



Agenda Item 2: Follow-up to the implementation status of the performance based navigation systems plans for the CAR and SAM Regions and to the latest amendments to the ATM and CNS related SARPS

FAA WAAS UPDATE

(Presented by the United States of America)

SUMMARY

The Wide Area Augmentation System (WAAS) was commissioned by the FAA in July of 2003. A series of enhancements were completed in September of 2008, increasing the availability of LPV operations throughout the National Airspace System (NAS) of the United States. Enhancements are ongoing to increase LPV-200 availability within the NAS. As of November 10, 2010, the WAAS Signal in Space is provided by three GEO satellites. The FAA has begun near-term replacement activities in anticipation of the Galaxy 15 satellite loss. WAAS supports over 2,327 LPV and 396 LPV-200 approaches within the NAS. Canada has recently published LPV approaches and Mexico is planning LPV approaches for the near term. WAAS supports new equipage requirements for new, more direct, en route operations: T and Q routes. The FAA has initiated activities in support of the future integration of the GPS L5 frequency into WAAS in support of L1 / L5 Dual Frequency Operations.

1 Introduction

1.1 The FAA entered into Phase III of the program in October 2008. This phase includes efforts to conduct a technology refresh of some of the fielded WAAS components, to integrate what the program has defined as the Gap Filler GEO, finalize algorithmic improvements to increase service availability and to initiate efforts to transition maintenance of the system over to the FAA. The Gap Filler GEO will be replaced with a full-performance ranging capable GEO as available.

1.2 Phase III of the WAAS program was planned to consist of three fielded releases of WAAS, at the rate of approximately one release per year. Release 1 was completed in April, 2010. Release 2, which consists of the integration of the Gap Filler GEO and Technology Refresh, is currently underway. Release 3, which completes algorithmic improvements, is planned to begin in late 2011.

1.3 In April 2010, one of the WAAS GEO satellites (Galaxy 15) experienced a failure in its telemetry, command and control units. This has resulted in the satellite drifting eastward and at present is located at 107 degrees west longitude. At present the satellite remains operational within WAAS, but it is expected to fail before the end of December, 2010. Mitigation activities to minimize WAAS service impacts due to this failure have begun.

1.4 In parallel with these activities, FAA has started initial planning for the development and implementation of WAAS Phase IV enhancements to support dual-frequency (L1/L5) service.

2 Discussion

2.1 WAAS Phase 3 Full LPV-200 Performance

2.1.1 The risk of a single-point WAAS failure has been mitigated by the activation of Inmarsat 4F3 GEO (AMR, PRN-133) as part of the initial fielding of Release 2. Called the Gap Filler, the 4F3 GEO will ensure all of the continental United States and most of Canada and Alaska have redundant coverage. AMR completed testing and became operational November 10, 2010. The remainder of Release 2 will introduce communication network upgrades into the WAAS system and will complete in mid 2011.

2.1.2 Release 3 was originally planned as a single release, but has now been replanned as two separate releases (3A and 3B). The integration of the Stop Gap replacement satellite Inmarsat III GEO (POR) into WAAS is planned to be included in Release 3B and completed in 2012.

2.1.3 Efforts are underway to finalize the design efforts for Release 3A with an expected operational date of late 2011. Replanning efforts for Release 3 have included the addition of numerous minor enhancements that support improved system reliability. The design of Release 3B will be finalized in June 2011 and fielded in 2012.

2.1.4 Planned as part of Release 3A will be the full implementation of the Kriging algorithm in support of improving the estimation of WAAS ionospheric error. Kriging prototyping efforts have shown improved performance along the perimeter of the WAAS service area during mild ionospheric storms.

2.1.5 With the implementation of Phase 3, Release 3A and 3B, WAAS Localizer Performance with Vertical guidance (LPV) approaches with 200-foot minimums are projected to be available nearly all the time (greater than 99%), with coverage encompassing the full continental U.S., most of Alaska, northern Mexico, and southern Canada. FAA planned future improvements include establishing LPV-200 service throughout the WAAS coverage area including potential expansion to international partners in the Americas. Additionally, the FAA is committed to global satellite-based augmentation system (SBAS) interoperability and is working towards supporting LPV-200 service world-wide.

2.1.6 Integrity of a navigation system includes the ability to provide timely warnings when its signal is providing misleading data that could potentially create hazards. The WAAS specification requires the system to detect errors in the GPS or WAAS network and notify users within 6.2 seconds. Certifying that WAAS is safe for instrument flight rules (IFR) requires proving there is only an extremely small probability that an error exceeding the requirements for accuracy will go undetected. Specifically, the probability is less than 1×10^{-7} , and is equal to no more than 3 seconds of bad data per year.

2.2 WAAS Procedure Status with Mexico/Canada development

2.2.1 WAAS expansion into Mexico and Canada was achieved by the integration of nine international wide-area reference stations (WRS) into the WAAS network. The new WRSs are located in Canada (Goosebay, Gander, Winnipeg, and Iqualuit) and in Mexico (Mexico City, Puerto Vallarta, Mérida, Tapachula, and San Jose del Cabo). In addition to extending WAAS coverage to users throughout Canada and Mexico, this expansion also benefits users within the U.S. who were on the fringes of WAAS coverage

2.3 **Non-fixed wing procedure development**

2.3.1 October 25, 2010, Volume 11, of the Flight Standards Program establishes policy and guidance for conducting Instrument Flight Procedure Validation (IFPV) of satellite-based Performance-based Navigation (PBN) and special wide area augmentation system Instrument Flight Procedures (IFP) for both fixed-wing and helicopter aircraft. It describes ground validation, preflight validation (including simulator evaluation and obstacle assessment), and flight validation. This chapter also establishes policy for the authorization and surveillance of IFPV evaluators.

2.4 **WAAS en route – T and Q route support**

2.4.1 The FAA, in cooperation with aviation stakeholders, is implementing performance-based navigation in the U.S. National Airspace System (NAS). Two key components of performance-based navigation are Area Navigation (RNAV) and Required Navigation Performance (RNP). Each includes lateral navigation standards for performance, functionality, and capability. These standards allow the flexibility to design more efficient airspace and instrument procedures that collectively improve safety, access, capacity and efficiency, and minimize environmental impacts.

2.4.2 Performance-based navigation resulted in development of RNAV "Q" routes in the en route environment. The routes, designed for use above flight level (FL) 180, can be flown using GPS or DME/DME/IRU. Q-routes require navigation track keeping accuracy of ± 2 nautical miles. Twenty routes have been published and 23 more are under development. Q-routes provide capacity and efficiency gains by allowing qualified traffic to be taken off crowded conventional routes.

2.4.3 Below FL180 (18,000 feet), RNAV IFR Terminal Transition Routes (RITTRs) - called "T" routes - allow improved access to Class B and Class C airspace for GPS-equipped general aviation aircraft. The T-routes segregate aircraft transiting airspace from arrivals/departures at the primary airport. The first T-routes were charted in the Charlotte, NC, in September 2005. Additional routes are under development for Cincinnati, OH, and Jacksonville, FL. Terminal RNAV development includes Standard Instrument Departures (SIDs) and Standard Terminal Arrival Routes (STARs). The FAA published 36 RNAV SIDs and 16 RNAV STARs in FY 2005, including 13 SIDs at Atlanta, GA, and 16 SIDs at Dallas-Ft. Worth, TX.

2.4.4 Immediate, tangible benefits have been noted. Controller/pilot transmissions are reduced over 30 percent, there is a significant reduction in track dispersion, and the more efficient procedure designs reduce flight distances resulting in fuel savings for the airlines.

2.5 **WAAS Phase IV – Dual Frequency Operation**

2.5.1 Dual Frequency Operation will increase signal integrity by having new GPS satellites broadcast the current L1 signal (1575.42 MHz) along with a new, civilian, L5 signal (1176.45 MHz). WAAS will continue to support legacy single frequency users by ensuring backward compatibility. With the use of L5, a dual-frequency GPS receiver could use the currently available WAAS corrections or generate its own ionospheric delay corrections by comparing the L1 and L5 signals. Space Vehicle Number 49 (SVN49) was launched on March 24, 2009 with an L5 demonstration payload. The L5 frequency has been in use by two geostationary WAAS satellites for transmitting WAAS correction messages, but SVN49 became the first satellite to broadcast a GPS L5 signal from a medium-earth orbit. Dual-frequency GPS receivers promise to provide greater accuracy and a larger GPS service volume. The US Air Force has finalized the design for its GPS III series satellites with production underway towards a usable constellation of L5 satellites by 2018.

2.5.2 The FAA has accelerated plans for acquiring additional GEO lease services to be available starting in the 2015 timeframe. The goal is to maintain a nominal constellation of three GEO satellites along with the potential for an in-orbit spare.

3 **Conclusions**

3.1 The meeting is requested to note the material presented in this paper and consider its contribution to the implementation of a global satellite-based navigation system.

3.2 Attendees are invited to visit the FAA's GPS website at <http://gps.faa.gov> for up to date FAA GNSS program information.

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