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CELEBRATING
20
YEARS

Horizon Air Completes Wide Area Augmentation System (WAAS) Equipage on Entire Q400 Fleet



On November 30, 2012, Horizon Airlines of Seattle, Washington, hit another milestone on the path to Performance Based Navigation and the FAA's Next Generation Air Transportation System by completing the modification of 48 of 50 (2 were recently purchased with WAAS installed) Bombardier

Q400 turboprop aircraft with WAAS avionics. All aircraft are now WAAS and Required Navigation Performance

(RNP) 0.3 Authorization Required (AR) capable, using the Universal UNS-1Ew Flight Management System (FMS).

Horizon Airlines has been participating with the FAA's Satellite Navigation Program Office, WAAS Operational Implementation Team (OIT), under a Government Industry Partnership (GIP). "This project began in 2005 with our first

meetings. Since that time, there has been a lot of hard work performed by many dedicated people," said Perry Solmonson, Director of Flight Operations Standards and Training at Horizon Air. The GIP enabled Horizon Air to equip 7 Q400 aircraft that were then used to collect comparison flight data between their use of conventional navigation and satellite based navigation along routes and instrument flight procedures in the northwest US.

The WAAS OIT program has encouraged equipage via GIPs with avionics manufacturers, aircraft manufacturers, and airlines. The objective of these partnerships is to collect data that substantiates the benefits of WAAS equipage and operational applications. GIPs guide the development of projects which are to be open to public participation.

Horizon Air used benefits derived from actual operational performance as well as analysis of data collected

... Life is good in the Northwest, thanks in large part to the FAA WAAS Program Office for their help initiating our WAAS upgrade program ...

The *SatNav News* is produced by the Navigation Services AJW-91 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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Tell Us 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, 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 Scott Speed at scott.ctr.speed@faa.gov

during the project to develop the business case to equip the rest of their fleet. These benefits included:

Primary Means Navigation

- WAAS allows for flight planning based solely on use of Area Navigation (RNAV) at the departure, destination and alternate airports.
- WAAS provides immunity to navaid outages.
- WAAS eliminates the need to conduct pre-departure GPS Receiver Autonomous Integrity Monitoring (RAIM) predictions required by AC 90-100A, 90-101A or OpSpec C-300.
- WAAS provides for minimum equipment list (MEL) relief of aircraft VHF navigation equipment.

Precision-like Approach with Vertical Guidance to all Runways

- There are currently over 3000 LPV approaches in the NAS as compared to only 1,553 Instrument Landing System (ILS) approaches. Approximately 160 of these are now available in the Horizon route structure, including regular, alternate, provisional and refueling airports. Several provide the lowest minimums to the runway served.
- Reduced minimums on RNAV GPS Localizer Performance

with Vertical guidance (LPV) approaches (similar to SA CAT I ILS). It is expected that reduced visibility will be received first and then a possible reduction in DA. Any reduction to standard minimums (visibility or DA) has the compound effect of increasing schedule reliability and maintaining a distinct competitive advantage over other carriers.

Safety

- Increased safety through elimination of Step-Down and Circling approaches.
- Stabilized optimum profile descents to precision-like approaches to each runway end.
- The 2012 IATA Operational Safety Audit (IOSA) requires air carriers to fly approach with vertical guidance to all runways and with the UNS-1Ew upgrade, all Horizon Q400 aircraft will meet this requirement via ILS, LPV or RNP approaches.

Fuel Burn Reduction

- Fuel burn is reduced using Optimum Profile Descent (OPDs) arrivals with Coupled VNAV from top of descent to the approach and landing. Since hub airports and several out-station airports already have RNAV

arrivals terminating with ILS or RNAV approaches, this benefit is already realized. However, WAAS is approved for RNP AR approaches and enables LPV approaches; these can serve as backup to many ILS approaches and as primary approaches to non-ILS runways. On these flights, there is a saving of 2.51 gallons of fuel per flight, based upon Bombardier data. For Horizon Air, this equates to an annual fuel burn reduction of approximately 29,000 gallons.

Aircraft landing on runways without ILS usually use VOR or RNAV (GPS) approaches which typically have higher ceiling and visibility requirements. Poor weather conditions can effectively close these runways. If equipped with WAAS LPV avionics, however, the aircraft benefit from the lower weather minimums available and can safely land on these runways using RNAV GPS approaches with LPV. This results in fewer flight cancellations and diversions. Also, the vertical guidance provided by an RNAV (GPS) approach to LPV lines of minima, allow for a vertically guided stable descents to runway ends where we used to employ the conventional step-down method to descend to minimums. The stable descent greatly enhances safety.

"Life is good in the Northwest, thanks in large part to the FAA WAAS Program Office for their help initiating our WAAS upgrade program," said Mr. Solmonson.

Helicopter Instrument Procedure Milestone Accomplished

On November 20, 2012, FAA Order 8260.42B, Change 1, US Standard for Helicopter RNAV, which provides guidance for initiating and processing requests for public and special instrument and visual flight procedures, including Area Navigation (RNAV) procedures, was updated to include new Instrument



Flight Rule (IFR) Helicopter Departure and Localizer Precision with Vertical (HLPV) criteria.

Until recently, Helicopter Point In Space LPV Approaches were only available as Special IFR Approach Procedures. This revised order gives all IFR helicopter operators access to public use IFR procedure design criteria. Helicopter IFR operators have an excellent safety record due to the investment in IFR equipped helicopters, development of instrument approach procedures, and IFR trained flight crews. This new public criteria will enable helicopter pilots and operators to further increase their efficiency and operational safety.

Use of these new helicopter criteria may allow for designs of low level IFR infrastructures that are non-interfering with the fixed wing community. This will increase safety, save fuel by allowing helicopters to get IFR clearances and not wait for the flow control into the mixed aircraft environment; also it will bolster the professional stature of the rotorcraft community and its pilots.

-Jim Smith, FAA AJM-321/NAV-TAC

WAAS of the Future: Dual Frequency Operation (DFO) Development

WAAS has been operational since July 1, 2003. WAAS is the United States' implementation of a Satellite Based Augmentation System (SBAS). Since beginning operation, WAAS has enabled the introduction of new approach procedures (LP, LPV and LPV-200) across thousands of airports within the United States, even extending into Canada and Mexico. WAAS provides these benefits to aviation users by providing real-time corrections with integrity to the L1 C/A civilian signal available on all GPS satellites processed by WAAS-enabled avionics. The term 'integrity' means that the position computed by the user equipment can be trusted to be correct, within the included error bounds, or the equipment indicates that the computed position should

not be used due to detected errors. WAAS integrity gives an operator confidence that the position computed is correct and true.

With Dual Frequency Operation (DFO), the FAA plans to implement important improvements to the WAAS program. These improvements will ultimately capitalize on the GPS-III program which will offer a second navigation signal (L5) in a protected 'safety of life' frequency band with the potential of supporting a Category I-like autoland, Category II-like approaches and the expansion of LPV capability to most of the globe.

What is GPS L5?

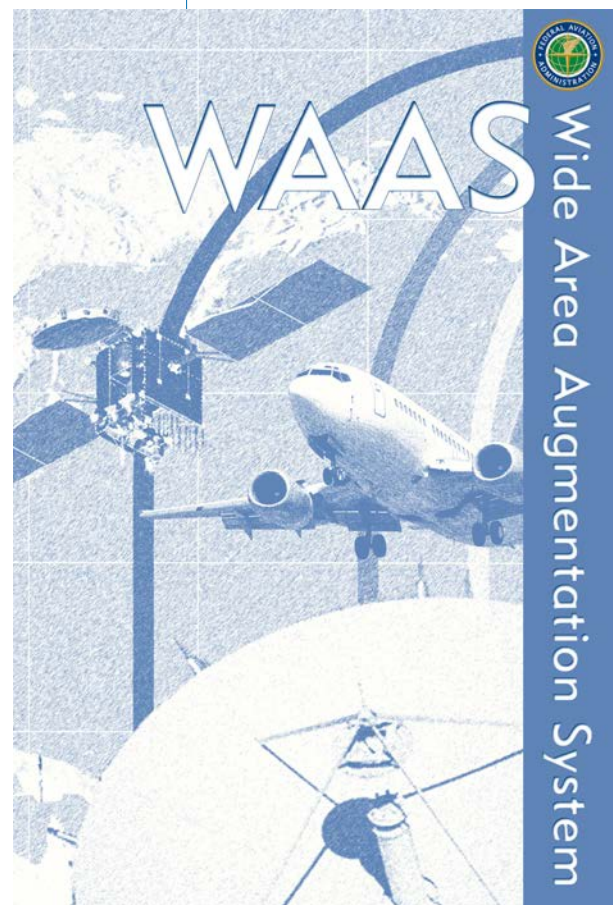
The GPS L5 signal is a civilian signal that will be broadcast by new GPS satellites (GPS-IIF and GPS-III). The frequency of L5 is within a protected 'safety of life' radiofrequency band, limiting potential interference from other signals. As of December 2012, two IIF GPS satellites were broadcasting a "developmental" L5 signal. A third IIF satellite has also been launched. The L5 signal is currently unusable for navigation as there is no navigation message embedded. A minimum constellation of 24 L5-capable GPS satellites, expected circa 2021 or after, is necessary for WAAS DFO services to commence.

What is DFO?

Beginning in FY2014, the WAAS Program Office will begin laying the groundwork for WAAS Dual Frequency Operations which will utilize the new L5 civilian frequency

that will be broadcast by GPS II-F and GPS-III satellites. The Dual Frequency WAAS service will provide real-time corrections with integrity for the L1 C/A and L5 signals.

Broadcast of the new L5 signal will also allow future aviation (and non-aviation) WAAS DFO-enabled equipment to locally compute ionospheric corrections. Current WAAS service requires the computation and transmission of a set of ionospheric grid points that receivers use to estimate the ionospheric corrections. Local computation of these corrections increases availability of the WAAS service and procedures, even during periods of solar storms. With Dual Frequency, the FAA anticipates that the capability to conduct LPV-200 procedures will exist over 100% of the CONUS and Alaska. Dual Frequency service also will enable



a big advantage when a pilot needs to land in low visibility conditions. Some airports do not qualify for LPVs because of obstructions or the terrain. In those cases, the FAA is providing WAAS Localizer Performance (LP) procedures.

WAAS makes it possible for pilots to use GPS from takeoff and departure, through en route and arrival to the equivalent of a Category I Instrument Landing Systems (ILS) approach and landing. Over 60,000 aircraft are now certified to use WAAS. As an important program for NextGen, WAAS supports Performance Based Navigation or PBN. The use of PBN frees aircraft from the old highways in the sky that are dependent on ground-based navigational aids. This allows for more direct and fuel efficient routes. It also provides options for getting around bad weather or unexpected air traffic congestion.

Since becoming operational in 2003, WAAS has made remarkable progress. With the consistent development of LPVs and LPs, WAAS will continue to enhance safety and give pilots the ability to fly into places they would not have been able to go just nine years ago.

The WAAS program reached another major milestone this year when the FAA awarded the WAAS Geostationary Earth Orbit GEO Satellite Service Lease contract to Raytheon Company of Fullerton, California. Geostationary satellites provide better broadcast coverage throughout the United States. WAAS uses three GEO satellites to broadcast the WAAS signal in space to aviation and non-aviation users across North America. Three GEOs are required to maintain WAAS availability to users. The current GEO satellite leased services expire between 2015 and 2017.

GPS Spoofing Risk Studied

In September 2012, the Federal Aviation Administration (FAA) initiated a study to develop specific, actionable recommendations to address the



vulnerabilities of Global Positioning System (GPS) to intentional interference and spoofing. The FAA plans to increase reliance on the use of GPS as a key aspect of the Next Generation Air Transportation System (NEXTGEN). Intentional interference and spoofing have long been identified as potential vulnerabilities for systems dependent on the Global Navigation Satellite System (GNSS).¹ GPS is the U.S.-operated GNSS core constellation.

The GNSS Intentional Interference and Spoofing Study Team (GIISST), consisting of FAA employees and contractors with responsibilities related to the use of GPS for civil aviation, will examine existing and emerging threats and determine the potential impact of GPS interference in aviation. The study team will identify technical, political, legal, and operational ways to mitigate the impact of GPS spoofing and jamming. The study team will produce a report by September 2013. The FAA is committed to the continued, safe use of GPS for navigation in airborne systems.

For many years, interference with GPS signals was a rare event. The past few years have seen an increase in GPS jamming. Recently experts have publicly demonstrated the ability to have adverse impacts on GPS-reliant systems through targeted GPS spoofing. In Congressional testimony, Dr. Todd Humphries recommended that critical navigation systems

be required to be spoof resistant.² The increase in jamming and the demonstrated ability of spoofing present a greater potential risk to aviation operations as the operations become more reliant on GNSS.

Besides GPS, the other currently operational GNSS core constellation is GLONASS (Russia). Two additional core constellations in development are Galileo (European Union) and BeiDou (China).

¹ *Vulnerability Assessment of the Transportation Infrastructure Relying on the Global Positioning System*; John A. Volpe National Transportation Systems Center, August 29, 2001.

² Humphries, Todd; *Statement on the Vulnerability of Civil Unmanned Aerial Vehicles and Other Systems to Civil GPS Spoofing*, July 18, 2012.

- Joseph Dennis, FAA A/JM-321/NAVITAC

What's New on the Web!

Just type <http://gps.faa.gov> into any web browser to access the best and most accurate information available from the FAA's Navigation Services Global Navigation Satellite System (GNSS) website.

Click on recently posted articles on the "In the News" sliding banner to stay informed of developments in satellite navigation.

Satellite Navigation Approach Procedures Update

December 13th, 2012 – During the summer of 2012, the number of all Wide Area Augmentation System (WAAS)-enabled approach procedures surpassed 3,000. In

Satellite-based Approach Procedures (by Procedure Type)			
	Procedures (Part 139 Airports)	Procedures (Non-Part 139 Airports)	Total Number of Procedures
LNAV Procedures	1,775	3,811	5,586
LNAV/VNAV Procedures	1,308	1,606	2,914
LPV Procedures (LPV w/200' HAT)	1,310	1,719	3,029 (760)
LP Procedures	53	342	395
GPS Stand-Alone Procedures	17	175	192

Note: Number of GPS Stand-Alone will continue to decrease as they are replaced by RNAV procedures (Data as of December 13, 2012)

November, the number of WAAS LPVs alone also crossed this same threshold. As of December 13th, 2012, there are 3,029 WAAS LPVs available in the U.S. LPVs can be found at small rural airports, regional airports, and even major metropolitan airports. At these locations, WAAS LPVs and other WAAS-enabled approach procedures are helping to improve access to the airport when visibility is limited due to the weather or other conditions. This provides both safety and capacity benefits.

Overseas, the number of LPVs enabled by the European Geostationary Navigation Overlay Service (EGNOS) also continues to grow. EGNOS, like WAAS, is a Satellite-Based Augmentation System (SBAS) that improves the accuracy and provides integrity to GPS signals for most of Europe. In December, Italy received their first LPV at Milano-Linate Airport. France, Switzerland, Guernsey, Germany, and Italy all have LPVs. More LPVs are planned for Europe. Information about EGNOS and European LPVs can be found at <http://www.essp-sas.eu/>.

For the U.S., the tables compare the number of satellite navigation approach procedures to those based

Instrumentation Approach Procedures (IAPs) Based on Conventional NAVAIDS	
ILS	1,281
ILS (CAT II)	159
ILS (CAT III)	113
NDB	824
VOR	1,302
VOR / DME	959

(Data as of November 15, 2012)

Table truncated for publication. Full table available at Instrument Flight Procedures (IFP) Inventory Summary

on ground-based navigation systems.

More detailed information on GPS/WAAS Approach Procedures can be found at http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/approaches/index.cfm.

- Mary Ann Davis, FAA AJM-321/NAVITAC

Towards a Full Scale LPV Implementation in Europe

Recent data indicates that the European Geostationary Navigation Overlay Service (EGNOS¹) implementation in European airports is growing slowly but firmly. Further expansion is expected in coming years. EGNOS is the first pan-European satellite navigation system. It augments the US GPS satellite navigation system and broadcasts signals with accuracy suitable for safety critical applications such as flying aircraft or navigating ships through narrow channels.

On March 2, 2011, the European Satellite Services Provider (ESSP), as EGNOS Service provider under contract with the European Commission, officially declared the start of the EGNOS Safety-of-Life (SoL) Service for aviation. Since that date European Air Navigation Service Providers (ANSPs) have been authorized to publish EGNOS-based procedures, in line with the International Civil Aviation Organization (ICAO) Assembly recommendations. Pau, in southern France, was the first airport with an operational Localizer Performance with Vertical Guidance (LPV) procedure published on March 17, 2011.

Business and general aviation operating at small and medium airports are the key niche markets for introducing EGNOS-based operations at this early stage. Today, almost all new navigation equipment sold by general aviation manufacturers is SBAS capable and pilots using Instrument Flight Rules (IFR) can decide to install a stand-alone SBAS enabled receiver for a relatively small price.

On the other hand a survey performed by GSA² confirmed that the vast majority of the European general aviation IFR community (85%) is interested in installing and using EGNOS or have at least considered it before. Indeed, approximately 48% of participants indicated that their aircraft are already SBAS approved, although this does not necessarily imply that they have operational approval to fly LPV approach procedures.

In fact, the still low availability of EGNOS-based approach procedures and the equipage/certification costs are the main barriers dissuading General Aviation users not equipped with EGNOS from upgrading.

To publish an LPV procedure, an ANSP under the EGNOS service area needs to sign an EGNOS Working Agreement (EWA) with ESSP the EGNOS Service Provider. This agreement defines the required framework (coordination processes, information sharing, etc.) between both entities using and providing the EGNOS service, establishing a fair and equitable approach for all ANSPs over Europe.

Actually, there are 7 EWAs signed in Europe, which have driven to the publication of the EGNOS-based approach procedures shown in Table 1. These pioneer EGNOS-based operations implementations are paving the way for the coming ones generating a

Country	Airports	LPV Procedures	APV Baro ³ Procedures
France	24	27	8
Switzerland	2	2	0
Guernsey	1	2	0
Germany	38	2	82
Italy	1	1	
Total	66	34	90

Table 1: EGNOS based operations already in place (13 December 2012)



snowball effect that will be extended soon all across Europe and that should boost the number of procedures published in the short term.

As support to the LPV implementation process, ESSP is also in charge of the EGNOS NOTAM⁴ Proposal service that provides information on planned EGNOS service outages to those ANSPs with published EGNOS-based procedures.

Other interfaces with EGNOS users are the EGNOS Helpdesk available 24H / 7D (egnos-helpdesk@essp-sas.eu / +34 911 236 555) and the EGNOS User Support website (www.egnos-user.support.essp-sas.eu) where to consult EGNOS daily and real-time performance and LPV availability in airports with published EGNOS-based procedures.⁵

¹ EGNOS is the European SBAS system, equivalent to the American Wide Area Augmentation System (WAAS)

² GSA is the European GNSS Agency

³ Approved to be flown with EGNOS vertical guidance

⁴ NOTAM: Notice To Airmen

⁵ This information is only provided for further awareness but should be never used for flight planning purposes

- European Satellite Services Provider (ESSP SAS)

Current and forecast EGNOS implementation status over EGNOS service area in Europe (2012-2013). Updated information and a full-size version of this chart above available at: (<http://www.essp-sas.eu>)

Clarification of Des Moines Project Article

An article in the Spring 2012 edition of SATNAV News, "Des Moines IFR Low Level Helicopter Infrastructure," named some, but not all, of the participants in the government-industry project that brought about the new Instrument Flight Rules (IFR) helicopter infrastructure in Des Moines, which is enabled by the Wide Area Augmentation System (WAAS). Specifically, we did not mention Hickok & Associates and the University of Oklahoma (OU). We regret this oversight. As such, we wish to extend recognition to these two organizations.

Handouts, based on this SATNAV News article and distributed at the October 2012 Air Medical Transport Conference (AMTC), also did not mention the contribution of Hickok and Associates and the University of Oklahoma to this pioneering project. We regret this omission as well.