



# SatNavNews

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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).

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(from left) PMO Vice President Rebecca Guy, Navigation Programs Group Manager Deborah Lawrence and ATO Deputy COO Katrina Hall;

## WAAS at 20: The idea began on a napkin

The FAA in July celebrated the 20th anniversary of the wide area augmentation system, which is known by the shorthand WAAS.

WAAS is a revolutionary, satellite-based navigational program conceived, constructed and commissioned by FAA professionals, including Leo Eldredge, the former program manager with expertise in the Global Positioning System gained during 20 years with the U.S. Air Force. "In 1993, a group of the program founders up in Atlantic City basically kind of scribbled the concept on a napkin in a restaurant," Eldredge explained in a WAAS tribute video produced for the 20th anniversary ceremony at FAA headquarters. "And that was the beginning of what we would wind up building."

It was a bold move that took 10 years to commission. The idea was to improve the navigational accuracy and capability of GPS.

While GPS is good for two-dimensional navigation, it does not provide the necessary levels of vertical guidance that is critical for pilots during landings, especially in bad weather. By contrast, WAAS evaluates all GPS signals for accuracy, enabling pilots to know exactly where they are with certainty throughout a flight. This significantly boosts safety and efficiency.

The WAAS team also saw the potential to open the national airspace system vastly by making airports without ground-based navigational equipment available to pilots.



Enterprise Services Director Malcolm Andrews at the WAAS event

The team collaborated with outside experts, bringing in professionals from NASA's Jet Propulsion Laboratory, MITRE, Stanford University and other institutions. They not only assisted in refining WAAS but also helped demonstrate its benefits to pilots and other potential users, such as airlines, airports and global air navigation service providers. While WAAS was developed for aviation, other industries have benefited from its performance. These include agriculture, forestry and geolocation services. Virtually every cell phone uses WAAS these days, a point made by Malcolm Andrews, the FAA's enterprise services director.

"Just think about it for a minute," Andrews said. "If we took your cell phones away, or took your GPS maps from your cell phones, can you get home? Can your kids get home? I think we've come to the point where we've come to think of augmented GPS just like we do electricity and water. We expect it to be there."

Today, the general aviation community uses WAAS the most. But that, too, is changing.



PMO Vice President Rebecca Guy

During the anniversary ceremony, Delta Air Lines technical manager Michael Mannino announced that Delta is set to be the first major commercial airline in the United States to "adopt a comprehensive WAAS strategy." "Delta already has two WAAS-equipped fleets," he said. "In 2025, we will take delivery of our third WAAS equipped fleet: the 737 Max 10 aircraft." Mannino added that over the next five years, Delta expects to add WAAS to most of its mainline fleet.

The reputation of WAAS has extended well beyond America's borders, prompting other nations to seek the FAA's expertise, according to Deborah Lawrence, group manager of the agency's navigation programs.

"Over the years, we collaborated with our peers in Japan, India and Europe as they developed similar systems to WAAS," she said. "Today, each air navigation service provider has compatible systems, which results in a better user experience for our stakeholders."

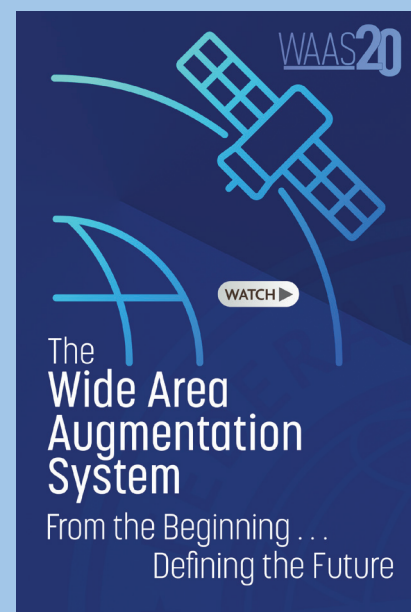
Throughout the past two decades, countless FAA staff have made WAAS a success, a reality that Greg Thompson, the current manager of the WAAS program, finds sincerely gratifying.

"I manage a program that is something that is being adopted not just in the United States, but worldwide," he said. "It's kind of the cliché, you know? I might actually be doing something that actually makes a difference."

- Catherine Maddux



"In 1993, a group of the program founders up in Atlantic City basically kind of scribbled the concept on a napkin in a restaurant,"



Celebrating twenty years, this video tells the story of the Wide Area Augmentation System, from the program's beginnings to how it is defining the future of satellite navigation



# Navigating the Future: WAAS celebrates 20 years with inspiring morning STEM session for girls

The Wide Area Augmentation System (WAAS) has been providing more precise positioning for over 20 years now but to the morning attendees of the all-day anniversary celebration it was new technology. The FAA's WAAS program and STEM for Her collaborated providing 30 aspiring engineers and aviation enthusiasts a peek into what the technology is all about.

The young women arrived early on July 11 from various parts of the Northern Virginia and Washington DC area. Three learning stations were available for them to understand and experience WAAS first hand. The William J. Hughes Technical Center in Atlantic City, New Jersey brought two of the learning stations; the WAAS storyboard, which illustrates how WAAS interacts and fits into the National Airspace System, and the website that track's live data from the WAAS system and coverage from the satellites. For a hands-on experience, the third learning station was a flight simulator with a certified flight instructor allowing them to test their aviation skills and fly a WAAS LPV.

After an hour of rotating through the learning stations the young women participated in a panel with Deborah Lawrence, Navigation Programs Group Manager, Pamela Gomez, FAA Senior Aviation Fellow, and Patricia Morrison, Computer Specialist. The panel was moderated by Serap Fern from FAA STEM and Intern Programs Flight Standards Service. Serep asked questions of the panelists so that the young women got an understanding of each panelist's journey in their career. Finally, the floor was opened for discussion. The young women were not shy with their questions and almost all had something to ask.

When it was time to say goodbye the group gathered for a photo in front of the WAAS 20th backdrop. It was clear by the engagement and smiles on faces, the WAAS 20th anniversary morning STEM event was a success.

- Amy Trevisan, FAA AJM-32/NAVTACII



Photos of STEM for Her Session during the WAAS20 celebration

## WAAS LPV/LPs

As of 8/10/2023 there are:

4,127 LPVs

734 LPs

2,004 airports served

537 airports served

1,239 are non-ILS airports

436 are non-ILS airports

This graphic reflects the continued growth of satellite-based LPV/LPs approach procedures. For more detailed information please visit: [http://www.faa.gov/about/office\\_org/headquarters\\_offices/ato/service\\_units/techops/navservices/gnss/approaches/index.cfm](http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/approaches/index.cfm)

# WAAS is Working for airports

“... the main goal was safety and service to our customers ...”



Bad weather approach to Friedman Memorial Airport, Hailey Idaho (KSUN)

Sun Valley, Idaho, is known for great skiing and beautiful weather. The web site boasts, “You’ll come for the winter but you’ll stay for the summer.”

Episode 8: WAAS IS WORKING

NOW SHOWING

WATCH ►



**AIRPORTS**

Friedman Memorial Airport  
Hailey, Idaho

In this episode of WAAS is Working, discover the multiple benefits airports can accrue from WAAS

In past years, winter flights into KSUN presented numerous challenges. The Airport Board struggled with improving the reliability of commercial flight arrivals. Before Chris Pomeroy took the job as airport director at Sun Valley in Hailey, Idaho, he was part of the Board’s efforts in this regard. As an airport planning consultant, he assisted the Board in considering instrument approach solutions, including ground-based navigation aids such as an ILS localizer, along with GPS and WAAS options. One of the biggest hurdles to implementation was the lack of equipment of NextGen avionics in the fleet of aircraft using the airport.

In 2016, when Pomeroy became the airport director, he was still carrying the torch to find an all-weather access solution for his community and air service partners. He

knew the technology had advanced along with avionics to support it. Through a mutual colleague, he was introduced to Alec Seybold with Flight Tech Engineering, an FAA-authorized third-party procedure developer, whose team takes approach designs from concept to implementation. Pomeroy knew from his days as a consultant that the solutions Seybold was proposing were possible. He remembers when they started getting into the nuts and bolts of integrating RNP with LPV, they knew they had something special. Now, the focus was on who would be the primary partner? Who would be the end user? The airport wanted to focus initially on the reliability for its air carriers. Enter SkyWest.

According to Pomeroy, SkyWest was instrumental in this partnership, working



very closely on the technical side with input and flight simulator validations and ultimately providing the actual aircraft used for commercial passenger service to ensure that the avionics flew the procedure as expected.

The team set out to find a solution for an approach to Hailey's Runway 31. Initially, the Flight Tech team started working closely with Salt Lake City ARTCC and Hailey Tower to ensure an efficient connection of the high-altitude enroute airspace to the airport/terminal environment. Once this was complete, the TERPS specialist began developing specialized radius-to-fix (aka: curved path) RNP segments to carefully guide the aircraft around terrain, which allowed it to connect to a WAAS LPV final. Among other challenges, the design team had to ensure a smooth capture of the LPV electronic Glidepath as the aircraft transitioned from barometric altitudes to the geometric altitudes used by the WAAS LPV technology. This requirement called for numerous simulator testing and procedure adjustments with SkyWest before a final path was determined. The result was a smooth continuous descent from the enroute phase of flight to a vertically guided LPV final. It was no longer necessary to rely on (1) the non-precision approach, which was considered high workload due to the numerous altitude changes (stepdown fixes); or (2) the unstabilized approach, which required the pilot to have the airport in sight 4NM out.

Feedback from the pilot group was overwhelmingly positive. Passengers were thrilled because the new LPV weather minimums allowed the aircraft to land in lower ceiling and visibility conditions.

What this new procedure has done over the past three winters for passenger satisfaction and the visitor travel experience cannot be overstated. Pomeroy says, with conservative counting, he believes it's 15,000 happy passengers not being diverted to the nearest airport, Twin Falls, Idaho, and bussed to Sun Valley. And, on the flip side, the same number of passengers on outbound flights have been saved the inconvenience of bussing out of Sun Valley. Because of the improved reliability of arrivals, the airport had to completely revamp its snow removal procedures and response times. Airline operating requirements do not allow more than 1/8 inch of contamination on the runway. With new procedures and removal equipment, the operations team is able to keep the airport operational during storms with as much as 1 inch of snow an hour.

Although the primary focus of this new procedure was to safely improve the visitor's air travel experience to Sun Valley, the airport has seen some benefits too. Sun Valley is no longer losing out on landing fees and passenger fees. Pomeroy says that while the main goal was "safety and service to our customers," the financial benefits to the airport have been a bonus. The benefits continue in additional ways: Pomeroy and Seybold both point to the environmental carbon emissions component. More aircraft are able to get in, without holding and burning fuel.

Pomeroy added, "the success of this procedure and its positive impact on our guest's air travel experience, the airport, and the community in general have been nothing short of game-changing. This is a great example of perseverance and a team effort focused on success. It's certainly one of my most proud career accomplishments."

- Amy Trevisan, FAA AJM-32/NAVTACII



Aerial view of Friedman Memorial Airport, Hailey Idaho (KSUN)

“... the success of this procedure and its positive impact on our guest's air travel experience, the airport, and the community in general have been nothing short of game-changing.”

# 22nd International GBAS Working Group (IGWG) meeting

The 22nd International GBAS Working Group (IGWG) was hosted by San Francisco International Airport in San Francisco, California, USA from June 27-29, 2023. The meeting was co-chaired by Shelly Beauchamp, FAA and Andreas Lipp Eurocontrol. San Francisco was the perfect place for this year's IGWG because SFO became the latest US airport to implement GBAS in March 2022, and continues explore novel GLS approach scenarios.

This meeting of the IGWG was a return to the largely in-person format enjoyed before the start of the 2020 COVID pandemic. Although a virtual option was made available for those unable to travel, nearly all presenters were on-site. This format allowed for additional side meetings amongst subgroups interested in particular topics in addition to the planned briefings. This was particularly beneficial, as it is rare that GBAS stakeholders from so many different groups (regulators, service providers, and users) are able to gather in one location.

Approximately 60 participants attended in person, with an additional 45 attending remotely. Participants represented US and international service providers, industry, airports, airlines and aircraft manufacturers. International attendees from Germany, France, Norway, Hong Kong, South Korea, Switzerland, and Japan were on site, along with numerous US attendees. Notable participating organizations included GBAS manufacturers (Honeywell, Indra Navia), aircraft manufacturers (Boeing, Airbus), airlines (Delta, United, Lufthansa, Southwest Airlines), and ANSPs and airport authorities (PANYNJ, SFO, Minneapolis, Fraport, Sydney).

Part of the meeting was held at the Airport Museum in the San Francisco International Terminal – a perfect environment for an aviation theme meeting. Briefing discussion topics were: National GBAS Updates, Aircraft / Avionics / Ground System Manufacturer Updates, Airline Updates, GBAS Operational Topics, Ionospheric Aspects & Monitoring, DFMC GBAS Research, Siting & Ground Monitoring Aspects, Data Collection & Evaluation, and Radio Frequency Interference.

During the various status updates provided, Delta and United each reviewed their plans to continue GBAS equipage on their mainline aircraft fleet. With current order book, United Airlines will have 350+ GLS equipped aircraft by 2024, and Delta Air Lines will have 410 GLS capable aircraft. Southwest Airlines offered an impromptu update that reflected the company's continued intentions to equip and retrofit all of their fleet as well.

Minneapolis International Airport (MSP) announced that the airport had purchased a Honeywell SLS-4000 GBAS system and intended to move forward with installation and commissioning in the near-



term. The FAA will work with MSP to ensure that this process proceeds as smoothly as possible.

A continued area of key interest is the potential to achieve CAT II approach minima using GAST-C ground systems. DFS briefed again on their process to achieve operational status on their currently published CAT II approaches using the Frankfurt Honeywell SLS-4000 Block II-S GBAS. There is significant interest from other ANSPs and regulators on how DFS handled the approval and implementation of the system and associated air traffic control (ATC) procedures, and interest from airlines and aircraft manufacturers on how they could use this experience to move forward with approvals with their respective regulators. US airline participants continued to show interest in pursuing such an approval for US GBAS systems, as well as utilizing the Frankfurt system and approaches for operational experience. SFO noted this as a possibility to maintain low visibility approaches during their sea wall construction, which will render existing CAT II ILS inoperative for some runways.

Updates were also provided on dual-frequency/multi-constellation (DFMC) GBAS standards work being conducted at ICAO and EUROCAE. The IGWG group appreciated the





San Francisco International GBAS intallation

updates on the direction of the standards, and additional briefings from various presenters on DFMC research taking place. As in past IGWGs, detailed technical presentations were provided on ionospheric aspects and integrity monitor designs. The increase in ionospheric activity in early 2023 has led to more interest in ongoing ionospheric monitoring activities as well. Other briefings focused on special topics, such as potential use of GBAS and GBAS derivatives in support of new entrants to the airspace, such as unmanned aerial systems (UAS) and advanced air mobility (UAM) aircraft.

On Wednesday afternoon the team took the opportunity to visit the SFO GBAS installation and learn about the complexity of SFO's operations, upcoming infrastructure changes, and how GBAS can potentially support the airport in maintaining their operational flexibility.

Participants remained in support of continuing International GBAS Working Group meetings. While a hybrid in-person/virtual format is likely to be maintained to accommodate those that are unable to travel, the group agreed that in-person attendance offered the most benefit. The four day duration was deemed appropriate. It is anticipated that wide interest in operationally focused topics will continue, due to the growing interest in advanced procedures.

The IGWG received an invitation from the German ANSP DFS, and FRAPORT to meet in Frankfurt Germany in June of next year for IGWG #23. The chairs accepted this invitation and will work to set final dates in the near future

- Dieter Guenter FAA AJM-32/NAVTAC II

“ Boeing and Airbus remain strongly committed to GLS and reported an increase in GLS customer base and increased numbers of GLS equipped aircraft. ”



Participants at the 22nd International GBAS Working

# Dual Frequency Multiple Constellation (DFMC) Satellite Based Augmentation System (SBAS ) demonstration service started

The Agency for Air Navigation Safety in Africa and Madagascar (ASECNA) continues to progress development and demonstration of the Augmented Navigation for Africa (ANGA) Satellite-Based Augmentation System (SBAS). ANGAs first started demonstration of L1 SBAS services over Western and Central Africa in September 2020. ANGAs plans to certify the service for safety-of-life use starting in 2025. More recently, ANGAs has developed a demonstration DFMC SBAS service. The DFMC SBAS demonstration service started broadcast in June 2023, with a target to be certified for operations in the late 2020s. The demonstration service uses a Thales Alenia Space DFMC SBAS navigation kernel to augment GPS and Galileo using 15 select reference stations from the SAGAIE network (Stations ASECNA pour l'Etude de l'Ionosphère Equatoriale) and from various agencies participating in the International GNSS Service (IGS), located mainly in the African equatorial region. The demonstration uses Nigcomsat 1-R GEO satellite broadcasting PRN-147.

More details will be presented at the Institute of Navigation's Global Navigation Satellite Services plus conference on September 13, 2023. The first part of the paper shows two representative African DFMC SBAS scenarios using real GNSS data. The scenarios use data from December 2021 and March 2022 to

evaluate the impact of the ionospheric activity on the DFMC SBAS performances. The last part of the paper described the real time DFMC SBAS testbed. The paper presented the performance analysis of the ANGAs DFMC demonstration signal regarding positioning accuracy, availability, continuity and integrity margins over the service area. The results will illustrate the level of navigation performances expected for a corresponding DFMC operational service over a wide service coverage area characterized by complex and challenging ionospheric conditions.

- Julien Lapie, ASECNA



The untold story of how GPS was saved.

Click [here](#) to read full article.

## WAAS Storyboard

### The WAAS Storyboard

... demonstrating how WAAS operates in the NAS

WATCH ▶



WAAS is a highly accurate satellite based navigation system developed for civil aviation that augments the basic service provided by GPS through improved accuracy, integrity and availability for all Performance Based Navigation (PBN) operations and vertically guided approaches.

This storyboard demonstrates how WAAS operates within the National Air Space (NAS).



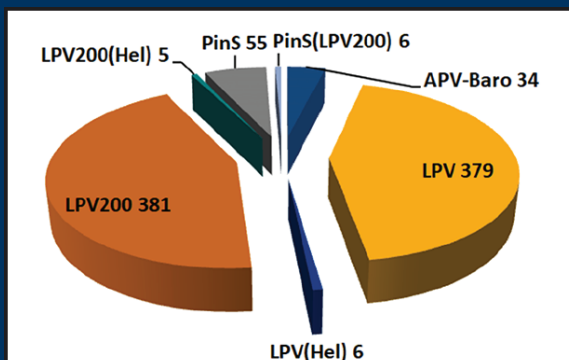
# WAAS is Working

A Video Series demonstrating the benefits of WAAS

**Featuring:** Horizon Air, the Goodyear Blimp, MedStar, Miss Virginia, Floatplanes in Alaska, Mid Atlantic Angel Flight and Airports



## LPVs Internationally



The number of LPVs in Europe is also growing. The graphic shows LPV procedures in Europe as of November 3, 2022. [https://egnos-user-support.essp-sas.eu/new\\_egnos\\_ops/news-events/egnos-bulletin](https://egnos-user-support.essp-sas.eu/new_egnos_ops/news-events/egnos-bulletin)



Canadian WAAS LPVs provided by NAV CANADA as of August 10, 2023 (click for map)

... 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](mailto:amy.ctr.trevisan@faa.gov)