



International Civil Aviation Organization

**THE THIRD MEETING OF THE ASIA/PACIFIC GBAS/SBAS
IMPLEMENTATION TASK FORCE (APAC GBAS/SBAS ITF/3)**

(Video conference, 27-28 September 2021)

Agenda Item 4: Technical Updates related to GBAS/SBAS

REVIEW OF GUIDANCE DOCUMENTS RELATED TO IONOSPHERIC ANOMALIES

(Presented by Co-Chairs)

SUMMARY

This paper reviews the GBAS safety assessment guidance documents related to anomalous ionospheric conditions and identifies items to be updated.

1. INTRODUCTION

1.1 The GBAS and SBAS safety assessment guidance documents related to anomalous ionospheric conditions were adopted by the ICAO Asia-Pacific (APAC) region in 2016.

1.2 Since then, there have been updates in ICAO SARPs. GBAS Approach Service Type D (GAST-D) has been standardized in SARPs to support Category II/III precision approach and landing. SARPs for the dual-frequency and multi-constellation (DFMC) SBAS will be effective in ~~2022~~ 2023. To support safety assessment related to anomalous ionosphere for these new services, the APAC guidance documents need to be updated.

1.3 Related to GBAS, the ICAO Navigation Systems Panel (NSP) is working on updating the Annex 10 Attachment D to revise guidance on safety assessment related to the ionosphere for both GAST-C, which is supposed to support Category I precision approach, and GAST-D. It is a good opportunity to review the APAC guidance on GBAS and the ionosphere so that the update of the APAC guidance will be aligned with the updates of Annex 10 Attachment D.

1.4 This paper reviews the GBAS safety assessment guidance documents related to anomalous ionospheric conditions and identifies items to be updated.

2. DISCUSSION

GBAS safety assessment guidance related to anomalous ionospheric conditions

2.1 The table of contents of the original document does not align with the structure of the document body. For example, while the document body is structured as nested sections such as Section 1, subsection 1.1, etc., the table of contents is structured as Section 1, item a, subitem i, etc. Furthermore, item 2f in the original document which is “Ionospheric front model (wedge model) and its important parameters” does not exist in the document body.

2.1.1 In view of the above, the contents of the GBAS safety assessment guidance related to anomalous ionospheric conditions are proposed to be amended as follows:

1 Introduction

- 1.1 GBAS and its fundamental principles
- 1.2 Scope: GBAS threat model to mitigate anomalous ionospheric conditions
- 1.3 Ionospheric effects on GBAS
 - 1.3.1 Propagation delay
 - 1.3.2 Scintillation effects

2 Ionosphere conditions to consider for GBAS safety analysis

- 2.1 Overview of relationship between GBAS safety assessment and ionospheric conditions
- 2.2 Nominal conditions bounded by PL (protection level)
- 2.3 Anomalous conditions and ionospheric disturbances to consider
 - 2.3.1 Storm enhanced density
 - 2.3.2 Plasma bubble
 - 2.3.3 Other
- 2.4 Ionospheric threat model for GBAS safety analysis
- 2.5 Ionospheric front model (wedge model) and its important parameters
 - 2.5.1 Ranging errors induced by ionospheric anomalies
 - 2.5.2 Positioning errors in the final implementation
- 2.6 Other important descriptions
 - 2.6.1 Locations, dominant season/time, occurrence rate and number of impacted satellites

3 Development and validation of the threat model

- 3.1 Observational approach
 - 3.1.1 Tools like LTIAM
 - 3.1.2 Time Step method
 - 3.1.3 Other
- 3.2 Simulation approach
 - 3.2.1 Three dimensional analysis
- 3.3 Validation

4 Post-implementation activities

- 4.1 Monitoring of ionospheric activity
- 4.2 Maintenance of threat model

5 Annexes

- 5.1 CONUS model
- 5.2 Safety analysis for GBAS prototyping in Osaka
- 5.3 other

2.1.2 In Section 1.1, the principles of GAST-D should be described, because the concept of integrity assurance will be different from GAST-C and the airborne equipment is partly responsible for integrity monitoring related to the ionospheric anomalies. Although this is briefly mentioned in Section 1.2, it is worthwhile being explicitly described in the principle section.

2.1.3 Section 2.2 describes about the protection levels (PLs) which bounds the position errors. In GAST-D, the formula to calculate PLs are updated to include additional terms, which should be added to this section.

2.1.4 Section 2.4 describes about the ionospheric threat model for GBAS safety assessment. Since the required integrity levels are different for GAST-C and D, the threat model may theoretically be different. Although the threat models are usually common to GAST-C and D, the relationship between the threat models for GAST-C and D may be described in this section.

2.1.5 Section 2.5.2 describes the position domain integrity monitoring specific to GAST-C. On the other hand, the GAST-D ground subsystem ensures the integrity in the range domain by broadcasting additional parameters for the maximum possible range error (E_{ig}). This is a prominent difference from GAST-C and should be described.

2.1.6 Section 3 describes how to develop and evaluate the ionospheric threat model. Since 2016 when the guidance document was published, a number of studies related to GBAS ionospheric threat model have been published. This section should be updated with the latest knowledges from the recent studies. They should be added to the reference list.

2.2 There may be more items to be updated in addition to those listed above. Members of the Task Force are encouraged to review the guidance document to identify additional items to be updated.

2.3 As mentioned above, a work to update Annex 10 Attachment D in terms of the ionospheric effects on GBAS and their mitigation is in progress in an ad hoc group of the ICAO NSP. Harmonization and coordination with the work by the ad hoc group is important.

3. ACTION REQUIRED BY THE MEETING

3.1 The meeting is invited to:

- a) review the guidance document with the information provided in this paper;
- b) consider establishing a small drafting group; and
- c) discuss any relevant matters as appropriate.
