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FAA Satellite Navigation Product Teams

SatNav News

GBAS Working Group Meeting - Sydney, Australia

by Dieter Guenter GPS TAC/FAA ATO-W

In February, Airservices Australia (AsA) hosted the fourth Ground Based Augmentation System (GBAS) working group meeting in Sydney, Australia.

The GBAS working group is an international working group originally established between FAA, EUROCONTROL, various air navigation service providers (Germany, Spain and Australia), European and American avionics industry, airline representatives, Boeing and Airbus. At this meeting in Sydney, representatives of many Asia Pacific Economic Conference (APEC) nations joined the working group for the first time. In addition to the core group participants, other nations participating were Japan, Korea, India, China, Chinese Taiwan, Brunei, Malaysia and Brazil. Industry/airline representatives were Honeywell, Thales, Lockheed Martin, Cathay Pacific, Qantas, Continental Airlines, FedEx, Boeing and Airbus.

The working group meetings serve the purpose to discuss national and international GBAS acquisition plans; to identify areas of cooperation; and to discuss technical and operational topics like GBAS integrity analysis, ionospheric data collection, operational safety

In this issue:

The **SATNAV News** is produced by the Navigation Services (ATO-W) branch of the Federal Aviation Administration (FAA). This newsletter provides information on the Wide Area Augmentation System (WAAS) and the Local Area Augmentation System (LAAS), and initiatives associated with the implementation of satellite navigation into the National Airspace System (NAS).

assessments, regulatory approval process, and early operational implementation activities.

The Sydney meeting provided an excellent venue for technical interchange between all participants on their plans and activities. Many countries support the implementation of GBAS and presented their national plans and ongoing efforts. The presentations of Airservices Australia, DFS Germany, and AENA Spain outlined in detail the progress made since the last working group meeting. All three service providers have prototype GBAS systems installed and are involved in technical and operational evaluation activities. Other nations presenting their ongoing GBAS activities were Japan, China, Korea, and Brazil.

AsA plans on being the first service provider to support regulatory approval for a LAAS at Sydney International Airport. A Honeywell "beta LAAS" has been installed at Sydney and AsA has successfully completed flight trials with Qantas Boeing 737 aircraft. A phased operational approval plan, a step-down program based upon operational experience, and Flight Operations Safety Assessment have been designed for Qantas Airlines, which has already taken delivery of nine GBAS-capable Boeing 737 aircraft.

Boeing and Airbus again underlined the importance of early operational experience with GBAS CAT I on the path to GBAS CAT II/III and stated that all new generation Boeing and Airbus aircraft will include GLS (GNSS Landing System) options. Airline support is increasing with Qantas, Continental and FedEx starting to equip and requesting early operational approval for operations against existing GBAS prototypes.

The GBAS working group moved from information exchange to coordination / harmonization of activities for successful implementation of GBAS technology. FAA technical know-how and approval processes are sought after. Nations are developing their own processes but are still aiming to be in compliance with FAA practices. FAA and AsA signed a Memorandum of Cooperation to support mutual activities with focus on regulatory approval of GBAS. Common understanding and practice of system approval, and the use of common test cases and tools are the near term goals for the working group.

LAAS Flight Testing is Heating Up!

by Dave Peterson, FAA ATO-W; Kristi Foster, GPS TAC/FAA ATO-W

As part of the research and development efforts to prepare for a non-Federal approval of the Local Area Augmentation System (LAAS) at Memphis International Airport, the FAA conducted a series of successful flight tests in early May. Using the LAAS Test Prototype, the flight tests were conducted at the FAA Technical Center in Atlantic City. The purpose of the flight tests was to determine the operational performance and feasibility of a LAAS complex approach. The aircraft used for the tests was the Tech Center's Boeing 727.

The approach was developed to mirror one of the existing RNAV GPS approaches at Memphis Airport using the waypoints and transitioning from the arrival corner posts to the final approach segment. The only difference between the Atlantic City and Memphis procedure is that the actual headings align the aircraft with the Atlantic City runway instead of the Memphis runway.

Four expert Tech Center test pilots (Mark Ehrhart, Keith Biehl, Larry VanHoy, and Lorry Faber) flew the procedure to determine any possible limitations of the approaches. Despite the variance in the pilots' technique, they agreed that the LAAS procedure was very flyable and provided them with some understanding of what to anticipate during the approach. A total of 30 approaches were flown and although the test report is still in development, the initial reports and preliminary analyses indicate that it is a very useful and beneficial procedure.

As anticipated, the command guidance was very accurate and allowed the pilots to navigate the aircraft through turns flying the paths right on track. Even with severe crosswinds, the procedure was very manageable which allowed the pilot more than enough time to prepare the aircraft for landing.

The pilots performed various turns to see if a different radius would impact the performance, and it did not. The pilots also varied the speeds for the approach to determine any impacts and still found the approach to be very easy to track and very stable. During the different approaches, the pilots found the cockpit workload to be very low.

Perhaps one of the greatest benefits noticed during the approach was how the pilots could pull the throttles back to an idle descent and track the glide path as the aircraft crossed the corner post waypoint 35 miles from the airport at 10,500 feet. This was done with lateral and vertical guidance from start to finish. During this descent there was a noticeable reduction in noise and the throttles were only applied after the final turn onto the final approach segment. This was significantly different from current approaches that use multiple radar vectors and speed adjustments to arrive at the final approach segment.

The flight tests also illustrated significant fuel savings. The preliminary calculations show reduced fuel burn between the normal step-down approaches and the continuous descent approach (which still met all the terminal area minimum altitudes). Initial recordings show that there was a savings of 500 to 700 pounds of fuel used per approach, an increasingly important factor as fuel costs continue to escalate.

The flight tests at the Tech Center were a precursor to flight tests planned at Memphis in September 2006. These flight tests will be performed by Federal Express pilots using a Federal Express Boeing 727. The FAA (Southern Region, Memphis ATC, and Headquarters), in conjunction with Honeywell, Federal Express, Boeing, and Rockwell Collins have developed an operational flight test concept. The activities at Memphis will test these potential applications and determine the feasibility and benefits of using LAAS in the terminal area. The LAAS Program Office is closely overseeing this project and is using the results to make necessary changes to the system and operational utilization. The RNP Program Office is also reviewing these applications to determine what the future potential might be. These exciting flight tests are helping to build a foundation for the continued development of the LAAS capability. LAAS, in combination with other systems, such as ADS-B and automation for the TRACON and tower, has the potential for increasing efficiency in the terminal area and producing dramatic economical savings for users.

New WAAS GEO Service Leases Undergo Testing Prior to Integration into WAAS

by Grace Pazos, GPS TAC/FAA ATO-W; Ed Sigler, GPS TAC/FAA ATO-W

Testing and integration is underway for two new satellite navigation transponders being leased by the FAA that will soon become an operational part of WAAS. The two navigation transponders, hosted on PanAmSat and Telesat geostationary (GEO) satellites, are components of the Geostationary Communication and Control Segment (GCCS) within the Wide Area Augmentation System (WAAS). The purpose of the GCCS is to generate and transmit the WAAS signal in space (SIS). The WAAS SIS provides WAAS-enabled GPS receivers with information that enables increased position accuracy. The information provided via the SIS also allows WAAS-enabled receivers to have very high confidence (integrity) in the computed position. Finally, the SIS can be used as a ranging source, similar to the signals of GPS satellites.

GCCS System 1 consists of the WAAS navigation payload hosted on the PanAmSat geostationary satellite (Galaxy XV at 133 degrees West) and two GUSTs (GEO Uplink Subsystem Type-1) - one in Napa, California and the other in Littleton, Colorado. GCCS System 2 consists of the WAAS navigation payload hosted on the Telesat geostationary satellite (Anik F1R at 107.3 degrees West) and two GUSTs - one in Brewster, Washington and the other in Woodbine, Maryland. PanAmSat Galaxy XV is assigned pseudo random number (PRN) #135 and Telesat Anik F1R is assigned PRN #138.

GCCS System 1 data link only (DLO) testing started April 12, 2006 and completed April 26, 2006. (DLO service means that the GCCS System 1, when introduced into WAAS operational service, will not provide a ranging capability similar to GPS satellites. The DLO approach was adopted in an attempt to minimize WAAS service disruptions caused by the relocation of the Inmarsat 3 satellite from the Atlantic Ocean to the Pacific Ocean.) Tests were conducted at Raytheon Corporation in California with support staff at both the Napa and Littleton GUST sites. The preliminary acceptance tests

were completed successfully. Additional activities to integrate the GCCS System 1 service with WAAS will continue through this summer with operational WAAS broadcasts expected to begin in October. The ranging function will be added to GCCS System 1 in the spring of 2007 after additional testing and certification.

The current outlook for the completion of GCCS System 2 (Telesat) preliminary acceptance testing is late 2006. GCCS System 2 integration into the WAAS, with full capability, is currently expected to be complete in the spring of 2007.

During the testing period, non-aviation WAAS-enabled GPS receivers will be able to use the signals from the new GEOs. During this period, the signals from the new GEOs will indicate that the signals are under test, preventing aviation-certified receivers from using the signals. Once the systems are certified and integrated into WAAS, the test indication will be removed, allowing use by aviation-certified receivers.

Lockheed Martin Transportation and Security Solutions (LMTSS) is the prime contractor for the GCCS, supported by key subcontractors, Raytheon Company and Dunhill. The Raytheon Company is the prime contractor for the WAAS.

GPS Approach Minima - "Knowing the Different Minima"

by Marty Heller, GPS TAC/FAA ATO-W

Global Positioning System (GPS) and subsequent system improvements have revolutionized the manner in which we fly. The Wide Area Augmentation System (WAAS) and new avionics have lowered instrument approach minimums and increased the types of GPS and RNAV* (GPS) lines of minima. This article attempts to clarify the nomenclature of these different types of GPS approach minima.

RNAV lines of minima now include: LNAV, LNAV/VNAV, LPV and circling. Not all GPS avionics can fly all GPS minima lines. (Of course, if the equipment isn't Instrument Flight Rules (IFR) certified and installed, one can't legally fly any GPS approach.) For starters, the originally GPS capability only provides two-dimensional, lateral navigation (LNAV). Vertical navigation (VNAV) became possible with the advent of flight management systems (FMS) with barometric pressure inputs. These systems are referred to as Baro-VNAV FMS. The latest advance is WAAS. WAAS provides localizer performance with vertical (LPV) guidance.

Approach Charts

Operational since 2003, some individuals might be wondering why they still haven't seen a WAAS approach chart. This is because WAAS is a system which enables LPV minima. Almost 400 LPV procedures have been published already, with a goal of producing 300 more each year. So you won't see a 'WAAS' approach chart — what you will see is a RNAV(GPS) approach chart. (For an example, see Figure 1).

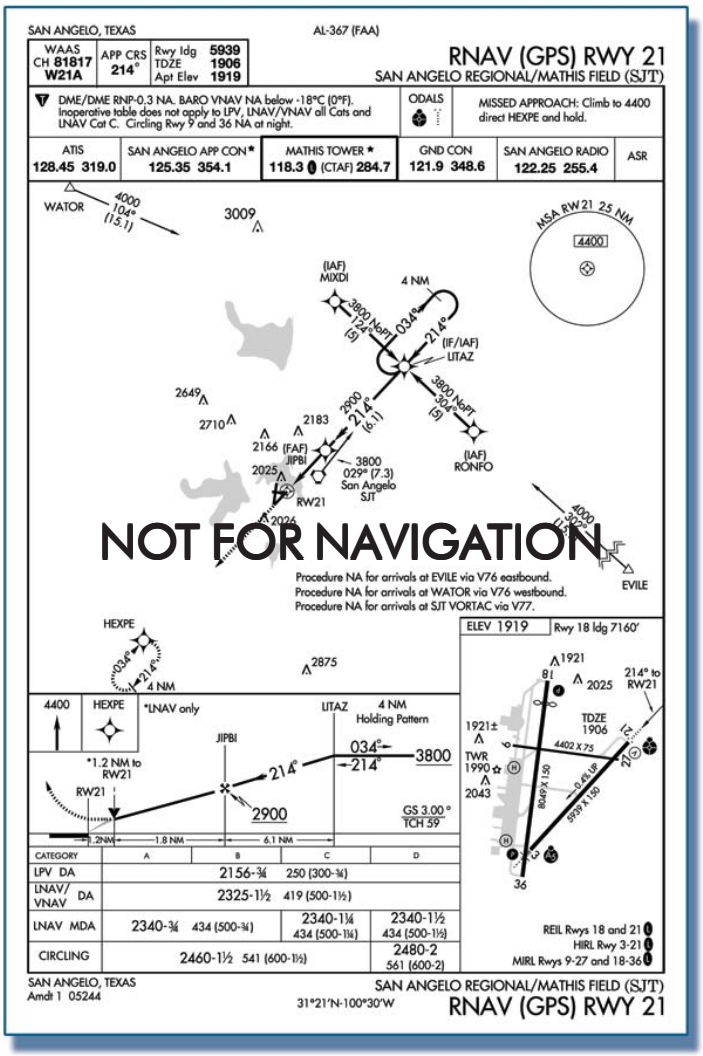

Figure 1. San Angelo Regional/Mathis Field (SJT) RNAV (GPS) Rwy 21

* *RNAV is "Area Navigation"*

Which Minima can your Equipment fly?
Every IFR-certified and installed GPS unit allows the pilot to descend to Lateral Navigation LNAV, or straight-in, minima. Baro-VNAV-equipped GPS systems can descend to LNAV and LNAV/VNAV minima. Certified WAAS receivers can descend to LNAV, LNAV/VNAV, and LPV minima.

Hard to remember? Another hint for knowing the different GPS minima is the Decision Altitude (DA) designation. Only procedures with vertical guidance have DAs, as demonstrated in figures 1 and 2. The Minimum Descent Altitude (MDA) abbreviation on the minima line indicates that only LNAV is

Types of GPS Equipment Required	CATEGORY	A	B	C	D
WAAS*	LPV DA	2156-¾ 250 (300-¾)			
WAAS or Baro-VNAV*	LNAV/VNAV DA	2325-1½ 419 (500-1½)			
WAAS or Baro-aided VNAV or GPS*	LNAV MDA	2340-¾ 434 (500-¾)		2340-1¼ 434 (500-1¼)	2340-1½ 434 (500-1½)
WAAS or Baro-aided VNAV or GPS*	CIRCLING	2460-1½ 541 (600-1½)			2480-2 561 (600-2)

*IFR Approach-Certified Equipment

Figure 2. Approach Minimum Equipment Comparison

provided. While a descent angle might be provided for an LNAV approach, the angle is only to aid in a stabilized descent, not provide vertical navigation; and the MDA must still be respected. The final authority for knowing what your aircraft can fly is your pilot's operating handbook (POH) and any associated supplemental pilot/flight manuals. The POH clearly spells out whether your aircraft is authorized to fly in IMC and what approaches it is authorized to fly.

Other Minima Lines
The GNSS Landing System (GLS) decision altitude (DA) was originally added to some charts as a place holder for ongoing upgrades to WAAS and for the Local Area Augmentation System (LAAS). GLS is now being replaced by LPV on the RNAV(GPS) charts. The acronym, 'GLS' is now associated with the LAAS minima and will be published on a separate chart when LAAS approaches become available.

LAAS
LAAS will augment the GPS and complement WAAS by providing an all-weather approach, landing, and surface navigation capability. Curved approach paths, not possible using the current instrument landing systems, will be possible for Category I, II, and III precision approaches as the system evolves. Approaches will be designed to avoid obstacles, restricted airspace, noise sensitive areas, or congested airspace. Increased accuracy through LAAS will also allow more arrival and departure procedures.

Need More Information?
You can find a condensed version of the information in this article on page A1 of each U.S. Terminal Procedures Flight Information Publications and in the Aeronautical Information Manual (AIM) paragraph 5-4-5, j. More GPS and WAAS information is also available in the AIM paragraphs 1-1-19 and 1-1-20. The following websites also have information on GPS approaches:

- FAA Satellite Navigation web site: http://gps.faa.gov
- Aeronautical Information Manual: http://www.faa.gov/atpubs/AIM/AIM.pdf
- Instrument Procedures Handbook; Chapter 5 : http://www.faa.gov/library/manuals/aviation/instrument_procedures_handbook
- FAA National Aeronautical Charting Office (NACO) In troduction to IFR Symbols: http://www.naco.faa.gov/content/naco/online/pdf_files/7th_IAP_Intro.pdf

Related advisory circulars are accessible at: http://faa.gov/regulations_policies. They include:

- AC 90-94, Guidelines for using Global Positioning System Equipment for IFR En Route and Terminal Operations and for Nonprecision Instrument Approaches in the U.S. National Airspace System
- AC 90-97, Use of Barometric Vertical Navigation (VNAV) for Instrument Approach Operations Using Decision Altitude
- AC 90-100, U.S. Terminal and En Route Area Navigation (RNAV) Operations

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