FAA Navigation Programs AJM-32
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SatNav News

Let it Snow . . . Let It Snow

RNAV (RNP) Approach "Saves" Get Skiers to the Slopes

Less than 2 months after receiving approval from the FAA to begin using its proprietary Required Navigation Performance (RNP) instrument approach procedure at Friedman Airport near Sun Valley, Idaho, Horizon Air (a subsidiary of Alaska Airlines) was able to give its passengers what they wanted – an arrival just in time to get in a few runs on the slopes. This was achieved despite the snowy weather conditions. Geared up for ski season, Horizon Air is able to employ its RNP technology at 2 airports, Friedman Memorial at Sun Valley, Idaho and Mammoth Lakes, California.

RNP enables certified aircraft and specially trained pilots to follow precise three-dimensional curved flight paths through difficult terrain using a combination of onboard navigation technology, Global Positioning System (GPS), and in Horizon Air's case, the GPS Wide Area Augmentation System (WAAS) navigation sensors. This system allows aircraft to fly more reliable approaches to lower weather minima and safe landings. It also eliminates the reliance on ground-based navigation aids.

Cody Hargreaves, RNP engineer at Alaska Airlines, who was an integral part of approval and implementation of this type of approach, explains just what this means to Sun Valley; "Friedman Memorial Airport is located in a deep valley with surrounding mountain peaks. As a result, instrument approaches used by pilots are often hampered by low cloud ceiling and extensive visibility requirements, resulting in a higher than average percentage of

> "Just in time for the ski season and holiday travel, the expected improvement in reliability this brings to our airport during inclement weather will greatly benefit our customers traveling to the area as well as local residents."

Sun Valley, Idaho skiers getting to the slopes

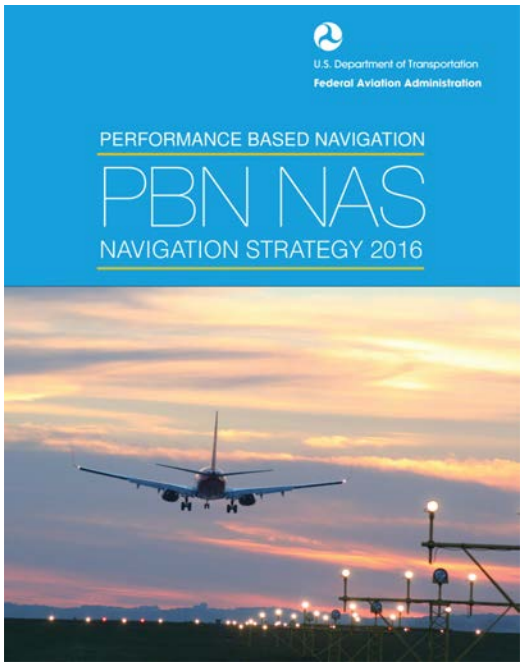
flight cancellations or diversions. The RNP approach Horizon uses will increase safety in this challenging environment and will drastically reduce the number of diversions."

"Just in time for the ski season and holiday travel, the expected improvement in reliability this brings to our airport during inclement weather will greatly benefit our customers traveling to the area as well as local residents," said Chris Pomoroy, airport manager at Friedman Memorial Airport. Since the ski season began Horizon Airlines has benefited from over a dozen "saves", preventing diversions and flight cancellations at these two airports by using these proprietary RNP approach procedures. The RNP effort, which was in development for over 10 years, has already started to pay off for Horizon Air and its customers.

- Amy Trevisan, FAA AJM-32/NAVTAC

The Future of Navigation Takes the Stage at Fall ATCA Conference

The much-anticipated "Performance Based Navigation (PBN) National Airspace System (NAS) Navigation Strategy 2016" was released to the public this past autumn. To provide an opportunity for aviation industry discussion on this important document, the Air Traffic Control Association (ATCA) dedicated a panel to this topic at its annual conference held in mid-October at National Harbor in Maryland. The panel session, entitled, "2016 FAA PBN Strategy - Now that it's official, what can we expect?", was well-attended. FAA Enterprise Services was represented on the panel by our Navigation Programs Group Manager, Deborah Lawrence.



Deborah Lawrence was invited as a panel member to represent the work being done by Enterprise Services' Navigation Programs group in support of the PBN strategy. As it pertains to the PBN strategy, FAA Navigation Programs is responsible for the delivery of augmentations to the Global Positioning System (GPS). GPS augmentation systems – like the Wide Area Augmentation System (WAAS) and the Ground Based Augmentation System (GBAS) - enable more satellite-based aviation operations than GPS alone. Navigation Programs is also directly involved in the development, acquisition and implementation of resilient navigation infrastructure programs. These programs include the Very High Frequency Omnidirectional Range Minimum Operational Network (VOR MON) and NextGen DME. DME stands for Distance Measuring Equipment.

The panel was moderated by Capt Ken Speir from Delta Airlines and also included representatives from the International Civil Aviation Organization (ICAO), airlines, National Air Traffic Controllers Association (NATCA), and other branches of the FAA. Each provided their perspective of what the newly-released strategy document means to members of their community and its importance to their respective organizations.

Your WAAS Story

. . . We're collecting testimonials about the benefits of Wide Area Augmentation System (WAAS) navigation from users. If you are a pilot, passenger, airport manager, controller, dispatcher, airline employee, or are involved in aviation in any capacity - whether you fly fixed-wing or vertical flight aircraft - we want to hear from you! Please send your stories and contact information to Amy Trevisan at: amy.ctr.trevisan@faa.gov

The 2016 FAA PBN Strategy is important to all these stakeholders for several reasons. The PBN NAS Navigation Strategy 2016 focuses on priorities and milestones to transition to a PBN-centric NAS. This is a NAS where PBN is the basis for daily operations. The strategy describes a pathway to this vision and includes commitments that will leverage existing and evolving aircraft capabilities, enable new operations using a blend of aircraft capabilities, enhance decision support tools and transition strategies, and reduce dependence on legacy navigation infrastructure. Additionally, the transition to PBN is largely enabled by the Global Navigation Satellite System (GNSS) which is comprised of GPS and its augmentations – WAAS/GBAS. To mitigate the potential for disruptions to GNSS caused by interference, the FAA is also developing a resilient backup for GNSS by retaining a portion of the ground-based NAVAIDs.

To check out a copy of the 2016 FAA PBN Strategy, please visit the FAA website at https://www.faa.gov/nextgen/media/PBN_NAS_NAV.pdf.

- Mary Ann Davis, FAA AJM-32/NAVTAC

The following is an excerpt from NovAtel's annual Velocity Journal, ***click here*** for complete article

Modernizing a Safety-Critical System

NovAtel has supplied the Federal Aviation Administration with the reference receiver for the agency's GPS Wide Area Augmentation System since the program's inception. Here's a look at why that receiver, the G-III, is so vital to WAAS, and the recent modernization that makes it even more accurate and robust.

IN CIVIL AVIATION, there's no room for navigation error. Precise positioning information is vital for aircraft, whether during en route navigation, airport departures, or approaches and landings—and NovAtel has been helping the Federal Aviation Administration (FAA) provide this information through the GPS Wide Area Augmentation System (WAAS) since the 1990s.

The WAAS system began in 1992 after approval of a mission need for improved satellite navigation capability, said Gregory Thompson, FAA program management analyst. WAAS became an official program two years later, with the actual development process beginning after the first contract was awarded in the mid-1990s. NovAtel was involved from the beginning, internally designing and funding the first reference receiver for this safety-critical system. The FAA purchased and fielded the NovAtel receivers in the late 1990s.

"NovAtel approached the FAA and its prime contractor with a receiver that integrated WAAS signal tracking, provided robust semi-codeless processing, and multipath mitigation technology that met the FAA's needs at the time," Thompson said. "The FAA has developed a very good relationship with NovAtel over the years. We benefit from the overall support that NovAtel has been willing to provide to a technically demanding and admittedly niche market."

The receiver is now in its third generation. The FAA determined the G-II receiver needed a

technology update in 2009, Thompson said; so, NovAtel went to work developing the latest iteration. The G-III, which the FAA began fielding in 2015, provides the upgrades the agency envisioned, including additional processing for modernized GPS signals as well as the ability to accommodate future enhancements. These potential enhancements include handling positioning signals from Europe's Galileo or another global navigation satellite system (GNSS).

How WAAS makes GPS Safe

WAAS is designed to provide augmentation information to GPS receivers, enhancing the accuracy and reliability of position estimates. It removes the errors that typically come through GPS signals, and unlike traditional ground-based navigation aids, WAAS covers most of the National Airspace.

> "WAAS makes it possible for the flight crew to make the best decisions based on the best data available"

"When GPS was in its earlier days we thought we could use it to navigate and land aircraft, but then we realized that was only true to a certain extent," said Jonathan Auld, NovAtel director, safety critical systems. "How do you know you can trust the satellites to work to their required level? That's kind of where WAAS came from. We needed a second system to monitor the first system so we could verify the data received is healthy and that pilots are able to make good decisions in the cockpit."

How does the system improve positioning accuracy? By providing correction data to the receiver that's inside the aircraft, Auld said. This includes correction data for GPS satellite orbits, GPS satellite clock corrections and ionosphere delays. The WAAS network calculates this data then provides it to the aircraft receiver and pilot over a geostationary satellite. This takes the achievable accuracy down to a level of a few metres rather than 10 metres.

The data WAAS provides also helps the aircraft receiver and pilot determine the protection level, Auld said, and if they can trust the data coming from a specific GPS constellation. If the receiver in the aircraft thinks the constellation is accurate to a meter but it is actually in error by 10 meters, for example, that will lead to problems.

Through the WAAS system, pilots know if a constellation isn't healthy, minimizing and even eliminating the risk of receiving hazardous misleading information (HMI). In fact, users are notified within six seconds of any issuance of hazardously misleading information that would cause an error in the GPS position estimate, according to the FAA.

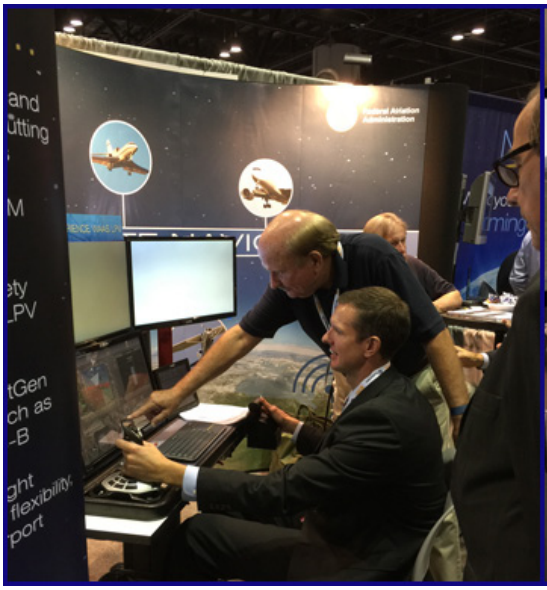
"WAAS makes it possible for the flight crew to make the best decisions based on the best data available," Auld said. "It's better the system says don't trust me, I can't be depended on right now, than for it to mislead you. Then you can fall back to other systems and take the necessary actions to do something differently or follow a different procedure. You don't want to depend on data you can't trust."

WAAS G-III features

NovAtel's WAAS G-III provides accurate reference range measurements and signal quality measurements for ground reference networks. The third-generation receiver is designed for satellite-based augmentation systems (SBAS) that generate correction data and monitor signal integrity for safety-of-life applications. Key features include:

- Independent acquisition and tracking of GPS L1 C/A, L1C, L2C, L5 and GEO L1 C/A and L5 signals
- Semi-codeless tracking of L2-P(Y) signals
- Temperature controlled RF deck to minimize code and carrier phase shift
- Chip-shape signal deformation measurements based on NovAtel Vision technology
- Signal Quality Monitoring (SQM) measurements based on correlation peak shape measurements
- RF interference protection and digital pulse blanking
- Advanced cross-correlation and side lobe tracking detection
- Adaptive phase-locked loop bandwidth for tracking in high-scintillation environments
- Support for memory-based codes for experimental and maintenance activities
- Support for modernized GPS signals. The added support for the L5 signal allows for the evolution of ground systems to provide dual-frequency SBAS support for civil aviation applications.

WAAS Program Office Attends NBAA/AMTC



The WAAS program office spent time connecting with those familiar with WAAS and those wanting to learn more at two conferences late Fall. The National Business Aviation Association (NBAA) Exhibit and Conference took place in early November, and the Air Medical Transport Conference (AMTC) was in December.

Founded in 1947 and based in Washington, DC, the NBAA is the leading organization for companies that rely on general aviation aircraft to help make their businesses more efficient, productive and successful. The association represents more than 11,000 companies and provides more than 100 products and services to the business aviation community, including the NBAA Business Aviation Convention and Exhibition, the world's largest civil aviation trade show.

The WAAS program exhibit was located across from the NBAA exhibit and next to the FAA's NextGen Equip ADS-B. Attendees were drawn to the new FTS WAAS Localizer Performance with Vertical (LPV) flight simulator where anyone could fly a WAAS LPV approach. Many people from all over the world, and Europe in particular were interested in the interoperability of Space Based Augmentation Systems such as WAAS and EGNOS.

The AMTC, in Charlotte, N.C., was the second event that the newly acquired FTS simulator was utilized as a tool to draw a crowd to the Satellite Navigation booth. The FAA WAAS Operational Implementation Team (OIT) was hoping to promote outreach about WAAS LPV and ADS-B. Our mission was to let pilots and operators fly an aircraft simulator (the Cirrus-22) for WAAS LPV approach demonstrations. Helicopter and fixed wing air ambulance pilots and organization operators took advantage of this opportunity. The FTS simulator was quite a popular attraction and we received many favorable comments about WAAS LPV performance.

> "interest in discussing WAAS equipage and Localizer Performance with Vertical (LPV) procedures was strong."

The AMTC Convention was somewhat hindered in size this year due to having been

postponed from September 2016. In spite of this, the Convention still generated attendee enthusiasm and the FTS simulator definitely acted as a draw to the FAA Satellite Navigation Booth. Attendees interacted often and lingered at the booth longer talking with OIT personnel. Their interest in discussing WAAS equipage and LPV procedures was strong.

- Dave Kerr and Amy Trevisan, FAA AJM-32/NAVTAC

Satellite-Based Augmentation System (SBAS) Interoperability Working Group (IWG) Update

In 2016, SBAS providers continued to meet semi-annually to progress development of the Dual Frequency Multiple Constellation (DFMC) SBAS concept, share lessons-learned about SBAS operations and address questions related to SBAS service. China hosted SBAS IWG-30 in May in Changsha, the capital of Hunan province. The Agency for Aerial Navigation Safety in Africa and Madagascar (ASECNA) hosted SBAS IWG-31 in Dakar, Senegal bridging the November/December transition. Participants in these meetings included the United States, Japan, Europe (including European Space Agency (ESA) and European GNSS Agency (GSA), and European Satellite Services Provider (ESSP)), India, Russia, China, Korea, ASECNA, EGNOS-Africa Joint Program Office and Canada.

After making progress in China, IWG approved a DFMC SBAS Definition Document and Interface Control Document in Dakar. These documents provide the SBAS provider vision for the DFMC SBAS services. IWG provided these documents to the International Civil

Aviation Organziation (ICAO) Navigation Systems Panel (NSP), RTCA and EUROCAE to use as a starting point for the development of DFMC SBAS standards. These bodies will further develop the DFMC SBAS standards over the next 2-4 years. IWG will continue to monitor the progress of these bodies with reports from IWG participants who attend these other organizations.

IWG received briefings about the status of current SBAS systems and plans for future SBAS systems. Current SBAS providers continue to see the publication of additional SBAS procedures and increased equipage and use of SBAS. Future SBAS providers view SBAS as a means to provide vertically-guided approaches to runways where precision approach procedures are not available today and see SBAS as the key enabler for Automated Dependent Surveillance – Broadcast (ADS-B).

SBAS providers also discussed concerns about the use of SBAS. Users can receive the SBAS signal well outside the approved SBAS Service Area. SBAS providers assess the integrity of the SBAS signal in the broadcast area and not just in the service area, so the signal is safe for use. The SBAS providers drafted an information paper that several members presented to ICAO at NSP.

- Joseph E. Dennis, FAA AJM-32/NAVTAC

SBAS Minimum Operational Performance Standards

In December RTCA approved the first revision to the SBAS MOPS in about 10 years, with approval of the DO-229E version. Global expansion of SBAS services prompted the change. The DO-229D version only approved the use of 19 pseudorandom noise (PRN) codes used to identify SBAS satellites for SBAS use. Of the 19 approved codes, 17 are currently allocated, supporting the four operational SBAS systems, WAAS, MSAS, EGNOS and GAGAN. The MOPS revision permits the use of an additional 20 PRN codes previously reserved by the USAF for SBAS use. The increased number of usable codes will support the planned addition of SBAS systems under development in China, Russia and Korea and planned for Africa. The MOPS revision also approved a change in behavior for SBAS equipment that addresses some past occurrences when horizontal guidance was not available from SBAS equipment but was available from RAIM-only equipment. The change will permit the SBAS equipment to operate in a RAIM-mode to support horizontal navigation even when SBAS status identifies satellites as "Do Not Use". This recognizes that SBAS systems remove satellites from use for precision approach users that might be adequate to support horizontal-only navigation. With this change, RTCA expects that SBAS equipment manufactured under the new MOPS will always have at least equivalent performance to RAIM-only equipment.

Wide Area Augmentation System at HAI

Visit us at Booth **4107**

The SatNav News is produced by the Navigation Programs AJM-32 branch of the Federal Aviation Administration (FAA). This newsletter provides information on the Global Positioning System (GPS), the Wide Area Augmentation System (WAAS) and the Ground Based Augmentation System (GBAS).

Satellite Navigation
Approach Procedures

WAAS Facts

CY16 maintenance release has improved WAAS availability in Alaska. An increase of:

10%

Satellite-based Approach Procedures

	Procedures (Part 139 Airports)	Procedures (Non-Part 139 Airports)	Total Number of Procedures
RNAV (GPS) Approach **LNAV Line of Minima**	1,777	4,353	6,130
RNAV (GPS) Approach **LNAV/VNAV Line of Minima**	1,411	2,232	3,643
RNAV (GPS) Approach **LPV Line of Minima**	1,413	2,354	3,767
Non-ILS runway	*51*	*1,753*	*1,804*
ILS runway	*1,362*	*601*	*1,963*
RNAV (GPS) Approach **LPVs w/200' HAT**			963
RNAV (GPS) Approach **LP Line of Minima**	91	531	622
GPS Approach **GPS Stand-Alone Procedures**	6	77	83
GLS Approach	11	0	11

(Data as of February 2, 2017)

Instrument Approach Procedures (IAPs) Based on Conventional NAVAIDS

ILS	1,559
ILS (CAT II)	158
ILS (CAT III)	119
LOC	1,328
NDB	536
VOR	1,100

(Data as of January 5, 2017)

The tables above reflect the continuing growth of satellite-based approach procedures as compared to the inventory of instrument approach procedures based on conventional NAVAIDs. For more detailed information about satellite-based instrument approach procedures, please visit our GPS/WAAS Approach Procedures web page. *http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/ approaches/index.cfm*

More information is available on the FAA Inventory Flight Procedures (IFP) Inventory Summary at *https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/ifp_inventory_summary/*

Country	Airports – SBAS APV procedures	# SBAS APV Procedures
Austria	2	2
Belgium	3	5
Croatia	1	1
Czech Republic	4	8
Denmark	4	8
Finland	1	2
France	86	140
Germany	22	37
Guernsey	1	2
Hungary	0	0
Italy	7	17
Netherlands	2	3
Norway	13	22
Poland	5	9
Portugal	1	2
Romania	1	2
Slovak Republic	2	4
Spain	1	2
Sweden	2	3
Switzerland	7	9
United Kingdom	3	6
Total	168	284

The number of LPVs in Europe is also growing. The table above shows LPV procedures in Europe as of December 8, 2016, as included in the EGNOS Bulletin Quarter 4. (Source: EGNOS Bulletin, Issue 21 Q4 2016)

Follow this link to the most recent EGNOS Bulletin Quarter 4, Issue 21: *http://egnos-user-support.essp-sas.eu/new_egnos_ops/content/quarterly-bulletin*