

Executive Summary

Independent Review Board
Federal Aviation Administration's
Wide Area Augmentation System
January 18, 2001

Background. Wide Area Augmentation System (WAAS) is a new augmentation to the Department of Defense's (DoD) Global Positioning System (GPS) that is designed to improve the integrity and accuracy of the basic GPS capability. From August to December 2000, an *independent review board (IRB)*, administered by the Institute for Defense Analyses (IDA), held 9 Plenary meetings over 15 days to provide the Federal Aviation Administration (FAA) an assessment of the development of the WAAS. The IRB was tasked by and reports directly to the Administrator of FAA, Ms. Jane Garvey.

Interim Report. The IRB has been gratified to see the FAA take early action on many of the recommendations that the IRB provided in its interim briefing to the Administrator.

Tasking. The IRB was chartered to provide an independent **assessment of the results of a panel of FAA, contractor, and academic experts (the WAAS Integrity & Performance Panel - WIPP)**, who were appointed to help resolve development difficulties. These problems had led to significant delays in fielding WAAS. The IRB was also asked to provide **additional "technical and strategic" advice**. This is a summary of the IRB findings and recommendations.

Principal Findings and Recommendations.

1. **WAAS.** Testimony from the SNUG (Satellite Navigation Users Group) *strongly supported the continuing development of WAAS*, based on safety and economic payoffs. Extensive prototyping of the WAAS at Stanford University and the FAA's Technical Center have proven that *it should more than meet its initial requirements*. It was noted that the prototype WAAS is already functional; in fact, users complain when it is turned off for upgrades.

The IRB sees no serious *technical* barriers to commissioning the initial capability (Lateral Navigation/Vertical Navigation, or LNAV/VNAV) within two years (see schedule comments below). However, the current integrity calculation is quite conservative (by factors of 2 or more). Consequently, the user frequently would be denied the use of a completely acceptable system. The IRB expects this situation to steadily improve following initial commissioning.

An *affordable pathway for this evolutionary improvement* has been developed by the WIPP, and was reviewed and endorsed by the IRB. If pursued, this evolution will eventually *lead to Category 1 (CAT 1) Precision capabilities* to any surveyed point in the United States. Furthermore, this integrity and accuracy will be available to any GPS user (in addition to the aviation community).

As part of this long-term development, the IRB pointed out a number of opportunities for synergies with existing or planned national systems (e.g., Local Area Augmentation System (LAAS) and Nationwide Differential GPS (NDGPS)) that should simplify and improve performance of all involved systems. **The IRB recommends that the FAA commit to this evolution, including exploiting the synergies as well as acquiring satellites (see satellite comments below).**

2. **WIPP.** The WIPP has performed an essential function for the WAAS in an outstanding manner. FAA is commended for its creation. WIPP has, in fact, acted as the "system engineer" for the WAAS, concentrating on the initial fielding of the WAAS. WIPP achieved an important milestone in December 2000, *on schedule*. This was to complete the description of all technical calculations (algorithm definition documents, or ADD) required for certification of the WAAS system. **The IRB recommends that the WIPP be extended at least through the initial commissioning of the system. Added responsibilities should include system engineering with sensitivity to cost and schedule trades.**
3. **Schedule.** A credible schedule for initial fielding of WAAS (LNAV/VNAV) *has not yet been established*. It has been delayed until the FAA resolves all of the "commissioning criteria". This is currently scheduled to be completed in March of 2001. Still, the IRB believes *that a credible schedule for completion by early 2003 should be achievable, provided that the system is strongly supported and the key personnel stay in place.* **The IRB recommends that a firm schedule be established not later than 31 March 2001, with significant contractor incentives to attain it.**
4. **Satellites.** The greatest near-term risk to system availability is the current *dependence on only two International Maritime Satellite Organization (INMARSAT) communications-relay satellites (called bent-pipes) for transmission of integrity and ranging corrections.* These geosynchronous satellites (GEO) have poor ranging accuracy and vulnerable uplinks. If one of them fails, about half of the United States will lose coverage until service is restored.

Studies on the best satellite configuration for the FAA were presented to the IRB. We found that the optimal long-term configuration is four satellites with autonomous navigation payloads, broadcasting all three civil GPS signals. **The IRB recommends that an additional, "bent-pipe" satellite be procured as soon as possible as an interim measure. At the same time, planning and initial actions should be undertaken to deploy the final four-satellite WAAS constellation, with autonomous payloads that broadcast all three civil signals.**

IRB Observations. The most important key to success, in the view of the IRB, is a **renewed and firm commitment, by the FAA,** to field the WAAS system. Evidence of this commitment will be to provide resources and to publicly support the program and key FAA and contractor personnel. To reinforce this commitment, periodic briefings by the lead program members could be provided directly to the FAA Administrator. This would help shorten a long and complicated reporting/approval chain.

Full List of IRB Recommendations. These are discussed in detail in the report and highlighted in a consolidated list as Appendix A of the full report. Recommendations are listed as leading to near term, mid-term, and long term capability in WAAS. Some recommendations to achieve later capabilities have long lead times and may require actions to begin in parallel with actions for earlier capabilities.

- **Near Term:** Recommendations to achieve LNAV/VNAV WAAS performance capability; that is, with a goal of attaining vertical protection limit (VPL) of 50 meters.
 - Define, coordinate, and freeze LNAV/VNAV commissioning criteria – February 2001
 - Solidify schedule – March 2001
 - Streamline reporting chain for WAAS and obtain full support of all FAA participants
 - Incentivize key individuals and organizations
 - Boost team morale
 - Deliver critical resources
 - Retain WIPP at least through commissioning
 - Publicize the national payoffs from WAAS
 - Add one “bent-pipe” GEO
- **Mid-term:** Recommendations to achieve Approach with Precision Vertical guidance (APV) WAAS performance capability, with a goal of attaining VPL of 20 meters.
 - Upgrade selected system components
 - Extend rim coverage of reference stations; consider other national resources
 - Refine algorithms based on additional data
- **Long term:** Recommendations to achieve GPS based Landing System (GLS) WAAS performance capability, with a goal of attaining VPL of 12 meters.
 - Upgrade to a certified processor as soon as possible
 - Prepare for second and third civil signals from GPS
 - Acquire four GEOs with full (3-signal) navigation package payloads
 - Develop Minimum Operational Performance Specifications (MOPS) and user equipment (UE) for full 3-signal use

Conclusions. When fielded, the WAAS will provide a significant capability, that is an **international symbol** of the **US determination** to remain **leaders in this new aviation safety technology**. The IRB believes it is likely that the *benefits of WAAS are currently understated*. Like GPS, many dimly understood payoffs will emerge only after WAAS is commissioned.