displaced threshold for wake reductions, etc.) are being investigated in the SESAR 6.8.8 project and work is on-going on an update of the GBAS GAST D safety assessment.

3.2.3.7 Airbus has successfully certified GBAS Landing system (GLS) Cat I autoland on various aircraft types since 2008. Airbus is involved in GBAS GAST D and MC/MF GBAS in the context of SESAR GBAS projects. Airbus contributed to the ICAO GAST D validation activities in several aspects and in particular the VDB link budget, the definition and validation of certification requirements through the All Weather Operations Harmonization Advisory and Rulemaking Committee (AWO HARC), and autoland performance demonstrations by simulations and guided take-off using GBAS.

3.2.3.8 Boeing has GLS capability available as a standard feature of the 787 and 747-8 airplanes and as an option on the 737NG. GLS capability for the 777 and out-of production airplanes (757, 767, MD 11 etc.) is under study.

3.2.3.9 Honeywell GBAS activities are focused in the following areas: 1) system design approval (SDA) of the Block II SLS-4000 SmartPath CAT I GBAS station; 2) support to European GAST-D validation activities (SESAR project); and 3) the active development of a GAST D system (SLS-5000).

3.2.3.10 Indra Navia is supporting European (SESAR 15.3.6) validation activities from an industrial point of view. The company has installed 17 Special CAT-I (SCAT-1) stations, which are used in daily operations.

3.3 COORDINATION WITH OTHER PANELS AND GROUPS

3.3.1 Flimsy 2 summarized the work done by EUROCAE Working Group 62 to assess the changes needed to ED114A to include the GAST-D requirements. The target to finish the work is the second quarter of 2018.

3.3.2 IP/4 summarized the status of GBAS MOPS development activities by RTCA Special Committee 159 (SC-159), Working Group 4. SC-159 is currently developing two products: 1) a revised RTCA GPS/LAAS Airborne MOPS (DO-253 rev. C to D), and 2) a revised RTCA GPS/LAAS Interface Control Doc. (ICD) (DO-246 rev. D to E). Also, RTCA will update the VDB MOPS requirements. The

updates to these documents reflect ICAO SARPs updates. RTCA will also work in coordination with NSP to incorporate requirements updates to define an Extended Service Volume (ESV) for the Precision Approach service. A number of issues are taking longer to close, and RTCA still plans to release DO-253D and DO-246E after ICAO NSP has completed validation of GAST D SARPs requirements. Since GAST-D SARPs validation is now planned for end of 2016, the RTCA MOPS and ICD are not anticipated to be approved until 2017.

3.3.2.1 Flimsy 7 discussed the status of requests to integrate the use of the GBAS positioning service into the navigation specifications of the ICAO PBN manual.

3.3.2.2 Flimsy 8 addressed the different uses of the terms GBAS and GLS in the different ICAO documentation and applications. It recommends that NSP develops and provides guidance on the use of both terms.

3.3.2.2.1 The GWG concluded that a definition of GLS in Annex 10 is no longer needed.

3.4 EXTENDED SERVICE VOLUME

3.4.1 WP/9 provided an updated summary of the working group progress and plan addressing extended service volume (ESV) for GBAS, as well as a high-level summary of the technical approach being investigated. The ultimate goal of this effort is to harmonize an ESV for incorporation into the Annex along with the GAST D amendment.

3.4.1.1 An RTCA technical team has identified several options for providing an extended service that could optionally be utilized in different ways to extend precision approach operations. The GWG decided to form an ad-hoc group that will work jointly with the RTCA ad-hoc group on a definition of the MOPS and SARPs changes needed to enable two approaches identified by the technical team. (See also Flimsy 3).

3.5 INTERFERENCE MASK

3.5.1 WP/7 reviewed the issue of interference in the GPS band and the applicability of the interference mask in the SARPs to GBAS ground station reference receivers. The SARPs contain an interference mask applicable for GPS receivers to ensure adequate performance in the presence of interference. The paper raised the question of the applicability of this mask to GBAS reference receivers in the ground subsystem.

3.5.1.1 The GWG decided that it would be desirable to include minimum interference mask characteristics applicable to GBAS reference receivers in the SARPs. A change to Annex 10 was proposed in Flimsy 12, but the GWG decided that the proposal needed more work.

3.6 REVIEW OF VALIDATION MATERIALS

3.6.1 GBAS SARPs material for GAST-D was developed over the past ten years, approximately. WP/4 provided the current status of validation for the GBAS GAST D and SARPs maintenance change proposal given in NSP/1 Report on Agenda Item 3 in Appendices B and C. It had

been noted at NSP/1 that two outstanding issues remained to be closed, with 17 total associated requirements yet to be validated, and a plan had been presented aiming at completing the validation prior to NSP/2. The meeting was informed that one of the two issues (and 15 associated requirements) remained open. The paper explained the work that has been done, the requirements that have been closed, and those that remain open. In addition, a plan for completion of the remaining validation was presented.

3.6.1.1 The GWG confirmed that the paper presented an accurate description of the status of the validation work.

3.6.2 WP/13 presented the results of GAST-D flight experiments at the New Ishigaki airport in the South of Japan during both quiet and disturbed ionospheric conditions. The GAST-D performance was similar for flights in quiet and moderately disturbed ionospheric conditions.

3.6.2.1 The GWG discussed the results and noted that, although severe ionospheric conditions resulted in poor availability during the flight tests, integrity was maintained. Hence the ionospheric monitors were performing their intended function. The GWG agreed to include the paper as partial validation of the Ionospheric Gradient Monitor (IGM) requirements.

3.6.3 IP/10 presented the results of a GBAS Reference Receiver Antenna Local Object Consideration Area (RRA LOCA) assessment conducted in the framework of the SESAR 15.03.06 project. Preliminary conclusions of the assessment indicate that, with proper antenna siting, critical and sensitive areas (CSA) will not be needed for GBAS installations

3.6.4 IP/11 reported on the European SESAR GBAS validation activities. It highlighted the completion of the CAT III validation activities in SESAR project 6.8.5, the definition of extended activities in both SESAR projects 9.12 and 15.3.6, and the progress of the MC/MF GBAS activities in SESAR project 15.3.7.

3.7 VDB LINK BUDGET

3.7.1 Papers WP/6, WP/8, WP/10, WP/12 and WP/17, discussed below, were considered by the joint GWG/Spectrum Working Group (SWG) meeting (in addition to the GWG meeting). Additional details are provided in Flimsy 20.

3.7.2 WP/6 provided an update on preliminary frequency compatibility conditions for GBAS VDB and ILS. These conditions are preliminary pending the finalization of final frequency coordination criteria. Further work on frequency coordination criteria for GBAS VDB by SWG is expected and may or may not be completed in time for 2018 SARPs amendment cycle. The paper contains proposed changes to Attachment D sections 7.2.3 and 7.2.4 and associated validation.

3.7.2.1 The meeting agreed to the proposed changes to sections D.7.2.3 and D.7.2.4 contained in revision 1 of WP/6 with small editorial changes.

3.7.3 WP/17 presented the results of an analysis of several frequency compatibility scenarios to evaluate the interference impact of certain input parameters in the RTCA MOPS (i.e., on-board antenna gain variation factor, AGVF, and transmission line loss variation factor, TLVF). The analysis shows that the adjacent channel rejection requirements in the GBAS draft MOPS lead to a desired-to-undesired

signal ratio (D/U) of −46 dB, which in turns leads to separation distances between GBAS, ILS and/or VOR that are impractical.

3.7.3.1 It was then commented that an on-board antenna gain variation of 15 dB should be considered in the analysis when the ILS is the interferer and the GBAS VDB is the victim, and that RTCA should explore a potential change of the adjacent channel rejection requirement beyond the 3rd adjacent channel. RTCA SC-159 WG4 members present at the meeting pointed out that related changes are in the work program of RTCA SC-159 WG4.

3.7.4 WP/10 presented the results of several actions assigned to Airbus during the NSP SWG meeting of April 2015. The meeting decided that additional guidance material should be developed and agreed values of the on-board antenna gain variation that should be applied in frequency compatibility analyses (15 dB for ILS interferer, GBAS victim, and 0 dB for GBAS interferer, ILS victim).

3.7.4.1 Flimsy 5 was produced to define "reasonable" spatial separation assumptions between a VDB transmitter and an aircraft VHF navigation receiver antenna in the operational environment of an airport. This definition is intended then be used to determine the required D/U ratio for ILS desired to GBAS undesired and to derive siting criteria for VDB transmit antennas.

3.7.5 WP/8 presented the initial results of GBAS VDB frequency planning exercises conducted in the frame of SESAR 15.03.07 project Task 011. These exercises were executed in accordance with the assumptions and scenarios described in WP/26 from the May 2014 NSP meeting. The main objective of the task is to revise the GBAS VDB capacity study conducted by the ICAO GNSS Panel in 2000 and assess the VDB frequency availability in Europe. An additional aim was to assess the difference between the use of existing ICAO European Frequency Management Group (FMG) temporary criteria for GBAS compatibility with ILS and VHF COM, contained in EUR DOC 011, and the use of SESAR criteria that were submitted to ICAO in WP/4 from the NSP/1 meeting. The assessment was conducted in two phases (runs), using different versions of the Eurocontrol spectrum management tool and different scenarios/assumptions. The results of the first run showed that a 100% GBAS frequency allocation success rate was reached, However, initial results from the second run (which included additional constraints, such as out-of-band compatibility) indicated that it was not always possible to find a free frequency for the 916 GBAS stations considered in the study. In many cases the limitations were due to the constraints imposed by FM broadcast stations. Additional results will be present at the next NSP meeting.

3.7.5.1 The meeting noted that the results of this study were much better than those presented in 2000, and commented that an evaluation should be made using existing adjacent channel requirements in RTCA DO-253 C (e.g.,−46 beyond 3rd adjacent channel).

3.7.6 WP/12 discussed VDB field strength variation at airports served by multiple VDB stations. Transmission of the VDB signal from multiple antenna locations on the airport surface may be necessary at complex airports in order to take full advantage of GBAS services. The proposed ICAO SARPs impose limits on the variation in incident power at the airborne receiver antenna port. The paper discussed that requirement and its implications for installations with multiple VDB antenna locations.

3.7.6.1 Flimsy 11 provided proposed changes for guidance material related to approval of approaches where multiple VDB stations are radiating for a single ground station, and the power variation between consecutive burst in subsequent frames exceeds the allowable limit due to alternation of messages between the transmitters.

3.8 IONOSPHERIC GRADIENT DETECTION

3.8.1 IP/17 presented the results of the ionosphere impact evaluation on GBAS operations in Brazil using data collected during solar cycle 24 (2008 -) by SLS-4000 station installed in Rio de Janeiro International Airport (SBGL) airport and L1/L2 GPS receivers.

3.8.2 WP/5 provided an overview of investigations performed since the last GWG meeting in April 2015. It also presented the work plan to close the validation activity prior to the planned December 2016 NSP/3 meeting.

3.8.2.1 The full mitigation of the threat due to ionospheric delays is an important aspect of the finalization of the GAST D SARPs requirements, and resolving this issue has proven to be challenging. The mitigation is a shared responsibility between the ground and airborne subsystems, with the ground subsystem being responsible for verifying compliance. The proposed SARPs material addresses the ionospheric requirements and associated guidance material in Sections B.3.6.7.3.4 and D.7.5.6.1. The paper describes the current proposed path to closing the issue, provides a brief history of the issue, and identifies other possible avenues of investigation. It describes two approaches to validating ionospheric gradient monitor requirements.

3.8.3 IP/5 presented additional information regarding Approach 1 to validating ionospheric gradient monitor requirements. The primary concept of Approach 1 is to detect and respond to the presence of tropospheric gradients that could potentially mask an ionospheric gradient.

3.8.4 IP/19 provided additional information on the plan on using Approach 2 to validating ionospheric gradient monitor requirements. Approach 2 relies on a proposed reduction in the distance from the ground centroid to the Landing Threshold Point (LTP).

3.8.4.1 The above two papers generated much discussion, in particular aimed as assessing the advantages and disadvantages of the two approaches, but the meeting could not reach a firm conclusion.

3.9 OTHER ISSUES

3.9.1 No papers were presented under this agenda item.

3.10 CONCLUSIONS

3.10.1 Noticeable progress has been accomplished since NSP/1 toward resolving the open issues. The VDB link budget issue has been resolved. Resolving the ionospheric gradient monitor issue continues to present a difficult challenge. However, progress has been made and a path to resolving the issue has been laid out. A work program to ensure completion of the work by the NSP/3 meeting has been agreed. It includes several teleconferences between NSP/2 and NSP/3, as well as a meeting of the GWG in Seattle, Washington, in August 2016, to review the SARPs package prior to NSP/3.

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