*International Civil Aviation Organization*

**FIFTEENTH MEETING OF THE ASIA/PACIFIC AIR NAVIGATION PLANNING AND IMPLEMENTATION REGIONAL GROUP (APANPIRG/15)**
**Bangkok, Thailand, 23 to 27 August 2004**

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**Agenda Item 3: CNS/ATM Implementation and Related Activities**

# STATUS OF THE U.S. WIDE AREA AUGMENTATION SYSTEM (WAAS)

**Information Paper**

(Presented by the United States of America)

**SUMMARY**

This information paper provides status on the U.S. Wide Area Augmentation System (WAAS) which was commissioned for operational use in the U.S. National Airspace System (NAS) in July 2003.

## 1. THE FUTURE OF NAVIGATION

1.1 Satellite navigation technology is already in use in the United States and around the globe as a navigation aid for en route, oceanic and remote airspace, and non-precision approach operations. The U.S. Global Positioning System (GPS) provides this service as an integral part of the International Civil Aviation Organization's (ICAO) envisioned seamless Global Navigation Satellite System (GNSS).

1.2 Satellite navigation, represented by GPS and its various augmentation systems under development today, provides significant flight safety and system capacity and efficiency benefits by making precision approaches possible at thousands of airports worldwide where no such capability exists today. The introduction of new, straight-in GPS approach procedures has reduced the need for procedure turns and circling approaches, thus providing a very reliable and accurate navigation system that dramatically improves safety over a Non-directional Beacon (NDB) approach or a VHF Omni-directional Range (VOR) approach when the VOR is not collocated with the runway.

1.3 GPS and the Wide Area Augmentation System (WAAS) are operational in the United States and the Federal Aviation Administration (FAA) continues to aggressively work towards the operational implementation of the Local Area Augmentation System (LAAS) to complete the transition to satellite-based navigation.

## 2. WIDE AREA AUGMENTATION SYSTEM (WAAS) COMMISSIONING

2.1 The WAAS uses a network of ground reference stations (WRS), master stations (WMS), geostationary communication satellites (GEO), and GEO uplink stations (GUS) to augment the basic GPS service and provide increased accuracy, availability, integrity, and continuity of service to all properly equipped users in the U.S. National Airspace System (NAS).

2.2 The WAAS program has progressed significantly over the past several years. The initial system stability test was completed in July 2000 and demonstrated total system accuracy to be much better than originally anticipated or required. The accuracy requirement for WAAS initial

operating capability (IOC) is 7.6 meters (horizontal and vertical) and these preliminary test results showed that total system accuracy was 2-3 meters (horizontal and vertical).

2.3 Following these successful tests, the FAA announced in August 2000 that the WAAS signal-in-space would be continuously available for aviation users to increase situational awareness during visual flight rules (VFR) and non safety of life flight applications, as well as for non-aviation users for recreational, maritime, agricultural, surveying, and other applications requiring precise positioning and time. The most recent user data shows that at the end of 2002, over 1 million non-aviation users were already using the WAAS signal in space as part of their daily routines.

2.4 The WAAS program achieved another significant milestone in September 2002 when the FAA successfully completed the 60-day stability test. This test, which ran from July 19 through September 6, 2002, had a goal of proving WAAS to be a stable system that met or exceeded all performance requirements. The results demonstrated continuous operation of the WAAS in support of required coverage, accuracy and integrity requirements.

2.5 After the 60-day stability test, the next major hurdle for the WAAS program was the contractor acceptance inspection (CAI) milestone. CAI is the official hand-off of the WAAS system from the contractor (Raytheon) to the FAA. This can only be accomplished if the contractor successfully demonstrates that WAAS meets or exceeds all system, reliability, and performance requirements and guidelines set forth by the FAA. This milestone was completed on January 24, 2003 and thus positioned the FAA to commission the WAAS for widespread operational use.

2.6 WAAS was commissioned for use in all phases of air navigation in the U S NAS. WAAS performance consistently demonstrates 1 meter horizontal and 1.5 meters vertical accuracy. WAAS IOC provides users with the capability to fly approaches with vertical guidance throughout the U.S. NAS. This initial WAAS capability also provides improved guidance to users in the en route and departure domains. At commissioning, over 500 LNAV/VNAV procedures were published, which can be flown by WAAS capable aircraft. LNAV/VNAV is an approach procedure with vertical guidance with nominal minimums of a 350’ decision height, 1½-mile visibility, 556m horizontal alert limit (HAL), and 50m vertical alert limit (VAL). The WAAS service area is the continental United States and portions of Alaska.

2.7 The FAA also improved the precision approach capability provided by WAAS through terminal approach procedures (TERPS) optimization. This improvement takes full advantage of the capabilities of the WAAS Signal-in-Space and provides a new approach procedure with vertical guidance called LPV. LPV provides more lateral precision over LNAV/VNAV resulting in lower approach minima for most runways. LPV procedures have nominal minimums of a 250’ decision height, ¾ mile visibility without proper lighting (½ mile visibility with proper lighting), 40m HAL, and 50m VAL.

2.8 LPV and LNAV/VNAV approaches do not require any equipment beyond standard WAAS Technical Standard Order (TSO) avionics, and will make vertical guidance safety benefits accessible to the general aviation community, thus directly affecting flight safety for general aviation aircraft and other WAAS users.

*3.* ***WAAS Post-IOC Implementation Strategy***

3.3 The FAA also plans to complete several other WAAS service/system enhancements in the post-IOC time frame, namely:

- More efficient monitor algorithms
- 13 additional reference stations to improve availability and coverage
  - 4 in Alaska
  - 5 in Mexico
  - 4 in Canada
- Provide two GEO satellites in view to all users
- Enhancing the terrestrial communications
- Enhancing operations and maintenance efficiency
- Equipment upgrade using commercially available components when feasible

3.4 Due to the long lead-time necessary to plan for and secure GEO satellite services, the FAA has been working for the past couple of years to ensure that WAAS IOC and FOC are supported with redundant GEO services. The initial and critical goal is to provide a third GEO satellite on orbit as soon as possible after WAAS IOC to mitigate the single thread failure of the existing INMARSAT-III AOR-W and POR satellite solution. The FAA also wants to improve WAAS system availability (during GUS switchovers) and improve overall system coverage through more optimized GEO orbital locations.

3.5 In support of the GEO initiatives, the FAA awarded a contract to Lockheed Martin Air Traffic Management on March 5, 2003 to provide additional satellite services for the WAAS. This contract provides for a 24-month development of ground earth stations with the flexibility for the FAA to procure up to three (3) payloads on satellite-leased communication services. Designed to support both the initial and final operating capabilities of WAAS, this contract also provides the FAA with flexibility in acquiring additional GEO assets to ensure uninterrupted GEO service and system reliability for all WAAS users.

3.6 The FAA's goal is to have additional GEOs (at least one) on orbit by 2006/07. Beyond this time frame, the FAA will continue to develop a GEO constellation sustainment strategy to ensure the required redundancy in WAAS broadcast over the U.S. National Airspace.

3.7 WAAS development of full LPV capability in the United States is scheduled to be completed in 2008. At this time, the U.S. Government schedule to incorporate a second civil frequency (L5 at 1176.45 MHz) on GPS satellites will be more solidified. When available for use, WAAS will incorporate L5 into its operation to upgrade the LPV capability to a GPS Landing System (GLS) capability. GLS is the Category I precision approach equivalent for GPS systems with aviation minimums of 200' decision height and ½ mile visibility (with proper lighting).

## 4.0 U.S. – EU SUMMIT: AGREEMENT ON GPS-GALILEO COOPERATION

4.1 On June 26, 2004, the United States and the European Union reached an agreement covering their satellite navigation services, the U.S. Global Positioning System, and Europe's planned Galileo system.

4.2 Recognizing the added benefit to civil and commercial users if the two independent systems were compatible and interoperable, the United States and the European Union have shared technical analysis and information, resulting in an agreement to establish a common civil signal. The additional availability, precision, and robustness that will be provided by dual GPS-Galileo receivers

lays the foundation for a new generation of satellite based applications and services, promoting research, development, and investment that will benefit business, science, governments, aviation and recreational users alike.

**CONCLUSION**

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

5.2 Attendees are invited to visit the FAA's GPS Product Team's website at http://gps.faa.gov for up-to-date WAAS program information

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