



FAA Navigation Programs AJM-32  
<http://gps.faa.gov>

# SkyWest Equipping Fleet with WAAS

Beginning July 2016, SkyWest Airlines began taking delivery of the first ERJ-175s updated with the software load 27.1. This software load is the upgrade that, among other things, enables WAAS LPV. We were able to discuss what this means for the future of the airline with Captain Alan Lisonbee of SkyWest.

The addition of WAAS to our CRJ fleet was driven primarily by the requirements of the ADS-B Out mandate and to ensure dispatch reliability we have planned for a dual WAAS GPS installation. We are still evaluating options to provide LPV on the CRJ aircraft.

**SNN: Was the ADS-B 2020 mandate the main driver for adding WAAS and considering WAAS LPV on your aircraft?**

SW: Our ERJ-175 fleet comes equipped and completely compliant for ADS-B Out and requires no additional systems upgrades or modifications. With the latest software upgrade on our ERJ-175 fleet we are in the process of incorporating LPV into our fleet operations.

**SNN: How do you see the addition of the Wide Area Augmentation System (WAAS) LPV capability to be beneficial to SkyWest?**

SW: We have provided a business case to our leadership and partners

“The addition of WAAS to our CRJ fleet was driven primarily by the requirements of the ADS-B Out mandate and to insure dispatch reliability we have planned for a dual WAAS GPS installation.”



for the incorporation of LPV into our ERJ-175 fleet and we are now in the process of putting the necessary documentation and training in place to be able to utilize LPV in our flight operations.

We believe that LPV will help provide an added component to safety through stabilized approaches to runways that do not have a precision approach available.

***SNN: Once your aircraft are equipped and operating with WAAS/LPV, how will it affect pilots? Do you believe it will be readily accepted by them? How much more training will WAAS LPV require?***

SW: The training requirements, as it turns out, are minimal and have been completed and provided to the pilot group. We believe that the LPV program will be well received by our pilot group since it will provide precision approach capability down to the runway and enhance approach safety by using stabilized approach profiles and criteria.

Our Advanced Qualification Program (AQP) program will require an additional year to completely check and validate each pilot once the program is implemented.

***SNN: What is SkyWest's opinion overall on Performance Based Navigation (PBN)? Is SkyWest authorized to fly Required***

***Navigation Performance (RNP) procedures?***

SW: Currently SkyWest is working towards Ops Spec approval for the ERJ-175 to become RNP-AR compliant. This is a large program and its anticipated initial approval by Q4 2016 with complete approval a year later. We are involved with and participate in numerous industry support programs under the NextGen umbrella, predominately OAPM program development and regional airline representation throughout the NAS.

We continue working to position SkyWest as a top regional airline in several PBN programs being developed throughout the NAS.

***SNN: Thank you for taking your time to tell us how SkyWest will be benefiting from WAAS and WAAS LPVs. Do you have anything else to add?***

SW: SkyWest plans to remain engaged in and actively participate with the numerous Next Gen capabilities and initiatives. We believe strongly in programs such as LPV that will be essential and a critical tool for enhancing operational.

Thank you for the opportunity to provide and share the vision of SkyWest Airlines as we continue to evolve into the NextGen world.

- Amy Trevisan, FAA AJM-32/NAVTAC



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

# Pilot Survey Shows WAAS Enhances Safety, Access and Performance

**June 15, 2016**

*by Dan Namowitz, AOPA Contributor*

A large majority of pilots who used the Wide Area Augmentation System (WAAS) in IFR operations between 2009 and 2013 strongly agree that the technology, which enhances the quality of GPS, improved their flights, based on responses to an AOPA WAAS usage survey completed in May.

“At night, the WAAS vertical guidance on final approach enhances safety.”

About 80 percent of respondents agreed or strongly agreed that the safety, access, and performance benefits that WAAS provides outweigh the cost of the equipment. A slightly higher percentage said WAAS accuracy was “at least as good as promised by the FAA.”

AOPA received a total of 1,129 responses to the WAAS usage survey, which concluded May 20.

“AOPA has been very supportive of WAAS and will share the survey data with the FAA WAAS Program Operational Implementation Team so they can use the data to further improve the system based on this user feedback,” said Rune Duke, AOPA director of airspace and air traffic. “GPS is important and we want it to be improved and expanded per users’ wishes. We need to make sure it is resilient, and that there is a plan for when it is unavailable.”

WAAS’s ability to increase access to airports and airspace was broadly endorsed by respondents—especially where GPS approaches include localizer performance with vertical guidance (LPV). According to the FAA, there are now 3,678 WAAS/LPV approach procedures serving 1,790 airports, of which 1,041 airports do not have an instrument landing system (ILS) approach. In March 2016, AOPA estimated that about 80 percent of active general aviation IFR aircraft were WAAS/LPV-equipped.



Satellite-based navigation is becoming the norm (iStock photo)

About 88 percent of survey respondents agreed or strongly agreed with the statement that “at night, the WAAS vertical guidance on final approach enhances safety.”

Respondents weighed the cost benefits of WAAS across a range of measures, registering generally positive assessments of the technology’s capability to reduce overall flight time, terminal flight time, and time on approach; and cut operational costs.

With many pilots still relying on VOR as their go-to backup navigation system in the event of a GPS outage, users expressed concerns about the reduction of the number of VORs in operation as the satellite-based air traffic system modernization proceeds.

Although about 94 percent of the 842 respondents who addressed the issue in the survey agreed that WAAS provides advantages over VOR and other ground-based systems, only about 65 percent believed that WAAS-equipped aircraft would likely no longer use VOR. A similar percentage embraced the idea that “if everyone had WAAS, the FAA could reduce VOR without negatively impacting flight operations.”

AOPA remains “very engaged” with the FAA in advocating for a long-term sustainment plan for the aging VORs, about 94 percent of which are more than 30 years old, Duke said. A nominal network of VORs known as

the Minimum Operational Network will be maintained to allow IFR aircraft to navigate in the event of a GPS outage, as explained in AOPA’s fact sheet.

The survey also measured users’ impressions of the extent of GPS outages, with slightly more than 89 percent saying outages were “rare or never happen.” In a separate survey on GPS interference conducted in the fall of 2015 with the Canadian Owners and Pilots Association, 21 percent of respondents reported having experienced a complete or partial loss of RNAV capability while using an IFR-certified GPS. Of those, 44 percent had only the single occurrence in the prior 12 months; the remaining pilots reported multiple interruptions.

When there was a loss of GPS, 66 percent of pilots relied solely on VOR as their backup navigation system.

Pilots are encouraged to report the GPS service interruptions they experience to air traffic control, and to share their reports with AOPA. According to the joint AOPA/COPA GPS interference survey, more than 74 percent of pilots neither filed a report nor advised ATC of the problem encountered.

“AOPA tracks GPS jamming and interference events and is advocating for sufficient warning being provided to pilots,” Duke said. *(reprint from www.aopa.org/news-and-media)*

## Cargolux Makes Inaugural GBAS Landing at Houston Airport

### GBAS News

... Sept. 11, 2016, Cargolux, Europe’s leading all-cargo airline, made its inaugural GBAS landing at George Bush Intercontinental Airport (IAH) . Cargolux joins United, Cathay Pacific, Lufthansa, Emirates and British Airways using the GBAS technology at the Houston destination.





# Ground Based Augmentation System (GBAS) Demonstration San Francisco International Airport (SFO)



United and Delta Airlines taxiing out for the GBAS Demo with the Honeywell Portable GBAS in the foreground .

In an outstanding collaborative effort, San Francisco airport (SFO), local Western Service Area FAA, local ATC, FAA TRACON, Boeing, United Airlines and Delta Airlines successfully completed a GBAS demonstration at SFO this August.

San Francisco is not alone in expressing interest of what GBAS can provide for their airport environment and capacity. Recently more US airports are expressing interest in implementing GBAS as an additional precision approach capability.

## **Background on GBAS**

GBAS has been operational as a non-Federal system at Newark International Airport (EWR) since September 2012 and at George Bush Intercontinental Airport (IAH) since April 22, 2013.

Houston and Newark GLS approaches are flown on a regular basis by United Airlines and

international airlines including Cathay Pacific, Emirates, British Airways, Lufthansa and Cargolux. United Airlines and Delta Airlines have the largest number of GLS equipped aircraft in the US and are champions for the GBAS technology. Over 3300 total GLS approaches have been flown at EWR and IAH as of August this year.

Boeing and Airbus remain strongly committed to GBAS and report an increasing GLS customer base and increased number of GLS equipped aircraft sales, with Boeing reporting over 1500 equipped aircraft and 47% of customers (over 60 airlines) choosing the GLS option. All new Boeing aircraft are GLS capable either as option or as standard equipment; GLS is Standard on the B787, B747-8 and B737MAX. Airbus has delivered GLS equipped aircraft to 31 different customers and noted the possibility to activate GLS on over 1100 additional fielded Airbus aircraft. All new Airbus aircraft offer GLS as option.



**Why the SFO GBAS Demo?**

SFO clearly has a few challenges: noise abatement, terrain, airspace constraints, weather causing frequent reduced visibility and a runway configuration with two sets of parallel runways 750 feet apart.

San Francisco airport, local Western Service Area FAA, local ATC, Northern California Terminal Radar Approach Control, Boeing, United Airlines and Delta Airlines got together to review the benefits of RNP and GLS for SFO. The overall objective was to demonstrate the benefits of combining RNP and GLS to different runways. To maximize the demonstration's

potential, the airlines and Boeing worked with air traffic controllers at Northern California Terminal Radar Approach Control to design the approaches. Jeppesen provided the Navigation Database and charts. The

procedures were pre-flown by Boeing, United and Delta Pilots using a 737 simulator. Boeing and SFO airport worked closely on a temporary location for the portable GBAS and on providing lighting for the displaced threshold approaches. The runway 28R GLS procedure targeted a displaced threshold some 2,000 feet farther down the runway than the normal touchdown zone.

“ Thank you NCT, Tower, SFO, United and Delta, Awesome Coordination! ”

The planned flight profiles included:

- Simultaneous Offset Instrument Approach (SOIAs) to Runways 28L, 28R
- Precision approach to runways without existing PA capability (19R, 10L)
- Closely Spaced Parallel Operations (CSPO) – Runways 28L, 28R
- 3.25 degree glide path angle approaches (for noise mitigation and increased vertical separation)
- Alternate touchdown/displaced threshold approaches (for potential wake mitigation and increased vertical separation)
- RNP to GLS/short turns to final (Potential Established on RNP application to reduce turn on distance to runway)

The demonstration flights were conducted in the evening hours of August 27, 2016 under VMC conditions. Airline, Boeing & FAA personnel were able to witness the approaches first hand. The flights were conducted as planned except for one approach to runway 10L, which was discontinued above minimums because of incoming weather. The Honeywell portable GBAS performed flawlessly and flight operations and coordination was exceptional as addressed in the out-briefing with the following statement:

“Thank you NCT, Tower, SFO, United and Delta, Awesome Coordination!”



As a next step the team will work on a joint data analysis process which will support the evaluation of the GBAS demonstration for:

- Benefits to improved airport capacity and access during low visibility operations
- Reduction of neighboring airspace interference

- Flyability of approaches
- Noise & Emissions Reduction
- Lowest minima available
- Wake turbulence mitigation

A final report is expected by December 2016.  
- Dieter Guenter, FAA AJM-32/NAVTAC

## Talking about EGNOS benefits with... Dassault Aviation

**Dassault's Falcon 2000LXS became the first business jet to fly an LPV-200 approach in Europe on the 3rd of May 2016 at Paris' Charles de Gaulle Airport. As Dassault representative at this flight event, Alain Boucher wanted to share his experience with our EGNOS Bulletin readers.**

*First of all, thank you Alain for your dedication and for making this first LPV-200 flight a reality. How did you find the whole LPV-200 experience?*

We were waiting for this to happen in Europe for a long time. With WAAS – the North American equivalent to EGNOS – such operations have

been a reality for several years. The fact that Europe is catching up and offers now the same level of operational capability is a great step forward, especially for Business Aviation. The French DGAC did really a great job in organizing those first LPV-200 flights in Roissy CDG, and Dassault Aviation was pleased to be invited to fly a Falcon 2000LXS down to the 200ft LPV minima. This is really a big step for European satellite navigation, with much more to come with Galileo!

*You seem quite enthusiastic and committed with EGNOS and Galileo, which we appreciate, but why were you so interested in becoming the first business aircraft*



**manufacturer to ever fly an LPV-200 in Europe?**

Dassault Aviation has always been an ardent supporter of satellite navigation, LPV being today the most advanced application thanks to GPS augmentation systems such as EGNOS. On top of that, the French DGAC has been pushing hard for the publication of a high number of instrument approach procedures with a LPV line of minima. So Dassault Aviation, as a European Business Jets manufacturer, had really to be the first in that user segment to fly a European LPV-200. The

LPV benefits are particularly important for general aviation and Business Aviation.

“ Thanks to EGNOS, LPV will progressively replace ILS Cat1 in Europe ”

**Speaking of that, what are, in your opinion, the main benefits of EGNOS for business aviation?**

LPV approaches make it possible to land at facilities which are not equipped with expensive instrument landing systems, including many small regional and local airports. Lowering the decision height from 250 ft to 200 ft provides a substantial operational benefit in poor weather and low visibility conditions. LPV offers a very accurate and stable guidance to the runway, and this is now available at no cost for the smallest airports used by business jets. Thanks to EGNOS, LPV will progressively replace ILS Cat1 in Europe, as we know it is already happening in France, for instance We

can even guess that LPV-200 is just one step more and in the near future satellite navigation technology will enable to go lower than 200ft on approach.

**Before we jump into future technologies, tell us, how did you get to know EGNOS for the first time?**

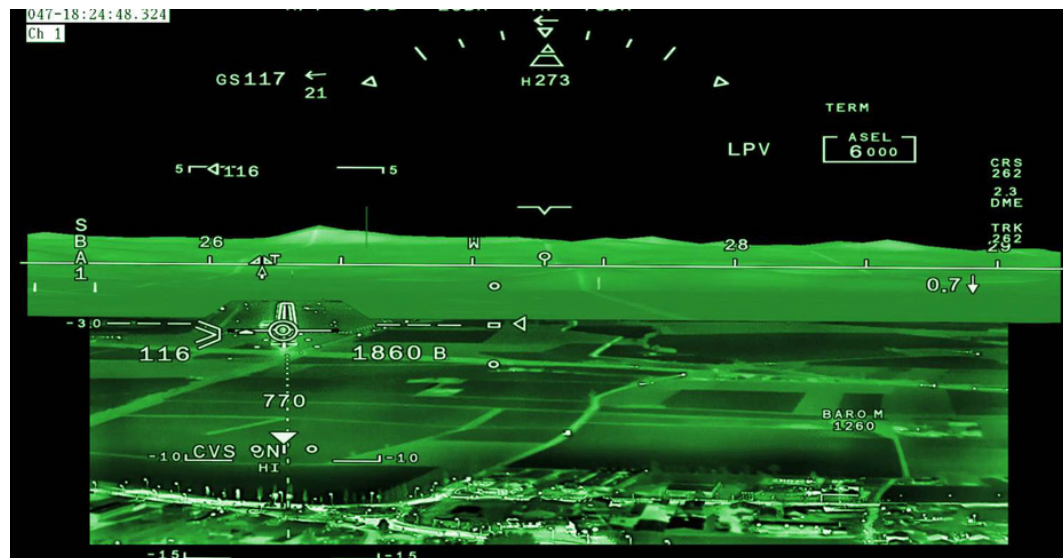
In fact it all started with WAAS in the US: Dassault Aviation was able to certify their airborne systems for LPV-200 operations with the EASY2 cockpit upgrade back in 2011. After WAAS, EGNOS was the next, and European, piece of a worldwide effort to develop Navigation performance augmentation systems for the GPS – and tomorrow Galileo.

**So it has been a few years now that you were able to offer EGNOS (SBAS) solutions but do you currently do it on all your new aircraft models?**

Yes, all in-production Falcon Jets are equipped with Dassault's second generation EASY 2 avionics suite, which is designed to support SBAS, LPV200 and other new navigation features. For the older aircraft, some retrofit solutions also exist. Around 80% of our customers are asking for the LPV capability.

**Could you give us an estimate on how many of these SBAS capable Dassault's units are currently flying in Europe?**

It is hard to answer precisely this question, as many of our aircraft are flying all over the world. Since the rollout of the first Falcon 20 in 1963,



LPV approach with Enhanced Vision System from Dassault Aviation



over 2,400 Falcon jets have been delivered and around 600 of them are equipped with the EASy2 cockpit and therefore LPV-200 capable today.

***How about US operators? Do you get a higher demand there due to the availability of procedures?***

A lot of LPV approach procedures have been published in the US after WAAS entry into service. Current number is now higher than for ILS Cat1. LPV is very popular in the US because it is accessible to small operators of general aviation and business aviation. The demand for LPV is very high. We can imagine that the same thing will happen in Europe with EGNOS, as the number of published LPV is already quickly increasing!

***You commented earlier on future navigation technologies. Is Dassault working on something specific which could improve the current LPV200 performances?***

Indeed, we are working, amongst other things, on the Enhanced Flight Vision System

(EFVS) which does not exactly allow to reduce the decision height (DH) of the Instrument Approach Procedure (IAP) being flown but it allows the crew to actually “see” the required visual references for landing with augmented vision, in a head-up display, in weather conditions which would make it impossible for natural vision. Basically, EFVS allows to fly a procedure and to proceed to landing with reported visibility lower than the one required on the IAP published chart.

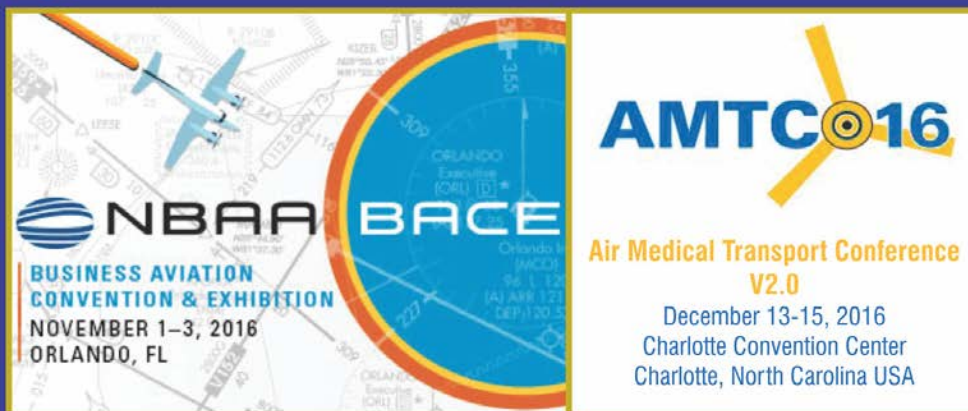
So LPV and EFVS are very complementary, allowing Business Aviation operators – most of which are not ILS Cat2 approved - to even land in worse than Cat1 weather conditions.

Alain Boucher, Navigation and Flight Guidance Systems Specialist at Dassault Aviation. He has been working in that field for more than 25 years, on all Dassault Aviation types of aircraft. He is also a member of several Eurocae & RTCA standardisation working groups.

*(reprint from EGNOS Bulletin/Issue 19/Q2 2016)*

## Wide Area Augmentation System at NBAA and AMTC

Visit us at:



# Satellite Navigation Approach Procedures

Satellite-based Approach Procedures			
	Procedures (Part 139 Airports)	Procedures (Non-Part 139 Airports)	Total Number of Procedures
<i>RNAV (GPS) Approach</i> <b>LNAV Line of Minima</b>	1,775	4,332	6,107
<i>RNAV (GPS) Approach</i> <b>LNAV/VNAV Line of Minima</b>	1,401	2,198	3,599
<i>RNAV (GPS) Approach</i> <b>LPV Line of Minima</b>	1,403	2,319	3,722
<i>Non-ILS runway</i>	51	1,724	1,775
<i>ILS runway</i>	1,352	595	1,947
<i>RNAV (GPS) Approach</i> <b>LPVs w/200' HAT</b>			949
<i>RNAV (GPS) Approach</i> <b>LP Line of Minima</b>	88	533	621
GPS Approach <b>GPS Stand-Alone Procedures</b>	8	78	86
GLS Approach	11	0	11

(Data as of September 15, 2016)

The tables shown here 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](http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/approaches/index.cfm)

Instrument Approach Procedures (IAPs) Based on Conventional NAVAIDs	
ILS	1,559
ILS (CAT II)	158
ILS (CAT III)	119
LOC	1,314
NDB	553
VOR	1,109

(Data as of September 15, 2016)

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/](https://www.faa.gov/air_traffic/flight_info/aeronav/procedures/ifp_inventory_summary/)

Country	Airports – LPV procedures	# LPV Procedures
Austria	2	2
Belgium	2	3
Croatia	1	1
Czech Republic	4	8
Denmark	3	6
Finland	1	2
France	86	144
Germany	22	36
Guernsey	1	2
Italy	7	17
Netherlands	2	3
Norway	11	23
Poland	2	4
Portugal	1	2
Slovak Republic	2	4
Spain	1	2
Sweden	2	3
Switzerland	8	10
United Kingdom	2	4
<b>Total</b>	<b>160</b>	<b>271</b>

The number of LPVs in Europe is also growing. The table to the left shows LPV procedures in Europe as of June 23, 2016, as included in the Quarter 2 EGNOS Bulletin. (Source: EGNOS Bulletin, Issue 19 Q2 2016)

Follow this link to the most recent Quarter 2 EGNOS Bulletin, Issue 19: [http://egnos-user-support.essp-sas.eu/new\\_egnos\\_ops/content/quarterly-bulletin](http://egnos-user-support.essp-sas.eu/new_egnos_ops/content/quarterly-bulletin)