



# SatNav News

## WAAS is Commissioned

by Marv Ann Davis, GPS TAC



On July 10th, 2003 at 12:01 AM, the Wide Area Augmentation System (WAAS) became a part of the U.S. National Airspace System (NAS). The WAAS, a navigation system based upon the Global Positioning System (GPS), provides an extremely accurate and reliable navigation service for a majority of the United States. Although, GPS has gained popularity as a supplemental navigation aid, it doesn't provide sufficient reliability,

nor does GPS provide a means of notifying the user if the position that it is providing is hazardously misleading. As a result, the use of GPS has been limited for aviation. However, WAAS combines the benefits of GPS with the safety and reliability demanded by aviation. WAAS also provides better accuracy than GPS alone provides. By specification, the WAAS is designed to provide accurate position determination within 7.6 meters horizontally and vertically. In reality, WAAS has been determined to exceed that accuracy, and generally provides accuracy between 0.5 and 2 meters. Most importantly, WAAS is able to detect and correct errors in GPS satellite broadcasts, detect instances when GPS satellites should not be used for position determination, and notify WAAS users within just over a second of any potential hazardously misleading information resulting from a GPS-derived position solution. WAAS is able to do this quickly and reliably, and as a result, provides a very accurate and very reliable navigation solution.

Now that the WAAS signal is available, WAAS receivers and WAAS-related procedures are becoming available to enable the benefits of WAAS. WAAS receivers certified for aviation operations are arriving on the market and are now available to users. (More information on these avionics can be found in the [June 2003 edition of the SATNAV News](#).) Additionally, the FAA has published nearly 600 approaches at almost 300 airports throughout the U.S. that can be used with WAAS. The approaches, referred to as

### In this issue:

- WAAS is Commissioned...1
- Happenings on the Hill.....2
- LAAS in Alaska.....3
- LAAS CAT II/III Update.....4
- Additional Geostationary Satellites for WAAS.....5
- WAAS International Update.....6
- FAA Survey Program.....6
- Joint Precision Approach and Landing System (JPALS).....8
- WAAS on the Road.....8

LNAV/VNAV, include the safety of vertical guidance, and can provide minimums as low as 350 ft. above touchdown. A current list of LNAV/VNAV approaches can be reached from the link at <http://gps.faa.gov>. The FAA has also developed a new type of approach procedure specifically designed to take advantage of the exceptional performance of WAAS. The approaches, referred to as LPV, also include vertical guidance, and provide minimums as low as 250 ft above touchdown. There are currently 7 LPV approach locations in the U.S. The FAA is continuing to develop WAAS-related procedures, and expects to develop 300 additional procedures each year. With the availability of the WAAS signal, WAAS receivers, and WAAS approach procedures, use of WAAS by the aviation community is expected to be adopted quickly and with positive results.

The FAA continues to work towards Final Operating Capability (FOC). Future enhancements to WAAS include additional WAAS geostationary satellites (GEOs), additional WAAS reference stations, and updates to incorporate the benefits to be provided by future, modernized GPS constellation. WAAS GEOs will be added to ensure that two GEOs are available to WAAS users at all times throughout all of the Continental United States and most of Alaska. WAAS

reference stations will be added to extend the WAAS coverage area, to include potential stations in Canada and Mexico. GPS modernization activities will include the availability of the L5 frequency. FOC for WAAS is anticipated in approximately 2007.

## Happenings on the Hill

*Darcy Weber, GPS TAC*

Fiscal Year (FY) 2004 looks to be a challenging year in the budget arena for the WAAS and LAAS. In July 2003, the House Appropriations Subcommittee ([http://budget.faa.gov/newsite/form\\_pdf/04\\_housereport.pdf](http://budget.faa.gov/newsite/form_pdf/04_housereport.pdf)) recommended full funding for the WAAS program. However, the Senate Appropriations Subcommittee in September 2003 (<http://thomas.loc.gov/home/approp/app04.html>) specifically reduced and restricted WAAS funding precluding the development of implementation and certification funding needed to achieve the operational safety improvements provided by WAAS. The impacts of this budget cut to the newly commissioned WAAS would be very critical due to the fact that (1) approach procedures would not be developed to enable pilots to safely land at more airports, (2) receiver development to support air carriers, business aviation, and re-



gional jets will be delayed, and (3) support for Advanced Procedure Development will be terminated. In sum, if the Conference Report upholds the Senate's recommendation, WAAS user acceptance, and therefore the benefits, would be significantly delayed.

As for LAAS, the House noted the potential benefits of the system for the National Airspace System but did not recommend full funding. The House Subcommittee eliminated funding in CAT II/III capability studies and program management. There was no mention of LAAS in the Senate report. The House Subcommittee also directed FAA not to provide funds for production of CAT I beyond the limited number planned until at least one system has been certified, and a revised cost, schedule, and benefit baseline has been approved by the Administrator and submitted to the House and Senate for review. If the House Subcommittee recommendation prevails in the upcoming Conference deliberations, then all Category II/III studies planned for FY2004 would be eliminated, significantly delaying CATII/III implementation. Moreover, the LAAS program will be unable to confidently select CAT II/III architecture or an acquisition strategy on which to base revised cost and schedule estimates for an updated Acquisition Program Baseline. Basically, the proposed elimination of funds for CAT II/III studies will result in inaccurate estimates in the Investment Analysis Report and an overall delay in implementation of CAT II/III.

## LAAS in Alaska

by Campbell Motley, GPS TAC



Juneau is unique in several ways. First of all, Juneau averages more than 320 days of precipitation a year. While rain in and of itself is no biggie, those clouds that produce the rain can be, especially when they are low enough to obscure Juneau's next claim to fame, "mountains." Juneau has a bunch of them and the ones we are most concerned with are nestled all around the airport. In fact, you have to maneuver between two peaks and fly over a natural cut when landing to the South. If you are landing to the North, you must fly up the famous Gastineau Channel with mountains lurking off both wingtips. *Alaska Air* pilots tell me on really bad days, it would be better if you

could drive to Juneau. However, you can't. Although Juneau is the capital of Alaska, someone decreed (I think it was Mother Nature) there would be "no roads into or out of Juneau." So if you find yourself in downtown Juneau, you either arrived there by boat or by air.

So why the Local Area Augmentation System (LAAS) in Juneau of all places? The answer is simple. Juneau's isolation, not to mention the rugged terrain that comprises most of Alaska, makes this entire region a haven for pilots. According to their own statistics, "1 in every 58 people is a pilot, there are 6 aircraft for every 10 pilots, and they have an aircraft accident/incident every other day, which equates to one fatality every nine days." With little fanfare, Juneau has issued a challenge to LAAS - a "terrain/obstacle" challenge. The FAA's LAAS program hopes to play a significant part in making Juneau arrivals and departures more accessible, more dependable and a whole lot safer. Depending on how good LAAS accuracy and integrity are, LAAS will hopefully serve as a catalyst for change and force the FAA to reexamine its current approach and clearance criteria throughout the NAS. For without criteria/containment changes, no technology can improve Juneau's situation. Furthermore, if LAAS can improve approaches into Juneau, it can surely do it elsewhere in the National Airspace System (NAS).

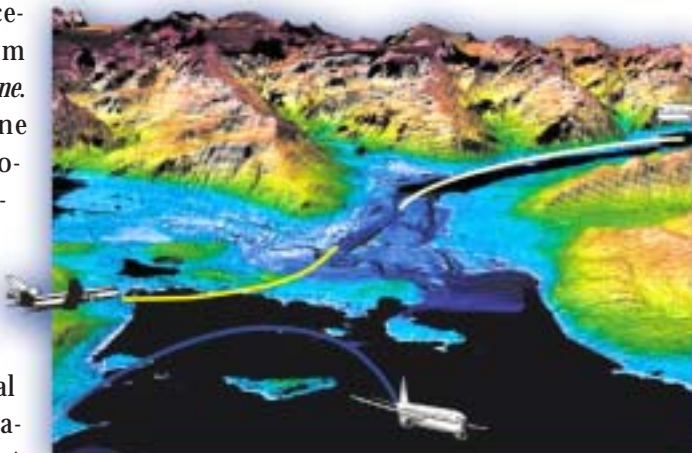
Juneau does not have an ILS due to its unique terrain features. Due to the mountainous terrain surrounding Juneau's non-radar environment on three sides, and the potential for a missed approach in inclement weather, all NAS traffic around Juneau gets tied up anywhere from 10 - 12 minutes every time an aircraft attempts a (minimum weather) approach into the airport. This "one aircraft in and one aircraft out" process is currently flown by commercial pilots trained to fly special approaches using aircraft uniquely equipped for Juneau. A missed approach during these conditions results in an aggressive climbing turn at maximum power to clear the mountainous terrain. Often this means a carrier has to leave fare-paying customers and cargo behind just to meet weight restrictions in the event of a missed approach. Currently, *Alaska Air* is the only carrier that can service Juneau in poor weather conditions. To prevent a controlled flight into terrain (CFIT) event, *Alaska Air* must be on the mark (altitude, speed, and position) throughout the approach. They do this with specially equipped aircraft and



pecially trained pilots flying special approaches only they can fly. All of this costs *Alaska Air* a significant amount of money - so much in fact, that no other carriers are willing to follow suit.

Alaska Air is interested in LAAS because it has the potential to give them a smooth/continuous constant rate of descent type curved approach into Juneau with much tighter RNP values than any other NAVAID currently available. *Alaska Air* even envisions LAAS giving them a near Category III approach capability into Runway 26 at Juneau with LAAS improved RNP capabilities for flights up the Gastineau Channel. LAAS could provide for the development of "public" procedures instead of the current specials used by *Alaska Air*:

Due to the density of pilots in Alaska, its formidable terrain, precarious climate and corresponding high aircraft accident/incident rate, the FAA has focused a great deal of attention in Alaska via a safety enhancement program known as *Capstone*. The *Capstone* program provides off-the-shelf equipment and training to small private and commercial aircraft operators in an effort



to reduce the accident rate. Alaska, in effect, is an active, real-world test bed for the advancement of aviation safety. The Global Positioning System (GPS) and the Wide Area Augmentation System (WAAS) are currently used as part of the *Capstone* solution to provide guidance for *Capstone*-equipped aircraft. LAAS with its increased accuracy, availability, continuity and integrity and ability to provide RNP guidance has the potential to greatly enhance *Capstone*'s efforts. Together with *Capstone*'s efforts, LAAS may greatly enhance the ability of aircraft to fly safely in and out of Juneau.

## LAAS CAT II/III Update

by Richard Lay, FAA LAAS CAT II/III Program Manager/AND-710; Navin G. Mathur, GPS TAC/AND-710; Wayne Hanley, GPS TAC/AND-710; and Ranjeet Shetty, GPS TAC/AND-710



The Federal Aviation Administration (FAA) Local Area Augmentation System (LAAS) program office (AND-710) continues to make substantial progress in GPS-based navigation system development. The LAAS Category (CAT) II/III program is receiving increased emphasis now that the CAT I LAAS Ground Facility (LGF) contract is underway with Honeywell. LAAS CAT I development activities are helping to illuminate future LAAS CAT II/III considerations. Additionally, the development of an initial CAT II/III program plan has sparked dialogue on a number of CAT II/III-related topics.

LAAS CAT II/III system development is proceeding in two phases. Phase one continues the research and development (R&D) effort to determine the architecture which will be used for CAT II/III precision approaches. Phase two will permit the use of dual frequencies including the new GPS L5 civil frequency when available, or the future Galileo E5a or E5b frequencies, along with L1 frequency used in Phase one.

Integral to the LAAS CAT II/III approach is the effort being carried out by the FAA's Aircraft Certification group (AIR-100). This group will investigate the reallocation of increased safety requirements of CAT-II/III (beyond CAT-I) to airborne equipment while retaining the CAT I ground architecture.

Near-term R&D efforts initiated by the LAAS program office include coordination with RTCA Special Committee 159 (SC-159) Working Group 4 on the development/update of several technical documents. These include the:

- ✓ Minimum Aviation System Performance Standards (MASPS) for LAAS,

- ✓ Minimum Operational Performance Standards (MOPS) for LAAS CAT II/III Airborne Equipment, and
- ✓ LAAS CAT II/III Interface Control Document (ICD).

RTCA's goal is to achieve CAT II/III performance with minimal change to the CAT I LGF architecture.

Additional goals include the finalization of the internal FAA CAT II/III program plan to outline FAA's strategy for timely implementation of CAT II/III, and working with Boeing to define an accurate airborne multipath model. Airborne multipath modeling is also being investigated at the FAA. This is performed by using Boeing's data collection and modeling capabilities. Flight tests on Boeing 737 and 777 are currently scheduled.

The LAAS Program Office is also preparing for a LAAS CAT II/III Joint Resources Council (JRC) meeting that is scheduled during FY 05. The JRC is the body within the FAA that determines whether or not the FAA should proceed with the acquisition of a system. Requirements for a successful JRC include completion of the CAT I integrity design in Phase I of the Honeywell contract, addressing the radio frequency interference (RFI) issues associated with CAT-II/III, definition of a viable CAT-II/III LAAS architecture at the RTCA, and a comprehensive SATNAV Business Case (Investment Analysis).

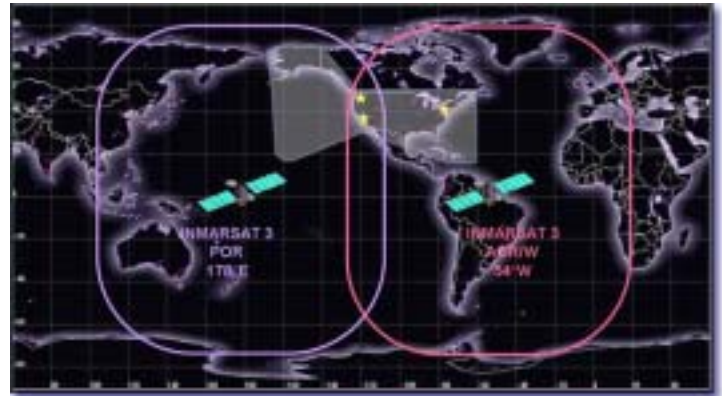
## Additional Geostationary Satellites for WAAS

*by Bill Tisdale, GPS TAC/AND-730*

The Wide Area Augmentation System (WAAS) is a major Federal Aviation Administration (FAA) program that consists of both space and terrestrial elements. When used with WAAS-certified avionics equipment, WAAS will provide major improvements in the accuracy, reliability and safety of the Global Positioning System (GPS).

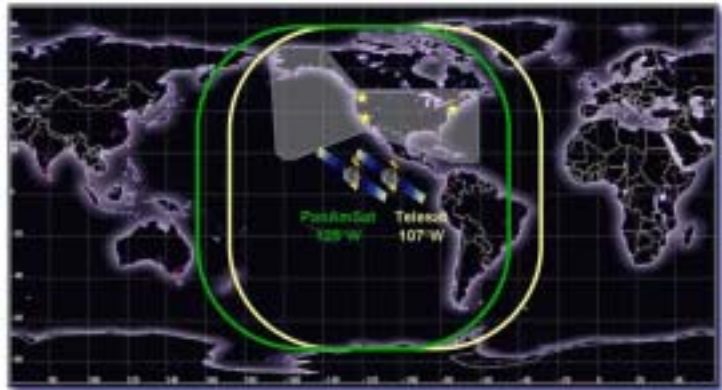
The Geostationary Communications and Control Segment (GCCS) program is a key element of the WAAS that provides enhancements in both performance and reliability. In its basic configuration, the GCCS element consists of two ground up-

link stations (GUS) and a geosynchronous satellite carrying a navigation payload. Under the terms of the contract, the FAA may procure services on as many as three Geosatellite Payload – GUS pair elements.



*Current WAAS Geostationary Satellites*

The GCCS program has recently seen substantial progress, marked by the successful establishment of a contract to place an FAA navigation payload on one commercial geosynchronous satellite, and nearly completed negotiations for a second. Both satellites will be launched in calendar year 2005.



*Future WAAS Geostationary Satellites*

GEO-3, the first of the two satellites to reach orbit, will be PanAmSat's Galaxy XV. Completion of contractual negotiations with PanAmSat is anticipated by early September. The satellite is being manufactured by Orbital Sciences Corporation, and is a member of Orbital's small-to-medium sized STAR spacecraft family. Orbital will design and manufacture the navigation payload as well. The launch mass of Galaxy XV is approximately 1,760 kilograms. STAR spacecraft are three-axis

stabilized vehicles. Launch is planned for March 2005, and on-orbit tests will be completed in May. The launch vehicle will be Ariane 5. Galaxy XV's orbital position will be 125 degrees West Longitude. From this position, it will provide coverage to the North American Continent, including all but the most northwestern part of Alaska.

GEO-4, for which the necessary contract is now in place, will be Telesat's ANIK F1R. The prime contractor for the ANIK F1R satellite is Astrium, and Astrium will also manufacture the navigation payload. The design is based on the E-3000 version of the Astrium's Eurostar family. ANIK F1R is a large, three-axis stabilized spacecraft – the launch mass is 3,600 kilograms, and the deployed span of the solar array panel is 35 meters. The satellite will be placed in its orbital station by a Proton booster in October 2005. On-orbit tests will be completed in January 2006. From its 107.3 degree West Longitude location, GEO-4 will also provide coverage to the entire North American region, including all but the most northwestern part of Alaska.

## WAAS International Update

*by Greg Thompson, GPS TAC/AND-730*

The Wide Area Augmentation System (WAAS) Team continues to work within the international arena to support the goal of a seamless, interoperable global navigation satellite system (GNSS).

One of the WAAS team's major initiatives is to expand the WAAS signal into Canada and Mexico. This effort, also covered in the June SatNav News, is proceeding rapidly. Meetings between the WAAS Product Team and representatives from the FAA international offices, Mexico, and Canada continue in order to discuss and to address the various policy decisions that need to be made to support this effort. To expedite this effort, technical work is being done in parallel to policy negotiations. Accordingly, pre-site surveys have already been completed in Alaska and in Canada, and similar surveys are scheduled to take place this fall in Mexico.

Additionally, the WAAS Team participated in the International Civil Aviation Organization's (ICAO) 11<sup>th</sup> Air Navigation Conference in Montreal, Canada. This meeting, held from September 22<sup>nd</sup> to October 3<sup>rd</sup>, is a major international

meeting including representation from over 120 states. On the opening day of the meeting, the FAA Administrator addressed the conference, and reaffirmed the FAA's commitment to GNSS. The U.S. also hosted a reception featuring a 5-minute video on the WAAS, and provided an exhibit on WAAS to address questions delegates may have about the system.

Other international work continues in various regions of the world. The WAAS team continues to provide support to the Asia Pacific Economic Cooperative (APEC) GNSS Implementation Team (GIT). Also, representatives from the government of South Korea recently met with FAA officials to request support in the development of a Korean satellite-based augmentation system (SBAS). Negotiations are ongoing between the FAA and Korea to determine the level of cooperation required. Additional international activities continue to be supported as they arise.

## FAA Survey Program

*by Kimberly Ford, GPS TAC/AND-720*

Aeronautical surveys are a critical element associated with all new instrument approaches. For more than 50 years, the National Geodetic Survey (NGS) organization, a part of the National Oceanic and Atmospheric Administration (NOAA), has provided airport obstruction surveys to the Federal Aviation Administration (FAA). NGS is the sole provider of these highly accurate surveys, which are designed to provide the data necessary to construct an instrument approach.

With the introduction of the Wide Area Augmentation System (WAAS) into the National Airspace System (NAS) in July 2003, aircraft gained the ability to be guided safely to the runway through the use of satellites - no ground-based navigation equipment required. This new technology made thousands of vertically-guided approaches possible. However, to support the development of these approaches, precise surveys are needed. Due to the strong demand for these WAAS-enabled approaches, NGS does not have adequate staffing to meet this demand. Even if the FAA were to supply funding to the NGS to accelerate the survey process, NGS would still not be able to provide sufficient staffing to support this activity.



Realizing that a solution was needed, the FAA recognized that an alternate means would have to be found to meet the aeronautical survey data requirements for the new satellite navigation (SATNAV) based procedures. A solution was also needed to address the costly problem of duplicate surveys that in the past had been funded by separate lines of business within the FAA. These surveys were unable to be validated by the NGS and entered into the NGS database. The solution would also have to include the standardization of data to be forwarded to an FAA created Airport Layout Plan (e-ALP).

In 1999, the FAA Airports organization (ARP) put in place a program to give airport owners and their sponsors the ability to perform aeronautical surveys through the use of private contractors. To conduct the surveys, these contractors would need a set of standardized instructions. The FAA provided funding to the NGS to develop a series of manuals to provide detailed technical guidance to third party surveyors. This guidance was to spell out the requirements, accuracies, and procedures necessary to perform aeronautical surveys in compliance with FAA Specification No. 405, "Standards for Aeronautical Survey and Related Products". The manuals needed to be specific in detail, but easy to follow with clear and concise language. The manuals also needed to be evaluated by independent contractors conducting Specification No. 405 surveys using the manuals and providing feedback.

In the summer of 2000, the manuals were completed, and ARP initiated the Airports Survey Pilot Program to help transition the survey processes to private contractors through the use of Airport Improvement Program (AIP) funds, instead of FAA funds. The Pilot Program standardized the Aeronautical Survey Process with the goal of reducing costs and elimi-



nating survey duplication, as well as, providing airports and regions control over the survey process. By using independent contractors instead of the limited staff at NGS, the number of surveys conducted annually is envisioned to increase dramatically to help meet the growing demand for aeronautical surveys.

Additionally, the FAA Specification No.405 instruction manuals are to reside on a newly-developed FAA website. This

Survey website will provide access to survey guidance material and documentation in a central location. Airport managers, contractors, and FAA personnel will have access to the website. All relevant documents pertaining to surveys will be placed and maintained on the Survey website. The Survey website will also include access to the e-ALP, a database that will house all collected survey data. The e-ALP will maintain and organize airport layout data in a spatial format, and support all FAA business lines that use such data. The system will support the NGS validation work flow, capturing accuracy metadata for every airport feature, capturing airport layout plans in a spatial format, and supporting AVN's requirements for procedure development.

The Pilot Program is also contracting the development of a data logger, which will assist the surveyor in the field with the data retrieval and submission to NGS. The objective is to create a non-licensed application that will expedite data collection during the ground survey and improve accuracy for NGS validation.

The ultimate goal of the program is to provide all the tools necessary for an airport to plan, fund, and implement the infrastructure needed to support an approach for any given runway. The Pilot Program will be phased in starting in March 2004 and should be available to all airports in January of 2005.

## Joint Precision Approach and Landing System (JPALS)

by Rick Packard, ARINC/JPALS



While the Federal Aviation Administration (FAA) moves forward with its effort to field the Local Area Augmentation System (LAAS), a GPS-based satellite landing system to improve aircraft safety during airport approaches and landings, the Department of Defense has been steadily working on a parallel effort called the Joint Precision Approach and Landing System, or JPALS.

Currently, the US military and its allies do not have a single precision approach capability. The long-standing NATO standard, the precision approach radar (PAR), has become obsolete. Today's PARs are old (some date back to 1950's). They require frequent maintenance, their spare parts are nonexistent, and they can only handle one aircraft on final at a time. Additionally, they are manpower intensive to operate and maintain. The few deployable systems in existence are very bulky and heavy, requiring extensive airlift and set-up times. Very few US civil airports and military bases have PARs, and overseas, the situation is worse. Given the expeditionary nature of today's military, the DoD needed a system that can respond as fast as world events unfold. JPALS is the answer to that need.

Like LAAS, JPALS is a ground-based GPS augmentation system designed to aid aircraft in precision approaches and landings around the globe, day/night and in all weather conditions. JPALS will also provide the same signal that LAAS provides so appropriately equipped civil aircraft can land at military airfields here in the states and at locations overseas. During times of crisis, JPALS can use a unique military signal broadcast by the GPS satellites to help ensure the robustness and security of the system.

The DoD is developing a deployable version of JPALS as well. It's designed to help in times of need to provide a precision approach capability for military/relief missions at those locations affected by war, civil unrest or natural disasters, such as floods. Light weight and with quick set up times, JPALS will provide precision approach guidance faster than any of today's existing systems. Another unique aspect—JPALS will be used aboard ships to guide helicopters and aircraft to the deck.

JPALS isn't merely a dream or science project lurking in the back room of a lab somewhere. It's a proven capability. In April of 2001, a Navy F-18 successfully flew 10 auto-coupled GPS approaches to the USS Roosevelt (CVN-71). The DoD also tested JPALS at Holloman AFB where a specially-equipped military King Air used the signal to fly over 275 precision approaches. Shortly after the King Air completed its test runs, a FedEx B-727 flew to Holloman and successfully flew 10 approaches demonstrating the civil interoperability of the system.

As highlighted during the recent Mid East conflicts and in the Volpe study on GPS vulnerability, GPS jamming is a concern and a very realistic threat. Right now, the JPALS acquisition effort is focusing on selecting the right technology to minimize and/or negate the impact of this threat to ensure US forces can fly, fight and win whenever, wherever.

The DoD plans to start fielding JPALS in the 2009 timeframe with initial operational capability shortly thereafter.



## WAAS on the Road

by Shelby Wheeler, GPS TAC

Numerous aviation-related events take place each year, including trade shows, conferences, conventions, meetings and fly-ins. This fall, the WAAS team traveled around the U.S. to many of these events to spread information and enthusiasm about the system and its benefits.



These events included:

- ✓ Experimental Aircraft Association (EAA) AirVenture Oshkosh 2003  
*July 29 – August 4, Oshkosh, WI*
- ✓ Air Line Pilots Association (ALPA) Air Safety Forum  
*August 20 – 21 2003, Washington, D.C.*
- ✓ Institute of Navigation (ION) GPS/GNSS 2003  
*September 9-12, Portland, OR*
- ✓ National Association of State Aviation Officials (NASAO) Convention and Trade Show  
*September 21-23, Charlotte, NC*
- ✓ American Association of Airport Executives (AAAE) National Airports Conference  
*September 21-23, San Diego, CA*
- ✓ International Civil Aviation Organization (ICAO) Air Navigation Conference  
*September 29-October 2, Montreal, Canada*
- ✓ National Business Aviation Association (NBAA) Meeting and Convention  
*October 7-9, Orlando, FL*
- ✓ Air Traffic Controller's Association (ATCA) International Technical Program & Exhibits  
*October 27-30, Washington D.C.*
- ✓ Aircraft Owners and Pilots Association (AOPA) Expo 2003  
*October 30-November 1, Philadelphia, PA*

To those of you who attended any of the above events and stopped by the WAAS exhibit we are very glad you did. We hope you found the exhibit materials informative and the staffers pleasant. If you weren't able to make it the above events this fall, please stay tuned for the 2004 event schedule. If you have questions regarding WAAS outreach, please email [Shelby.ctr.Wheeler@faa.gov](mailto:Shelby.ctr.Wheeler@faa.gov).



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