Final Report
Exemption No. 12555 Action Team for the FAA's Performance-based Operations Aviation Rulemaking Committee (PARC)

May 2021

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Executive Summary

In September 2020, the Performance-based Operations Aviation Rulemaking Committee (PARC) received a tasking (Appendix A) to provide the FAA with an assessment of the extent operators (exemption holders) would be able to comply with planned upgrades prior to the expiration of Exemption No. 12555 given the ongoing uncertainty in the aviation industry.

It was requested that the PARC establish an Action Team composed of relevant air carrier and manufacturer stakeholders and proposed that the Action Team leaders be selected from each of these two communities in coordination with representatives from FAA (Appendix B & C). This report provides details on the assessment of:

1. Identification of barriers and appropriate mitigations to air carrier Exemption 12555 equipage plans that lead to full compliance with 14 CFR 91.227.
2. Description on the status of applicable equipment availability relative to achievement of operator equipage plans toward the end state of Exemption 12555 expiring on December 31, 2024.
3. The current state of the industry and any changes affecting Exemption 12555 equipage; aggregated and de-identified operator report(s) detailing equipage plan revisions due to changes in operations, fleet composition, and positioning source needs; and manufacturer reports on the availability of equipment to support revised operator equipage plans.
4. Identification of the benefit from investments made during the implementation of Automatic Dependent Surveillance-Broadcast (ADS-B)
5. The operational risk associated with aircraft ADS-B equipment that fail to meet the performance requirements of §§ 91.227(c)(1)(i) and (iii) after Exemption 12555 expires.

The report covers many observations and conclusions, and includes the following key recommendations:

- New aircraft delivered after December 31, 2024 must have Global Positioning System (GPS) position sources that are fully compliant with the Rule and therefore would not be required to perform a service availability prediction.[1]
- Remove the requirement for aircraft equipped with SA-Aware GPS receivers to use an acceptable preflight verification tool (e.g., Service Availability Prediction Tool (SAPT)). This ability would remain in effect, unless the FAA determines at a later date that satellite availability is insufficient, or air traffic control services require a higher level of accuracy and/or integrity.
- The 12555-exemption deadline should be extended by 2-years for SA-On GPS receivers installed on aircraft covered by the current exemption allowing for continued operation with use of an acceptable preflight verification tool; to avoid potential negative

[1] e.g., Satellite-based Augmentation System (SBAS), Aircraft-based Augmentation Systems (ABAS), or developing technologies such as; Multi-frequency Multi-constellation (MFMC), Dual-frequency Multi-constellation (DFMC).

operational impact on the carrier SA-Aware/SBAS or other rule compliant equipment upgrades should be considered after December 31, 2026.
- FAA should work towards providing promised benefits to operators that have already made significant investments to meet ADS-B Out rule requirements. Additionally, any extension of the 12555-exemption should not inhibit the delivery of proposed capabilities.

The aviation community consensus contained in this report provides a path for moving forward to address ADS-B Out performance requirements.

Background and Introduction

The FAA has published via Title 14 of the Code of Federal Regulations (14 CFR) part 91, §§ 91.225 and 91.227 the ADS-B out requirements for operation in FAA airspace after January 1, 2020.
The FAA published AC 90-114A Change 1 (and subsequent revision AC 90-114B) that provides users with operational guidance on a means of conducting flight operations in accordance with § 91.225 and 91.227. This Advisory Circular clarifies that periods of reduced GPS satellite availability may lead to ADS-B Out DO-260B installations broadcasting position data with accuracy and integrity below the performances required by § 91.227. As stated in the NPRM, operators may equip with any position source. Although Wide Area Augmentation System (WAAS) was not required, at the time it was the only positioning service that provided the equivalent availability to radar (99.9 percent availability). The FAA expects that future position sources such as Global Navigation Satellite Systems (GNSS) using the L5 GPS signal, GPS using Galileo signals, and GPS tightly integrated with inertial navigation systems will also provide 99.9 percent availability. Operators who equip with other position sources, such as non-augmented GPS, may experience outages that limit their access to the airspace defined in this rule. This availability takes into account possible GPS and WAAS satellite outages. The position source must meet required accuracy and integrity levels for the entire flight.

In order to comply with FAA policy provided in AC 90-114B to ensure availability of the position source at required performance levels during the entire flight, operators are required to use one of the two following means:
- Use a service availability prediction tool to check the availability of the position (at expected performance levels) before each flight, or
- Equip aircraft with SBAS or ABAS position sources to support ADS-B Out reports.

Except for aircraft exempted (refer to §4 of this report), operators with aircraft installations with the following configurations are required to use a pre-flight availability prediction tool prior to dispatch:
- SA On, or
- SA Aware without SBAS solution, or
- SA Aware without FAA approved ABAS solution

If the tool predicts non-compliant performance of the position source along the flight, the operator is required to delay, reroute, cancel departure, or request/obtain an authorization to deviate from applicable regulatory requirements from ATC.

Due to the lead time to equip all aircraft with GPS receivers capable of SBAS, or with ABAS, the FAA has introduced Exemption 12555 which grants a time-limited exemption from requirements outlined in 14 CFR part 91, §§ 91.227(c)(1)(i) and (iii) for aircraft whose ADS-B performance can fall below the requirements. The relief granted exemptions beginning on January 1, 2020 and expiring on December 31, 2024 for aircraft declared in the operator upgrade plan transmitted to the FAA.

With the Exemption 12555 granted, the FAA allows operations of ADS-B installations that do not meet the operational availability requirement of AC 90-114B under certain conditions. The aircraft must maintain ADS-B Out DO-260B capability.

In order to continue the operation of any aircraft subject to this exemption, each operator must create, maintain, and annually update a GPS equipage plan for airplanes equipped for ADS-B Out and meet the requirements of § 91.227(c) within the timeframe of relief under this exemption.

The FAA confirmed that upgrade plans can be updated and submitted at any time (e.g., update of upgrade schedule, introduction of new aircraft operating in the US, or removal of aircraft from the operator's fleet).

Areas of Analysis

Current State of Industry Exemption 12555 Equipage

In 2015, the FAA published Grant of Exemption No. 12555 (Appendix D) and made it available to any operator who notified the FAA of their intent to comply with the conditions and limitations specified in the Grant. The purpose of the exemption was to permit exempted operators to continue use of existing GPS position sources that may not always meet the integrity and accuracy requirements of §91.227. Exemption 12555 is a one-time, time limited exemption that expires on December 31, 2024. The specific conditions require that:

a. Each operator must create, maintain, and update a GPS position source equipage plan for aircraft equipped for ADS-B Out to meet the requirements of § 91.227(c).
b. The equipage plan must be updated as needed, but at least annually throughout the term of the exemption; and reflect increased technical and schedule confidence and details regarding each aircraft's projected equipage.
c. Operators of SA-Aware equipped aircraft are not required to conduct preflight verification of GNSS service availability. Aircraft subject to this exemption may operate in airspace specified in 14 CFR § 91.225 when their ADS-B Out equipment does not meet the requirements of § 91.227(c)(1)(i) and (iii).
d. Operators of SA-On equipped aircraft must conduct preflight verification of GNSS service availability. They may operate in airspace specified in §91.225 when their ADS-B

Out equipment does not meet the requirements of §91.227(c)(1)(i) and (iii) and the FAA determines there is a backup means of surveillance.

Upgrade Plan Requirements

The Exemption specifies certain minimum information to be included in each operator's upgrade plan (Appendix D). Since the Exemption only applies to the aircraft listed in the operator's plan, the plan must list the registration number of each aircraft. Further, for each identified aircraft the plan must indicate whether the currently installed position source is SA-Aware or SA-On. This is relevant for understanding whether a preflight prediction is required for each flight of the aircraft.

For aircraft the operator plans to upgrade, the plan must also include the manufacturer, model and part number of the new or upgraded equipment that will replace the existing certified position source, as well as the Service Bulletin or Supplemental Type Certificate (STC) required and upgrade schedule.

The plan may also include aircraft that will not be upgraded. For those aircraft the operator must indicate their intentions for operations beyond December 31, 2024. For example, they may indicate that the aircraft will be retired from service, returned to lessor, or continue to be operated as currently configured.

Analysis Considerations

The upgrade plan data used in preparing this report represent plans submitted to the FAA as recently as March 19, 2021. To interpret the data presented in the accompanying charts properly, it is important to consider where applicable, the constraints mentioned below:

- The scope of the analysis is limited to 14 CFR part 121 and 129 operators.
- A majority of the plans were submitted since the outbreak of COVID-19.
- Some operators have been inconsistent in their compliance with plan submission instructions.
- Some operators submitted ambiguous or contradictory plan content.

Scope

There are 214 operators actively complying with the conditions and limitations of Exemption 12555. That number consists of operators on 14 CFR 121, 125, 129 and 135 certificates, as well as some State and foreign operators not yet holding a certificate to operate in the U.S. However, the data in this report represents only plans submitted by part 121 and 129 operators. There are 186 plans from 121 & 129 operators out of a total of 214 plans. Those plans cover 9765 aircraft (98%) out of a total of 9920. The PARC Action Team determined that those operators would provide a representative group for the issues to be addressed in this report.

Plan Currency

Exemption 12555 requires that plans be updated at least annually. However, operators' adherence to this requirement has not been consistent. As of this writing, 15% of the plans accounting for 6% of the total exempt aircraft are older than one year. Those older plans likely

would not reflect the economic impact of COVID-19 but are included because they represent part of the entire fleet of exempt aircraft. The FAA retains plans for all exemption holders until they are definitively identified as no longer in business, or otherwise no longer holding Exemption 12555.

Plans revised beginning in June 2020 up to the present should be considered more representative of operator plans that take into account COVID-19 impacts. Since June 1, 2020, 152 operators have submitted revised plans accounting for 92% of the exempt aircraft (refer to table) and thus should provide a more accurate representation in the reported data than the older data. However, it should also be considered that currently we are in a very fluid operating environment with no reliable prediction on the direction of future operations.

Plans submitted	Operator Plans	Aircraft
Since April 1, 2020	157 plans (85%)	9131 aircraft (94%)
Since June 1, 2020	152 plans (82%)	8086 aircraft (92%)

Inconsistent interpretation of plan submission instructions

The FAA directed operators to submit upgrade plans using a specifically designed spreadsheet template. The spreadsheet included detailed instructions designed to facilitate the submission of the precise information needed to show compliance with the Exemption. However, a review of the plans makes clear that the instructions were not consistently interpreted. For example, in some plans the operator indicated that the current position source for an aircraft is SBAS, yet the plan indicates an intent to upgrade that aircraft to SBAS at a time in the future.

Ambiguous and contradictory plan content

As operators submit revised plans, the FAA reviews the plans and attempts, when possible, to rectify ambiguities in plan contents with the operator. However, for this report no attempt was made to change apparently incorrect or contradictory information in the actual plans. One example of incorrect information is listing transponder manufacturer and model information where planned upgraded position source information is to be entered. In some plans, the operator indicates that they plan to upgrade the position source, but do not provide specific details such as manufacturer or model[2].

This report reflects the data submitted by operators, including some inconsistencies that should be considered when analyzing the data.

Aggregated Operator Equipage Plans

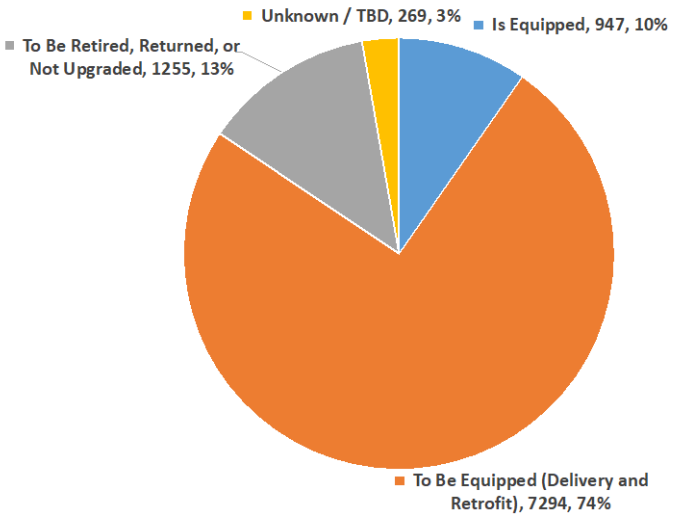
The accompanying graphs are intended to show the current state of operator planning for the exempt aircraft, the breakdown of position source type prior to plan implementation and the planned position source by manufacturer. The data underlying the graphs is based solely on the upgrade plans submitted by the exempt operators.

[2] The operator's plan and subsequent updates will not be approved by the FAA but must be made available for review.

Figure 1, “Equipage State: All” shows 14 CFR part 121 and 129 operators’ reported status of their aircraft position source plans at the time of submission. This is a graphical representation of exemption holders’ progress toward meeting the December 31, 2024 expiration date. Aircraft in the plan data are characterized as:

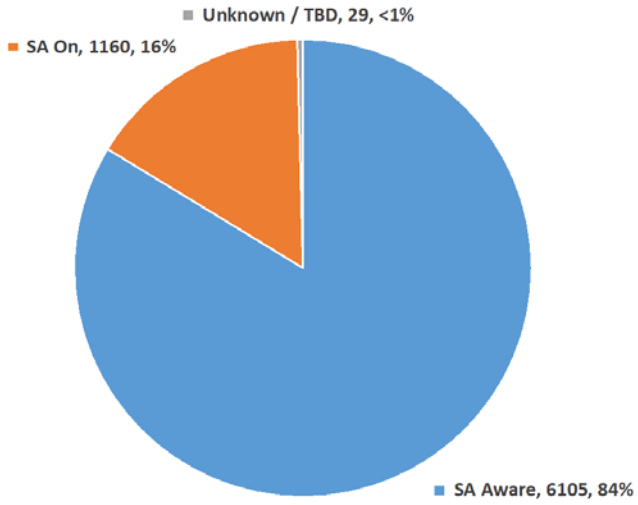
- Is Equipped: the operator indicated that the planned position source upgrade is complete. 947 aircraft (10%) are reported as complete.
- To Be Equipped (Delivery and Retrofit): the operator indicated that there is a plan to upgrade the position source via retrofit or a new aircraft will be delivered to their fleet equipped with a fully compliant position source. Operators report that 7,294 aircraft (74%) are planned to receive position source upgrades.
- To Be Retired, Returned, or Not Upgraded: the operator indicated that there is a plan to retire the aircraft, return it to the lessor, or to not upgrade the aircraft’s position source. In the latter case, some operators indicated that they plan to continue to operate the aircraft and incorporate a preflight prediction verification into their dispatch process. Operators report that 1,255 aircraft (13%) of their current exempt fleet will be retired, returned or not be upgraded.
- Unknown / TBD: the operator’s plan information is not clear with respect to intent to upgrade the position source or retire the aircraft; or the operator specifically entered “unknown” or “TBD” in their plan. 269 aircraft (3%) are in this category.

Figure 1-" Equipage State": All



Figures 2 and 3 show data drawn only from plans characterized as “To Be Equipped (Delivery and Retrofit).

Figure 2-"Equipage State": To Be Equipped (Delivery and Retrofit)



Of the operators who indicated that they planned to upgrade their position source (see "To Be Equipped" in Figure 1), Figure 2 shows what operators reported as their position source prior to that upgrade: SA-On or SA-Aware. Aircraft identified by operators with a current position source as SBAS were considered to be "Is Equipped" for this analysis (Figure 1). In Figure 2, there were 6,105 aircraft (84%) indicated as being equipped with SA-Aware position source and 1,160 aircraft (16%) listed as SA-On. There were 29 aircraft (<1%) where the GPS status was listed as "unknown" or "TBD".

Figure 3- "Equipage State": To Be Equipped (Delivery and Retrofit by Manufacturer)

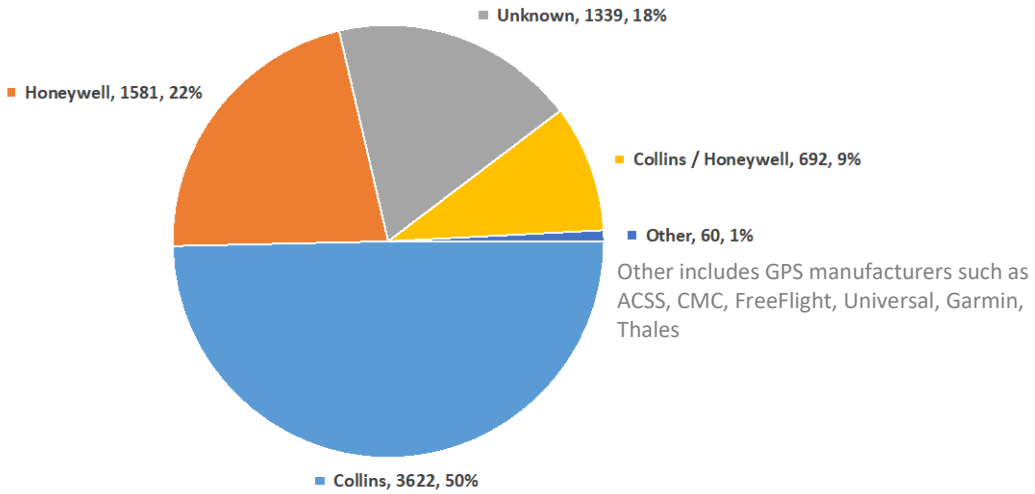


Figure 3 shows the distribution of the position source manufacturers indicated in operators upgrade plans. The distribution is: Collins, 3,622 aircraft (50%), Honeywell, 1,581 aircraft (22%), Unknown, 1,339 aircraft (18%), 692 aircraft (9%) are listed as planning either Collins or Honeywell product; 60 aircraft (1%) are planned to be equipped with a position source from one of the other manufacturers. The "Other" position source manufacturers include ACSS, CMC, FreeFlight, Universal, Garmin and Thales.

Equipment Requirement to Achieve Operator Equipage Plans

Aircraft OEMs have certified aircraft solutions compliant with FAA AC 20-165A or AC 20-165B requirements (ADS-B Out DO-260B) on A320/A330/A340/A350/A380 aircraft families and on 737/747/757/767/777/787 aircraft families.

The FAA confirmed that installations approved under AC 20-165A or AC 20-165B have been accepted to demonstrate compliance with the FAA rule 14 CFR 91.227. These ADS-B Out DO-260B installations correctly broadcast the required aircraft parameters including position and associated accuracy and integrity. However, to ensure compliance to 14 CFR 91.227 all along the flight, the mandate provides additional operational guidance that is not mentioned in airworthiness guidance of FAA AC 20-165A (and subsequent revision AC 20-165B).

Aircraft OEM ADS-B Out Position Source – Available Options by Aircraft Model
An overview of Multi-Mode Receivers (MMRs) certified on air transport aircraft (with information on Selective Availability (SA) type (On or Aware) or SBAS) as part of a DO-260B ADS-B Out solution is described in Appendix E: OEM Equipment List.

A320, A330/A340, A380 and A350 Families
These Airbus aircraft models are currently equipped with MMRs that are either SA-On or SA-Aware, which are not capable of SBAS. Airbus has made available SBAS solutions for the US operations for the A320 and A330 families. The SBAS-based position source for ADS-B Out is operational after activation of a dedicated modification on the MMR equipment and ATC Transponder. The expected certification of the SBAS position source for ADS-B Out position reporting is as follows:

- Honeywell iMMR – A320/A330: Certified
- Collins Aerospace GLU-2100 – A320/A330/A350: Certified – In Service Evaluation until Q2 2021
- Collins Aerospace GLU-2100 – A380: Certified Q3 2021

A380
For an aircraft configuration without the SBAS NAV option activated, the aircraft's ADS-B Out installations use the on-board inertial reference system to complement the Global Positioning/Inertial Reference System (GPIRS) information (also known as an ABAS). Per §4.5 of AC 90-114B, ABAS is an approved ADS-B position source that does not require a pre-dispatch prediction. For the A380, the GPIRS is an ABAS approved by FAA for ADS-B Operations.

737/747/767/777/787 Families
SBAS MMRs are currently certified on 737 NG (737-600/700/800/900ER), 737 MAX (737-8/-9), 747-8, 767F, and 777 (777-200/300/F) models. The new 777-9 model is planned to be type certified with both Collins GLU-2100 and Honeywell iMMR SBAS capable MMRs. The 787 model is currently certified with an SA-Aware position source with expected certification of an ABAS position source in 4Q 2022. Per §4.5 of AC 90-114B, ABAS is an approved ADS-B position source that does not require a pre-dispatch prediction.

Customers of new 737 MAX and 777-9 production aircraft have the option of selecting either the Collins SBAS MMR (GLU-2100) or the Honeywell SBAS MMR (iMMR). SA-On and SA-Aware MMRs are no longer listed as catalog options for 737 MAX and 777-9 aircraft. All 787s are currently delivered with an SA-Aware Honeywell Integrated Navigation Receiver (INR) (which has the same GPS functionality as an MMR). The primary ADS-B Out position source on all production 787s will change to an ABAS solution starting in 4Q 2022.

Manufacturer's Availability of Equipment to Support Revised Operator Equipage Plans

Of the over 7,000 plus commercial aircraft operating in the NAS, approximately two-thirds are equipped with a multi-mode receiver type architecture. The remaining third are equipped with integrated avionics architectures that include stand-alone GNSS receivers.

Many of the latter third are business and regional-type aircraft that have had SBAS capable GNSS receivers available for many years. Many of these aircraft already have the SBAS capability or have upgrade paths to the required functionality readily available today. There are multiple avionics manufacturers that provide standalone GNSS receivers capable of addressing this market and there is no concern that the remaining un-equipped aircraft will tax the avionics manufacturers capability to produce GNSS receivers before the end of the Exemption 12555 timeline.

For the two-thirds that are equipped with multi-mode receivers, it is only within the last few years that SBAS capability has been available. The manufacturers of multi-mode receivers now offer SBAS solutions for all major air transport aircraft platforms. The market for SBAS capability among these air transport platforms is significantly higher than business and regional aircraft. Each avionics manufacturer is capable of supporting market demand for SBAS solutions within the time remaining prior to the expiration of Exemption 12555.

There is a very small percentage of the aircraft operating in the NAS that do not have GNSS capability. For these aircraft, many of the avionics manufacturers have standalone GNSS solutions to support mandate compliance. This small market will not tax the production capability of avionics manufacturers to any significant extent.

With any mandate-type deadline, the sooner operators act, the more likely it is that they will not encounter a problem with product delivery or MRO availability. There is always a concern that as the deadline gets closer, more operators will come forward for upgrades. A recent example of this is the transponder upgrades to support the ADS-B Out Mandate deadline of December 31, 2019. In this example, the availability of MRO services was the leading issue associated with getting those upgrades, not the production of new avionics hardware to support the mandate. Avionics manufacturers recommend NAS operators equip with the SBAS solutions available today to ensure mandate compliance well before the Exemption 12555 timeline completes.

Appendices F/G/H present reports on manufacturing capabilities and the availability of equipment to support revised operator equipage plans.

Identify Barriers and Appropriate Mitigations to Exemption Compliance

All U.S. carriers have successfully complied with the FAA equipage mandate of 14 CFR 91.225. Airlines for America (A4A) developed Exemption No. 12555 to address delay to the market concerning the FAA ADS-B Out regulatory performance requirements requiring a consistent compliance with 14 CFR 91.227 (i.e., NIC of 7, NACp of 8). At that time, OEMs were also still developing newer technologies to include MFMC, DFMC and the technical work in RTCA SC-159 and EUROCAE WG-62 to advance the standards used remained underway. Avionics OEMs, along with world governments, are still developing Minimum Operational Performance Standards (MOPS) for the future GNSS receivers that support worldwide GNSS navigation.

Since the FAA granted the exemption, the number of satellites and their availability has been sufficient to support the continued use of SA-Aware as the positioning source currently and into the future. The FAA has identified 32 key sites as part of the first phase of the Secondary Surveillance Radars (SSRs) reduction plan expected to be complete by 2025. Although this work is on-going, removal of the identified SSRs has not begun. The FAA has also seen some delays in implementations caused by COVID-19. As noted above, no SSRs have been removed to date and no reduced separation airspace has been implemented as a result of ADS-B Out technology. These deferments are consistent with any industry requested delay to recover from the financial impact of this pandemic.

For operators of aircraft relying on the use of SA-On, when this date was chosen, no one could have envisioned the dramatic decrease in demand and airline operations due to the COVID-19 pandemic. Almost overnight, in March 2020, the COVID-19 pandemic hit the U.S. and the bottom fell out of the airline industry. As travel restrictions and stay-at-home orders were implemented, demand for air travel declined sharply and suddenly. Though air cargo volumes have held, the pandemic eviscerated passenger air travel. Coming off all-time highs in 2019, passenger traffic on U.S. airlines rose five percent in the first two months of 2020 only to fall by 96 percent six weeks later, to a level not seen since the dawn of the jet age in the 1950s. There was a slight uptick over the summer and into the fall of last year, but passenger levels remain 40 percent below year-ago levels and revenues are down about 60 percent due to the near-absence of business and international travel. The Global Business Travel Association (GBTA) expects overall business travel spending in the U.S. to reach just 73 percent of 2019 levels by 2024.

This type of event has never happened during the history of aviation. Financial impacts to the airlines are unprecedented and have resulted in the addition of industry debt which will compel industry to reduce costs even further, possibly resulting in additional loss of personnel and fleet realignments. Given the debt loads, financial health will be weak for the industry well into the future. As the pandemic recovery is yet undefined, it will most likely take over a decade to recover financially.

Out of service costs are often the largest expense when upgrading avionics packages. To minimize the out of service cost, airlines project maintenance intervals into the future and perform upgrade tasks in conjunction with heavy checks. This can extend time to equip by

years for carriers operating large fleets. For certain airlines with large fleets to retrofit, it can take up to 10 years to complete an equipage update. Therefore, to meet the current 2025 deadline for the expiration of the Exemption, large airlines will need to start funding now, during this financial hardship, putting even greater strain on the airline's debt structure.

There are two primary options for airlines to meet the performance requirements of ADS-B Out consistently:

- Replacing the MMR, which feeds aircraft position to multiple aircraft systems including the transponder, or
- Adding a simpler, supplemental GPS receiver with SBAS connected only to the transponder.

The MMR is the preferred choice over a simple GPS SBAS enhancement. Newly enhanced MMR LRUs provide significant improvements to the industry and the NAS as they incorporate the ability to expand future capabilities including LPV minimums for RNAV approaches. In addition, airlines have voiced a preference based on enhanced options and operational capabilities for DFMC capabilities, especially for long-haul international operations. Avionics OEMS, along with world governments, are still developing Minimum Operational Performance Standards (MOPS) for the future MMRs that support worldwide GNSS navigation. Foreign governments are even considering restrictions for entry into their airspace unless their indigenous GNSS is used for navigation.

Also, while the supplemental GPS SBAS unit is a less expensive piece of hardware, there are issues with that solution as well. As the aircraft OEMs have chosen to support only the MMR option, the supplemental option will require an STC for each aircraft type. In addition, since wiring is not in place for these stand-alone units, the aircraft would need additional down time to support its installation. This extended down time would likely occur when the industry is trying to recover from the pandemic.

Operators also want to ensure investments in current and future capabilities will have a direct and measurable return. Data collected by the FAA since the inception of the Exemption has shown SA-Aware navigation performance to be nearly identical to SBAS performance. The costs of retrofit and future fit alternatives to SA-Aware are very difficult to justify when they essentially provide little to no improvement in operational performance. For operators with SA-On equipped aircraft, the possibility of having additional time to meet SBAS or SA-Aware performance will help alleviate the near-term financial burdens of upgrade costs. OEMs could use this time to develop additional solutions that may provide more capabilities and a better return on investment for operators.

Importance of Advancing APNT/CPNT Policy

Considering the magnitude of the investment by the operators there are concerns that the current ADS-B regulations are dependent on a single GNSS source and therefore the resiliency of primary surveillance is at risk. Given that the current performance of SA-Aware GPS units is extremely high, it makes sense to allow industry to continue its pursuit of Alternate Position

Navigation Time (APNT)/Complementary Position Navigation Time (CPNT) solutions, which may deliver more operational and financial value than an investment toward increasing already acceptable NIC/NACp values.

Industry also encourages the FAA to continue development of APNT/CPNT solutions which will result in true resiliency provided by multiple, independent Position Navigation Time (PNT) sources. Past GPS receiver issues have demonstrated our great dependence on GPS. The first wide-scale event compromising the resiliency of ADS-B Out would be devastating to scheduled operations in the U.S. After the losses incurred with the pandemic, we cannot afford to be grounded if the ADS-B system is unable to support NAS operations.

Current ADS-B Position Source Performance

As part of the PARC meetings, the FAA provided information related to aircraft NIC/NACp performance for air carrier aircraft operating in U.S. Airspace. The FAA uses the ADS-B Performance Monitor (APM) to regularly analyze how well ADS-B Version 2 systems installed on air carrier aircraft are meeting the performance requirements of the U.S. ADS-B Mandate. The analysis focused on air carrier aircraft since general aviation aircraft with ADS-B Version 2 typically have SBAS position sources.

The NIC/NACp performance analysis presented to the Team included all major types of GNSS receivers (SA-On, SA-Aware, and SBAS). The information presented focused on highlighting aircraft which report NIC > 6 less than 99.900% of the time (averaged over the analysis timeframe).

The FAA presented data that was analyzed bi-monthly from August 9, 2020 through February 9, 2021. Figure 4 illustrates an example of the information provided for the two-month period ending on February 9, 2021.

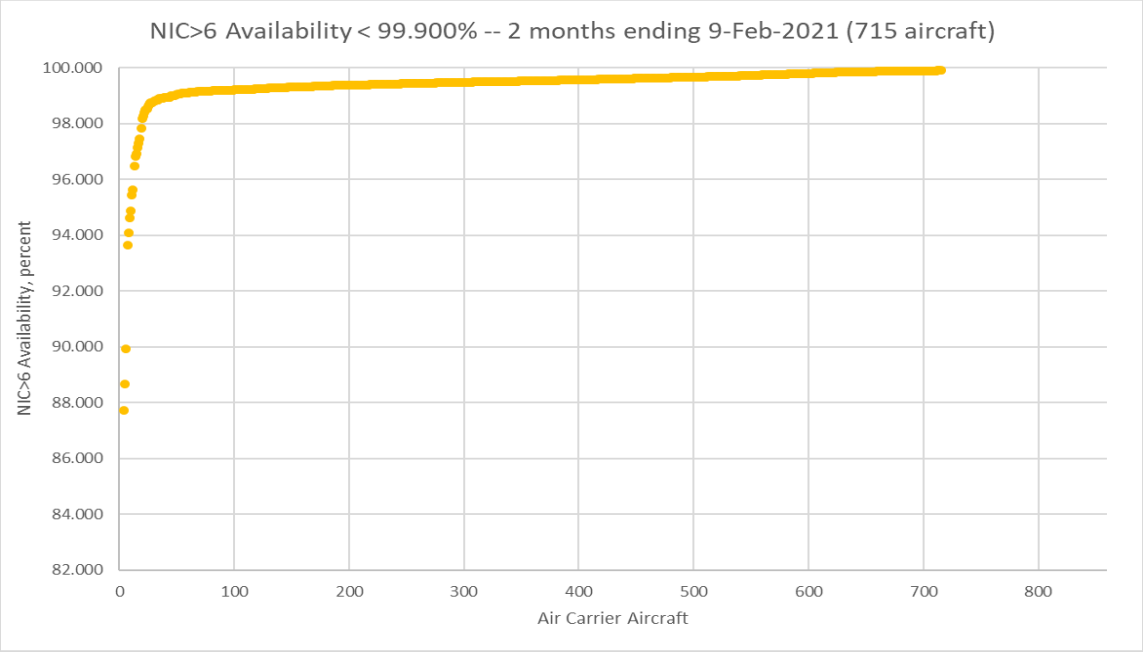


Figure 4: Aircraft with NIC > 6 Availability < 99.900%

The graph shows that 715 out of approximately 7,729 aircraft were not meeting the availability threshold. When looking at the performance breakdown, the largest number of aircraft not meeting the threshold are primarily equipped with SA-On position sources. The FAA also noted that other causes for NIC<7 reporting could be due to aircraft installation issues (including degraded/faulty GNSS antenna or cabling), a GNSS receiver fault, or interference from GNSS testing. However, the FAA information illustrated that those aircraft believed to be equipped with SA-On receivers continuously show higher probability of degradation in NIC/NACp performance in comparison to those believed to be equipped with SA-Aware and SBAS receivers.

Findings and Recommendations

Based on the assessment of GPS receivers that are currently used by operators (and new ones being manufactured and developed) to satisfy the ADS-B Out performance requirements in meeting the FAA's requirements in 14 CFR Section 91.227; the PARC 12555 Action Team presents the following Findings and Recommendations.

Findings

- Satellite-Based Augmentation System (SBAS) – Fully complies with rule accuracy and integrity requirements. Installation using the on-board inertial reference system to complement the GPS information (GPIRS), also known as an ABAS, fully complies with rule accuracy and integrity requirements as well. MFMC[3] and DFMC are anticipated to meet rule performance availability.
- SA-Aware GPS receivers – provide rule performance availability of 99.9%+. A decrease in the number of satellites in the GPS constellation would adversely affect this performance but there are no known plans for any such reductions.
- SA-On GPS receivers – Currently provide rule performance availability of 95% or greater and accounts for the significant majority of aircraft that do not meet rule performance requirements. The 12555-exemption provided relief for these equipped aircraft that may not always meet the integrity and accuracy requirements of the ADS-B Out rule.
- Harmonization of international surveillance requirements is critical for safety, efficiency, security, air traffic management, and environmental impacts.
- COVID-19 has had a dramatic impact on the economic viability of carriers, impacting fleet planning and equipage investments.
- The development of APNT solutions is critical in providing the needed resiliency of multiple, independent PNT sources.

[3] International standards for MFMC systems are currently under development by the RTCA and EUROCAE. Sufficiently mature standards may not be available until the end of 2022.

Recommendations

- New aircraft delivered after December 31, 2024 must have GPS position sources that are fully compliant with the Rule[4] and therefore would not be required to perform a service availability prediction.
- Remove the requirement for aircraft equipped with SA-Aware GPS receivers to use an acceptable preflight verification tool (e.g., Service Availability Prediction Tool (SAPT)). This ability would remain in effect, unless the FAA determines at a later date that satellite availability is insufficient, or air traffic control services require a higher level of accuracy and/or integrity.
- The 12555-exemption deadline should be extended by 2-years for SA-On GPS receivers installed on aircraft covered by the current exemption allowing for continued operation with use of an acceptable preflight verification tool; to avoid potential negative operational impact on the carrier SA-Aware/SBAS or other rule compliant equipment upgrades should be considered after December 31, 2026.
- FAA should work towards providing promised benefits to operators that have already made significant investments to meet ADS-B Out rule requirements. Additionally, any extension of the 12555-exemption should not inhibit the delivery of proposed capabilities.

As a general finding nothing in the recommendations should be construed to inhibit the pace of FAA ATC modernization.

[4] e.g., Satellite-based Augmentation System (SBAS), Aircraft-based Augmentation Systems (ABAS), or developing technologies such as; Multi-frequency Multi-constellation (MFMC), Dual-frequency Multi-constellation (DFMC).

Appendix A: FAA Tasking Letter

Captain Mark Bradley
Chairman,
Performance-based Operations Aviation Rulemaking Committee (PARC)
1030 Delta Boulevard
Atlanta, GA 30354-1989

Dear Captain Bradley:

In 2015, the FAA published Grant of Exemption No. 12555 and made it available to any operator that notified the FAA of their intent to comply with conditions and limitations specified in the Grant. The purpose of the exemption was to permit covered operators to continue use of existing Global Positioning System (GPS) position sources that might not always meet the integrity and accuracy requirements of 14 Code of Federal Regulations (CFR) §91.227. The exemption is time limited and expires after December 31, 2024.

In order to fully realize the benefit from investments made during the implementation of Automatic Dependent Surveillance-Broadcast (ADS-B), the FAA does not expect to continue accepting the operational risk associated with aircraft ADS-B equipment that fails to meet the performance requirements of §§ 91.227(c)(1)(i) and (iii) after Exemption 12555 expires. However, given the ongoing uncertainty in the aviation industry, we need to understand to what extent operators will be able to comply with planned upgrades prior to the expiration of Exemption No. 12555.

We request that the PARC establish an Action Team composed of relevant air carrier and manufacturer stakeholders and propose that the Action Team leaders be selected from each of these two communities. The Action Team activity will:

a. Identify barriers and appropriate mitigations to air carrier Exemption 12555 equipage plans that lead to full compliance with 14 CFR 91.227.
b. Describe status of applicable equipment availability relative to achievement of operator equipage plans toward the end state of Exemption 12555 on December 31, 2024. Deliverables should include reports on the current state of the industry and any changes affecting Exemption 12555 equipage; aggregated and de-identified operator report(s) detailing equipage plan revisions due to changes in operations, fleet composition, and positioning source needs; and manufacturer reports on the availability of equipment to support revised operator equipage plans.

If you have any questions, please contact James Marks, Flight Technologies & Procedures Division, Flight Operations Group, Section E Manager at (202) 769-8890.

Sincerely,

Mark Steinbicker
Manager, Flight Technologies & Procedures Division

Appendix B: Terms of Reference

Exemption 12555 Action Team Terms of Reference

1.	**Statement of Objective, i.e. what is the problem/requirement:** In 2015, the FAA published Grant of Exemption No. 12555 and made available to any operator who notified the FAA of their intent to comply with conditions and limitations specified in the Grant. The purpose of the exemption was to permit covered operators to continue use of existing Global Positioning System (GPS) position sources that may not always meet the integrity and accuracy requirements of §91.227. The exemption is time limited and expires after December 31, 2024. Two of the conditions are summarized as: a. Each operator must create, maintain, and update a GPS equipage plan for aircraft equipped for Automatic Dependent Surveillance – Broadcast (ADS-B) Out and meet the requirements of § 91.227(c) by December 31, 2024. b. The equipage plan must be updated as needed, but at least annually thereafter; and reflect increased technical and schedule confidence and details regarding each aircraft's scheduled equipage. In order to fully realize the benefit from investments made during the implementation of ADS-B, the FAA does not expect to continue accepting the operational risk associated with aircraft ADS-B equipment that fails to meet the performance requirements of §§ 91.227(c)(1)(i) and (iii) after December 31, 2024. The objectives of this activity are: a. Ensure that operators meet the conditions of the exemption and are fully compliant when Exemption 12555 expires. b. Assure alignment of FAA, operators, and manufacturers expectations toward Exemption 12555 compliance.
2.	**Statement of scope of task/activity:** a. Identify barriers and appropriate mitigations to air carrier Exemption 12555 equipage plans that lead to full compliance with 14 CFR 91.227. b. Describe status of applicable equipment availability relative to achievement of operator equipage plans toward the end state of Exemption 12555 on December 31, 2024.
3.	**What is the expected deliverable/product:** a. Reports on current state of the industry and any changes affecting Exemption 12555 equipage. b. Aggregated and de-identified operator report(s) detailing equipage plan revisions due to changes in operations, fleet composition, and positioning source needs.

	c. Manufacturer reports on the availability of equipment to support revised operator equipage plans.
4.	**Special Considerations:** a. The impact of COVID-19 on air carrier fleet, aircraft usage, and applicable 12555 equipage plans. b. Projected availability of position sources that fully comply with US mandate performance requirements and air carrier desire for global interoperability. c. Understand availability of dual frequency multi-constellation (DFMC) position sources and their impact to applicable operator equipage plans.
5.	**What is the schedule of activities:** 1. Deliver tasking to PARC (August 2020) 2. Group kickoff meeting (October 2020) 3. Deliverables/products (March 2021)
6.	**Related Activities:** RTCA SC-159, Navigation Equipment Using the Global Navigation Satellite System (GNSS) standards ADS-B IN operations 3 NM Separation FAA planned radar divestiture
7.	**What are the resource requirements and commitments:** Commitments include assignment of Action Team Leaders from industry and assignment of Action Team Members from industry and FAA. * Possible MITRE support for equipage plan data and update (operator sensitivity).
8.	**What is the urgency/criticality:** Impact of equipage changes on FAA infrastructure and programs planning.
9	**Who are the customers for the product/deliverable:** Domestic/foreign Airlines, aviation manufacturing industry, and the FAA
10.	**Will this result in PARC recommendations or is this coordination to keep PARC aware of significant related activities:** Yes
11.	**(Proposed) Action Team Leaders:** A4A and avionics manufacturer rep
12.	**(Proposed) Action Team Members:** Domestic/foreign Airlines, aviation manufacturers, IATA, and FAA representatives

Appendix C: Membership of Exemption No. 12555 Action Team

Jim Marks	FAA Co-chair
Pascal Joly	OEM Co-chair (Airbus)
Bill McDonald	Industry Co-Chair (A4A)
Paul VonHoene	FAA
Alex Rodriquez	FAA
Dan Salvano	FAA
Stuart Fox	IATA
Kieran O'Carroll	IATA
Sean McCourt	MITRE
Todd Stock	MITRE
Rick Niles	MITRE
Paul Harrison	Alaska
Bret Peyton	Alaska
Scot Sherbert	Alaska
Dave Surridge	American
M. Citrano	Atlas
Linda Green	Delta
Greg Young	Delta
Jon Tree	FedEx
Brian Beres	Hawaiian
De Paul Sunny	JetBlue
Andrew Brixner	JetBlue
Chuck Cook	JetBlue
Lee Brown	JetBlue
Gary McMullin	Southwest
Trey Turner	Southwest
Ron Renk	United
Rich Stillwell	United
Jonathan Bonds	UPS
Steve Schaffer	UPS
Andy Cebula	A4A
Jack Allen	A4A
Bill Whyte	RAA
Jens Hennig	GAMA
Heidi Williams	NBAA
K. Von Altier	Net Jets
George Paul	NACA
Benjamin Dwyer	NACA

Pascal Joly	Airbus
Jessie Turner	Boeing
Sheila Conway	Boeing
Ricardo Teixeira	Embraer
Elane Christina Viera	Embraer
Rich Donyan	Mitsubishi/Bombardier
Michael McDowell	Collins
Angelo Joseph	Collins
Charles Cook	Collins
Bill Forstie	Honeywell
Brian Bunch	Honeywell
Derek Mitchell	Honeywell
Cam Morast	L3 Harris
Chris Collings	L3 Harris
Geanine Ballard	Universal Avionics
Rex Highgate	CMC
Bill Stone	Garmin
Darrell Pennington	ALPA
Doug Willey	ALPA
Brian Townsend	APA
Brad Simms	SWAPA

Appendix D: Grant of Exemption No. 12555

Exemption No. 12555

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
WASHINGTON, DC 20591

In the matter of the petition of **AIRLINES FOR AMERICA** for an exemption from § 91.227 of Title 14, Code of Federal Regulations	**Regulatory Docket No. FAA-2015-0971**

GRANT OF EXEMPTION

By letter dated April 1, 2015, Mr. Paul J. McGraw, Vice President, Operations and Safety, Airlines for America (A4A), 1301 Pennsylvania Ave, NW, Suite 1100, Washington, DC 20004-1707 petitioned the Federal Aviation Administration (FAA), on behalf of A4A member airlines, for an exemption from the Navigational Accuracy Category for position (NACp) and Navigational Integrity Category (NIC) requirements in § 91.227(c) of Title 14, Code of Federal Regulations (14 CFR) for Automatic Dependent Surveillance-Broadcast (ADS-B) Out. The proposed exemption, if granted, would permit operations during periods when installed ADS-B Out equipment does not achieve the required accuracy or integrity performance, and where an alternate means of traffic surveillance safely used today can be implemented by FAA. A4A requests this relief for a period of five years, beginning January 1, 2020 and expiring on December 31, 2024.

The petitioner requests relief from the following regulations:

When operating aircraft equipped with ADS-B Out in accordance with 14 CFR 91.225, the aircraft equipment must meet the performance requirements of 91.227. Relief is sought from:

> Section 91.227(c)(1)(i), which requires the aircraft's NACp to be less than 0.05 nautical miles (NM).

AJV-15-1114-E

Section 91.227(c)(1)(iii), which requires that the aircraft's NIC must be less than 0.2 NM.

The petitioner supports its request with the following information:

A4A states that to meet compliance for ADS-B Out in January 2020 under the rule requires a two-step process. First, the Original Equipment Manufacturers (OEMs) and avionic manufacturers must produce equipment necessary to meet the requirements of 14 CFR 91.227 and issue service bulletins, or alternatively, operators must obtain a Supplemental Type Certificate (STC) for their aircraft. Second, the operators must retrofit aircraft with the equipment and information produced from the first step, which is time consuming for large fleets due to maintenance scheduling. A4A states that at this time, avionics manufacturers have not made available certified equipment that meets the requirements under the rule. A4A further states that while industry groups are working towards solutions that would provide enhanced GPS integrity and accuracy for ADS-B Out position sources, those enhancements will not be available for air transport category aircraft before the equipment requirement date in 2020.[1]

A4A contends that the position accuracy and integrity performance requirements of 14 CFR 91.227(c) exceed the capabilities of GPS receivers currently available for use in transport category airplanes. A4A also contends, however, that the performance capabilities of existing GPS receivers provide a safe means of surveillance when alternate surveillance sources, such as secondary surveillance radar (SSR), are available. In addition, A4A states that many SSRs are expected to remain available for the foreseeable future, and certainly beyond January 1, 2025, but notes that there will be fewer SSRs in the National Airspace System (NAS) over time, due to planned reductions.

A4A states the following reasons for seeking relief at this time:

> Carriers need assurance that aircraft retrofit/equipage completed prior to the ADS-B Out deadline will ensure uninterrupted operation after the January 1, 2020, deadline, even during periods of GPS degradation.
>
> The scope of this exemption is limited, because GPS disruption or inability to meet the ADS-B Out performance requirements for aircraft equipped with SA-Aware and SA-On equipment[2] will be rare and infrequent. Use of SSR as backup will eliminate any adverse operational effects of SA-Aware and SA-On receivers not meeting ADS-B Out performance for NIC and NACp.
>
> Alternate means of surveillance during such occurrences exist today and are used safely

[1] ARINC report 660B, "CNS/ATM Avionic Architecture Supporting NEXTGEN/SESAR Concepts."
[2] Further in this document, the FAA discusses SA-Aware and SA-On equipment in detail.

> GPS receivers capable of meeting the 14 CFR 91.227(c) accuracy and integrity requirements under a wide variety of GPS satellite constellation conditions are not available for purchase or installation in many transport category airplanes and may not be available in quantity until after January 1, 2020.

A4A argues that a grant of exemption would not adversely affect safety because the FAA would continue to use air traffic separation methods that are used today to safely manage operations. In addition, this petition if granted would be in the public interest by facilitating the operators' planned upgrade path for fleet compliance. The ability for operators to commit to upgrade plans instead should motivate vendors to improve the product availability so that a more coordinated effort can occur during the exemption period. A4A also argues that absent this proposed relief, operators will be forced to adopt a two-step process to upgrade the aircraft position source with a short-term fix and second step to provide full compliance or face the possibility of service interruptions if the GPS satellite constellation is reduced from its current levels. This would result in added delays to the NAS, and adversely impact the public. The FAA has invested significant public funds readying the NAS for this step forward in the NextGen effort. Granting this exemption would assure that this public investment is usable by operators and allows FAA to proceed with a retirement schedule for identified aging terminal area SSR systems.

A4A proposed that interested operators individually request the use of the exemption described in the petition. Operators would submit a GPS equipage plan to the FAA during the transition period, committing to equipage compliance to meet the requirements of 14 CFR 91.227 by January 2025. Operator specific plans should be available to the FAA by August 2018 with annual updates that reflect increased technical and schedule confidence and details. Additionally, the plan should be mature and include a high confidence of execution and may include:

1) Manufacturer and Part Number, applicable service bulletin, or STC, of GPS receiver to be implemented;

2) Upgrade schedule, preferably tail-number specific;

3) Interim fleet milestone, e.g. initial installation, 30 percent, 80 percent, 100 percent completion; and

4) If a specific set of aircraft will not be upgraded but are desired to be covered by the Exemption, the operator's plan for fully rule-compliant operation beyond the expiration of the Exemption must be included (e.g. the use of Service Availability Prediction Tool (SAPT), even for SA-Aware equipage and possible operational impacts).

A summary of the petition was published in the Federal Register on May 7, 2015 (80FR26317). Seven comments were received.

American Airlines (American), United Airlines (United), Boeing, United Postal Service (UPS), FedEx, Delta Airlines, and one individual pilot/homebuilt operator were in support of the FAA granting an exemption to A4A's petition, and expressed support of the development and deployment of ADS-B Out.

United supported the petition for exemption in that it would avoid multiple navigation upgrades and allow for the development of multi-constellation Global Navigation Satellite System (GNSS) receivers. United also commented that there is a slow rate of standards development of new GNSS constellations and requested that the FAA assist in accelerating the development of standards for GALILEO and the GPS L5 signal, because, without standards, multi-mode receivers (MMRs) will not be able to receive multiple constellations. United argues that this will impede carriers from upgrading their MMRs prior to the proposed 2025 deadline, and thereby need an extension to this exemption, if granted. Lastly, United urged the FAA to establish policy on the acceptability of using non-GPS GNSS constellations for navigation.

American supported the need for the exemption as it would allow development of integrated systems that will support the communication, navigation and surveillance requirements of the future and it will support final harmonization of ADS-B requirements with other operational regions. American separately stated its concern regarding the FAA's use of the SAPT[3], which is software designed to report "predicted availability" for technical standard order (TSO) compliant GPS position sources. American believes the use of the prediction tool will be operationally problematic for many operators.

Boeing and FedEx supported the petition and agreed that the requested 5 year period for relief would allow U.S. carriers adequate and necessary time to incorporate suitable position sources that meet the performance rules. UPS notes that it has extensive experience with ADS-B Out equipment, including SA-on and SA-aware GPS receivers, some of which meet the requirements of 14 CFR 91.227. UPS commented that the exemption would allow a much more efficient upgrade path to transition to the next generation of GPS receivers, either Satellite Based Augmentation System (SBAS) or multi constellation capable units, while still maintaining active ADS-B Out reporting requirements.

[3] The ADS-B Service Availability Prediction Tool (SAPT) is a preflight availability verification tool that predicts the ability of an aircraft to meet the requirements of 14 CFR 91.227(c)(1)(i) and (iii)along a given route of flight. This prediction is based on the ability of the aircraft avionics to meet performance requirements specified in Technical Standard Orders (TSOs) C129, C129a, C145c/C146c, and C196, as well as the predicted status of the Global Positioning System (GPS) constellation. The SAPT will also evaluate if backup surveillance is available where ADS-B outages are predicted, which can be used by the FAA to determine if a particular non-compliant flight can be accommodated.

One individual stated that the FAA should consider relaxing the requirement for TSO-compliant Wide Area Augmentation System (WAAS) GPS units in light private aircraft, not just air carriers. The commenter also expressed concerns regarding the costs of equipping light private aircraft that are based within 30NM of a major airport with Class B or C airspace with GPS receivers

FAA response to comments

The FAA and the Equip 2020 working group[4] continue to work with the aviation industry toward reaching a collaborative solution to predict times and locations of reduced GPS performance for different aviation receivers.

The FAA agrees with the commenters with respect to the need to continue work with industry to develop equipment standards and operational policies as soon as the technologies are mature for the standards for multi-frequency/multi-constellation equipment. However, the FAA does not agree that the transition to ADS-B could be further extended beyond the petition date of December 31, 2024. The basis for this petition is rooted in the lack of a currently available solution from some aircraft manufacturers, and these manufacturers have indicated that one will become available within the next few years.

As stated in the ADS-B Out Final Rule, operators may equip with any position source and WAAS is not required, thus there is no requirement for WAAS receivers.[5] On February 9, 2015, the FAA published an amendment to the ADS-B Out final rule that corrected an inadvertent error and clarified that the ADS-B Out equipment installed must meet the performance requirements of the Technical Standard Orders identified in the regulations.[6]

The FAA's analysis is as follows:

The ADS-B Out rule specifies the aircraft's ADS-B equipment performance requirements for each flight in airspace designated by the rule. For each aircraft, the achieved performance depends on the type of GPS receiver that is used as the ADS-B position source. The quality of

[4] On October 28, 2014, the FAA hosted a meeting with industry representatives of pilots, operators, installers, suppliers and senior FAA officials to identify and address barriers to equipping with ADS-B Out by January 1, 2020, as required by 14 CFR §§ 91.225 and 91.227. The resulting action plan was provided to the NextGen Institute, which convened the Equip 2020 working group to continue a collaborative discussion to address the identified barriers.

[5] Automatic Dependent Surveillance-Broadcast (ADS-B) Out Performance Requirements To Support Air Traffic Control (ATC) Service Final Rule; 75 Fed. Reg. 30160, 30172; May 28, 2010.

[6] Automatic Dependent Surveillance-Broadcast (ADS-B) Out Performance Requirements To Support Air Traffic Control (ATC) Service, Technical Amendment; 80 Fed. Reg. 6899; February 9, 2015.

each type of receiver can be described by its "rule performance" [7]availability, which is the average percentage of time and locations that it is capable of meeting the requirements of 14 CFR 91.227 and therefore capable of operating in the airspace designated by the rule. The ADS-B Out rule does not dictate any particular type of GPS receiver or any availability.

Three different variants of GPS receivers are currently in use by operators that satisfy the ADS-B Out performance requirements, to varying degrees, when adequate numbers of GPS satellites can be detected by the aircraft. Two variants of GPS receivers differ in their ability to interpret and report potential accuracy and integrity of navigation performance, based on design assumptions regarding whether Selective Availability (SA) is activated. SA was a feature that deliberately degraded the GPS satellite signal, resulting in a reduction of the reported accuracy of an aircraft's position. On May 1, 2000, the United States deactivated SA to allow more accurate civilian use of GPS.[8] SA is not included in new GPS satellite designs. A third variant of GPS receivers uses signals from a satellite-based augmentation system (SBAS) to improve accuracy and integrity of navigational performance. The FAA's implementation of SBAS is called the Wide-Area Augmentation System (WAAS).[9]

SA-On GPS receivers assume SA is still active. Due to design assumptions, SA-On systems experience the greatest challenge to achieving required performance under § 91.227 (NIC<0.2NM). Based on FAA monitoring of known ADS-B installations, SA-On GPS receivers currently provide rule performance availability of 95 percent or greater. This availability can be affected by the changes in the GPS constellation, which has been operated at a level well above the minimum specification defined in the GPS Standard Positioning Service (SPS) Performance Standard[10].

SA-Aware GPS receivers are aware that SA is inactive. Based on FAA monitoring of known ADS-B installations, SA-Aware GPS receivers currently provide rule performance availability of 99.9 percent or greater. This availability can be affected by the changes in the GPS constellation, which has been operated at a level well above the minimum specification.[11]

Based on FAA monitoring of known ADS-B installations, current aircraft equipped with an SBAS GPS receiver also provide rule performance with a rule performance availability of 99.9 percent or greater. In addition, SBAS GPS receivers are expected to provide the regulatory performance even if the number of satellites in the GPS constellation degraded to

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[7] As used in this grant of exemption, "rule performance" means achieving the performance requirement of 14 CFR 91.227(c)(1)(i) and (iii) for NACp and NIC.
[8] Statement by the President Regarding the United States' Decision to Stop Degrading Global Positioning System Accuracy, May 1, 2000.
[9] GPS receivers using SBAS are not addressed in this exemption.
[10] See http://www.gps.gov/technical/ps/2008-SPS-performance-standard.pdf
[11] The effects of GPS constellation degradation are different for SA-On and SA-Aware GPS receivers. See "Report from the ADS–B Aviation Rulemaking Committee to the Federal Aviation Administration" (http://www.faa.gov/nextgen/programs/adsb/media/arcReport2008.pdf)

the minimum specified in the GPS SPS Performance Standard. At present, few SBAS GPS receivers are installed on Airbus and Boeing aircraft, but new production, regional aircraft from Bombardier and Embraer are delivered with SBAS GPS receivers.

Multi-frequency/multi-constellation receiver standards are being developed by RTCA Special Committee 159, Global Positioning System, in coordination with EUROCAE Working Groups 28, Global Navigation Satellite System (GNSS), and 62, GALILEO, as well as with the International Civil Aviation Organization's (ICAO's) Navigation System Panel. The equipment standards are planned to be completed in 2021, subject to multiple prerequisites specified in the SC-159 terms of reference, which can be found at the RTCA website (www.rtca.org). The rule performance availability of this equipment is expected to exceed that of SBAS equipment.

In the preamble to the ADS-B Out final rule, the FAA stated that SBAS and multi-frequency/multi-constellation receivers are the only ones that provide the equivalent availability to radar using the minimum GPS constellation at the time of promulgating the rule.[12] Operators who equip with other position sources, such SA-On or SA-Aware GPS, may experience performance outages that limit their access to the airspace defined in the rule. Operators equipped with SBAS or multi-frequency/multi-constellation receivers may also experience performance outages, if there is interference to GNSS or if there is a significant degradation in one or more GNSS satellite constellation(s). During outages of GNSS (scheduled or unscheduled), the FAA expects to revert to the backup ground-based surveillance system and temporarily allow operations without ADS-B Out in required airspace. Pilots would be notified of such action via the Notice to Airmen (NOTAM) system. The FAA also expects to revert to the backup surveillance system during significant degradation in the GPS constellation, such as those that would result in performance outages for SBAS receivers.[13]

A4A's request is to allow limited relief for operations after January 1, 2020, of aircraft equipped for ADS-B Out operations, using position sources that may not provide the equivalent availability to Secondary Surveillance Radar (SSR) (99.9 percent availability). It is important to note that the aircraft affected by this exemption request are aircraft that are already equipped with GPS receivers and as discussed below, would be compliant with the regulations for a vast majority of the time.

The FAA agrees with A4A that a backup means of surveillance[14] will be able to support many operations and maintain safety. However, the FAA is changing the NAS to take advantage of

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[12] 75 Fed. Reg. 30160; 30172

[13] Automatic Dependent Surveillance-Broadcast (ADS-B) Out Performance Requirements To Support Air Traffic (ATC) Service, Notice of Proposed Rulemaking; 72 Fed. Reg. 56947, 56959; October 5, 2007.

[14] After January 1, 2020, ADS-B will be the principal means of surveillance in the United States. A backup means of surveillance may be provided by secondary surveillance radar or wide area multilateration, as these technologies have the ability to provide aircraft identification and altitude information. Other technologies may become mature which could offer the same backup capability at lower cost. Each technology has unique

the improved performance of ADS-B Out, and there are circumstances where a degradation of ADS-B Out as a result of non-compliant aircraft in ADS-B Out designated airspace will have an operational effect on the system. ADS-B already provides surveillance coverage at lower altitudes than SSRs, and the FAA plans to decommission many of the existing terminal SSRs, which will expand the volume of airspace where ADS-B is the only means of surveillance. At higher altitudes, current separation standards are limited by SSR performance and the FAA is considering plans to reduce separation standards using ADS-B surveillance information. In addition, air traffic control (ATC) performance is affected by the accuracy of surveillance data. Finally, other aircraft that use ADS-B In for future applications may be affected by aircraft that do not meet the requirements under the rule. For these reasons, the FAA cannot accept frequent degradation of ADS-B performance.

The FAA finds that with respect to SA-aware GPS receivers, the rule performance availability using the current GPS constellation warrants that the FAA continues the planned reduction of SSRs and the implementation of air traffic improvements using ADS-B. This performance depends on the GPS constellation, which has been maintained at a level well above the U.S. commitment. Using the current GPS constellation, SA-aware GPS receivers provide rule performance availability of 99.9 percent or higher. To accommodate these aircraft in the system under the requested exemption, the FAA is effectively accepting the risk of degraded performance from SA-aware GPS receivers (if the GPS constellation is degraded). The FAA cannot, however accept this risk indefinitely. Granting an exemption that will allow operators equipped with SA-aware GPS receivers to operate when their position source performs less than that specified in the ADS-B Out rule necessitates that the FAA provide a backup means of surveillance to support air traffic operations. The FAA finds that requested exemption relief for a period not to exceed 5 years aligns with the agency's implementation plans for NextGen.

For SA-on GPS receivers using the current GPS constellation, the rule performance availability is approximately 95 percent or higher, which is not sufficient for the FAA to continue the transition in SSR systems and automation enhancements. The difference in performance was also recognized by the Equip 2020 working group and the group's recommendation was:

> Operators with SA-On position sources will be required to use SAPT or an equivalent and may be required to change their flight plans if a "RAIM hole" overlaps with an SSR outage or the predicted ADS-B performance during the "RAIM hole" does not support an operation based upon ADS-B alone.[15]

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performance characteristics, which may also affect the separation standards that are achievable with that technology.

[15] See ADS-B CTA 11/18/2014: Transition Period for NIC and NAC Requirements, dated December 17, 2014.

An operator that predicts the aircraft's performance using the FAA's SAPT tool or equivalent preflight availability prediction tool[16], can avoid any adverse impact to the national airspace system, as that operator would need to change its flight plan to avoid the degraded performance. For those circumstances where the FAA determines an acceptable backup means of surveillance is operational, the flight could continue without disrupting the NAS. The SAPT can identify predicted times/locations when rule performance is not met, and evaluate if there is another acceptable backup means of surveillance that could compensate for that performance deficit.

The FAA finds that granting the exemption would not adversely affect safety and supports the public interest. This relief is appropriate for operators that have made the early investment to equip with GPS receivers but that are limited by the lack of available product for the next generation of GPS receivers that consistently meet the rule's performance requirements. A grant of exemption would assure that the FAA's investment in NextGen is useable by operators and allows the FAA to maintain its NextGen schedule with no safety impact. The effect of the exemption is to mitigate the effects of GPS receiver performance under minimum GPS satellite constellation conditions. For an aircraft equipped with SA-Aware GPS receivers and assuming current performance of GPS is maintained, this amounts to less than two days of accumulated performance below rule requirements over the five year period which represents an acceptable risk. For an aircraft equipped with SA-On GPS receivers, this equates to approximately 90 days of accumulated performance below rule requirements, which is an unacceptable risk if operators were authorized to fly under all conditions. By restricting the times and locations to those when a preflight prediction tool affirms that an alternate method of surveillance is available, the unacceptable risk is mitigated.

Even though the requirement for ADS-B Out equipage is January 1, 2020, the FAA agrees with the petitioner that the affected operators must begin their equipment planning now and resolve any market uncertainties in order to ensure that their fleet is equipped with ADS-B Out compliant solutions by the compliance date. By waiting for a certified SBAS solution to be available for Airbus or Boeing aircraft in about 2018 (and after), which would be too late to achieve fleet-wide installation by January 1, 2020, a more workable, single-upgrade path to improved GPS receivers will emerge that will benefit the public by adding more robust performance at a lower overall cost. Therefore, the FAA finds sufficient cause to grant this exemption more than four years before the January 1, 2020 compliance date.

Absent this relief, operators would be forced to adopt currently-available receivers and accept service interruptions until upgraded equipment could be purchased and installed throughout the fleet. This would affect the public interest with respect to increased NAS costs and potential delays to passenger travel and air cargo services. Granting this exemption is in the public interest as it would help to ensure that air travel and air cargo services will not be interrupted. In order to fully realize the potential of ADS-B, the FAA cannot continue to

[16] It has not yet been determined how enforcement of the requirement of 14 CFR 91.227(c)(1)(i) and (iii) may be handled differently if an operator utilizes a capability equivalent to that provided by the FAA.

accept the operation of ADS-B equipment which fails to meet the requirements of §§ 91.227(c)(1)(i) and (iii) after December 31, 2024.

The FAA has determined from the information provided that good cause exists for granting this exemption. However, as A4A is a trade association and not an operator, it cannot be granted an exemption from FAA operating requirements. Exemption from an operating rule can be granted only to affected operators. Since the affected aircraft represent a significant portion of the air transport category fleet, it is in the public interest for the FAA to allow continued operation of the aircraft subject to certain conditions. Accordingly, the FAA will grant the relief requested by A4A to the operators of the affected aircraft when requested.

Requests for Exemption

To make this exemption effective, each affected operator must submit to the FAA a request to use this exemption and affirm its intentions to comply with the conditions and limitations of this exemption cited below. The FAA will not consider any extensions of time for this exemption beyond that granted here.

The FAA's Decision

In consideration of the foregoing, I find that a one-time, time-limited grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S. C. §§ 106(f), 40113 and 44701 delegated to me by the Administrator, aircraft operators who notify the FAA that they adopt the conditions and limitations of this decision are granted a time-limited grant of exemption from 14 CFR § 91.227(c)(1)(i) and (iii) from January 1, 2020 through December 31, 2024.

Conditions and Limitations

1. This exemption only applies to the aircraft that are identified by the operator in Condition No. 4.

2. In order to continue the operation of any aircraft subject to this exemption, each operator must create, maintain, and update a GPS equipage plan for airplanes equipped for ADS-B Out and meet the requirements of § 91.227(c) within the timeframe of relief under this exemption.

    a. This equipage plan must be submitted to the Director, Flight Standards Service by August 1, 2018, and updated as needed, but at least annually thereafter; and

    b. Each update must reflect increased technical and schedule confidence and details regarding each aircraft's scheduled equipage. For aircraft subject to Condition No. 4.b, more frequent updates may be appropriate as schedule installations proceed.

c. The operator's plan and subsequent updates will not be approved by the FAA, but must be available for review.

3. Prior to January 1, 2020, the operator's plan must be complete, in that it details each affected aircraft's scheduled date for compliance with 14 CFR § 91.227(c)(1)(i) and (iii).

4. The operator's plan must include the following elements:

   a. Registration numbers of the affected aircraft and indication of whether Condition No. 5 (SA-Aware) or Condition No. 6 (SA-On) applies to the operation of that aircraft;

   b. For aircraft which will be upgraded —

      i. The manufacturer, model, and part number; applicable Service Bulletin; or supplemental type certificate (STC) of the new or upgraded GPS/GNSS receiver that will replace the existing certified GPS position source;

      ii. Upgrade schedule; and

      iii. Interim fleet milestones, (e.g., initial installation; 30 percent, 80 percent, 100 percent completion).

   c. For aircraft which will not be upgraded, the operator's plan for operations beyond the expiration of this exemption (e.g., planned aircraft retirement).

5. For operators having aircraft equipped with GPS receivers meeting the performance requirements of TSO-C196 (SA-Aware):

   a. Compliance to TSO-C196 performance is documented by the manufacturer for a given receiver, regardless of TSO marking or authorization;

   b. The GPS receiver must be installed in accordance with the version of AC 20-138 and AC 20-165 appropriate for that installation. The FAA will monitor the performance of each aircraft during the exemption period and, if the FAA determines that its performance is below that of a compliant and properly installed receiver, the FAA will notify the operator and may exclude that aircraft from this exemption until its performance is corrected. The FAA will make this determination using a validated model of TSO-C196 performance using a 5-degree mask angle; and

c. Aircraft subject to this exemption may operate in airspace specified in 14 CFR § 91.225 when their ADS-B Out equipment does not meet the requirements of § 91.227(c)(1)(i) and (iii).

d. The operator is not required to perform preflight availability verification.

6. For operators having aircraft equipped with TSO-C129-approved GPS receivers that do not meet the performance requirements of TSO-C196 or TSO-C145/-146:

a. Compliance to TSO-C129 performance is documented by the manufacturer for a given receiver, regardless of TSO markings or authorization.

b. The GPS receiver must comply with TSO-C129 (or TSO-C129a) and be installed in accordance with the version of AC 20-138 and AC 20-165 appropriate for that installation. The FAA will monitor the performance of each aircraft during the exemption period, and, if the FAA determines that its performance is below that of a compliant and properly installed receiver, the FAA will notify the operator and may exclude that aircraft from this exemption until its performance is corrected. The FAA will make this determination using a validated model of TSO-C129 performance using a 5-degree mask angle;

c. Aircraft subject to this exemption may operate in airspace specified in 14CFR § 91.225when their ADS-B Out equipment does not meet the requirements of § 91.227(c)(1)(i) and (iii) and the FAA determines there is a backup means of surveillance. The FAA will provide operators with a preflight availability verification tool and information about backup means of surveillance for use in flight planning; and

d. The operator must perform GPS preflight availability verification.

This exemption is in effect on January 1, 2020, and terminates on December 31, 2024, unless sooner superseded or rescinded.

Issued in Washington, D.C., on August 20, 2015

Jodi S. McCarthy

Jodi S. McCarthy
Director, Airspace Services Air Traffic Organization

Appendix E: OEM Equipment List

MMRs Certified on Air Transport Aircraft

A/C Family[1]	MMR Supplier	MMR Model	MMR Part Number	Selective Availability	TSO
A320	Collins	GLU-920	822-1152-121/-122	SA ON	TSO-C129a
A330 A340	Collins	GLU-920	822-1152-121/-130/-131	SA ON	TSO-C129a
A320	Collins	GLU-920	822-1152-123	SA AWARE	TSO-C129a
A330 A340	Collins	GLU-920	822-1152-132	SA AWARE	TSO-C129a
A320 A330 A340	Collins	GLU-925	822-1821-430	SA AWARE	TSO-C129a
A380	Collins	GLU-925	822-1821-430	SA AWARE	TSO-C129a
A350	Collins	GLU-925	822-1821-632	SA AWARE (Optional SBAS)	TSO-C145c [2]
A320 A330 A340	Thales	TLS755	TLS755-01-0101B/ -0102A/-0200A	SA AWARE	TSO-C129a
A320	Thales	TLS755	TLS755-14- 0101A/-102A/ - 103A	SA AWARE	TSO-C129a
A320 A330 A340	Honeywell	RMA-55B	066-50029-1161	SA ON	TSO-C129a

A/C Family[1]	MMR Supplier	MMR Model	MMR Part Number	Selective Availability	TSO
A320 A330	Honeywell	iMMR	69002602-0201	SA-AWARE (Optional SBAS)	TSO-C145c [2]
737NG	Collins	GLU-920	822-1152-002	SA ON	TSO-C129a
737NG 747-400	Collins	GLU-920	822-1152-004	SA AWARE	TSO-C129a
737NG 737MAX 747 757 767 777	Collins	GLU-925	822-1821-XXX[3]	SA AWARE	TSO-C129a
737NG 737MAX 747-8 767F 777	Collins	GLU-2100	822-2532-100	SBAS	TSO-C145c
737NG 737MAX 777	Honeywell	RMA-55B	066-50029-1201	SA ON	TSO-C129a
737NG 737MAX 747-8	Honeywell	iMMR	69002600-0101	SBAS	TSO-C145c
787[4]	Honeywell	INR	940-2001-004 or -008	SA AWARE	TSO-C129a

1. Not every sub-model of each aircraft family model will necessarily be certified with the listed MMR part number.

2. SBAS capability for ADS-B OUT (optional) and/or SLS activation (optional).
3. Collins GLU-925 P/N 822-1821-XXX dash number (-001/002/330/332) varies depending on aircraft model.
4. Certification of an ABAS position source is currently scheduled for 4Q 2022.

Appendix F: ACSS NXG-900™ GPS

Stand-alone WAAS/SBAS Compliant GPS Source designed and manufactured by ACSS, an L3Harris Technologies and Thales Avionics company

PRODUCT FEATURES

- Low-cost, retrofit solution.
- Rule compliant position source (AC 20-1380, AC 20-165B).
- Certified to TSO-C145c, TSO-C154c and TSO-C157a.
- ADS-B In providing 978 MHz UAT, Free Weather (FIS-B) products including NEXRAD, CONUS NEXRAD, METARs, TAFs, PIREPs, winds and temperatures aloft, NOTAMs, AIRMETs and SIGMETs.
- WIFI dongle interface to compatible mobile applications (Android, iOS, Windows).

PRODUCT AVAILABILITY

- ACSS production capability support approximately 1,500 units per year.
- Increase (ramp-up) could be supported if demand presents itself.

INSTALLATION APPROVALS

- ACSS is an FAA-approved STC Organization Designation Authorization (ODA).
- AML STCs available covering NXG-900 installation on majority of Part 25 and Part 23 aircraft models.
- Tailored STCs (for specific operator fleets) have been created for NXG-900 installations on B737, B747, B757, B767, B777 models.

NXG-900	
Part Number:	9009000-55000
PHYSICAL DESCRIPTION	
Size (inches):	2.29" (H) x 4.78" (W) x 6.50" (L)
Weight:	1.6 lb.
Mounting:	4-point Flange Mount
Cooling:	Passive
CERTIFICATION	
Environmental:	DO-160G
TSO/ETSO:	C145c, C154c, C157a
Software:	DO-178B Level C
ADS-B Capability:	ADS-B In per DO-260B (for FIS-B)
GPS Capability:	Class Beta-1 per RTCA DO-229D
Operating Altitude:	Sea Level to 55,000 ft NOTE: UAT capability is restricted to 24,000 feet or below
Operating Temperature:	-55 to +70° C
Power:	28VDC
Power Consumption:	8.9 Watts (nominal), 11.5 Watts (maximum)
No. of Antenna Ports:	2 (GPS & L-Band/UAT)
INTERFACES	
Diagn. Tool Interface:	Mini-USB or Wi-Fi
Mobile Applications:	Wi-Fi
Transponder Interface:	Compatible ACSS Transponders

Appendix G: Collins Aerospace GNSS Solutions

GLU-2100 Multi-Mode Receiver (MMR)

The GLU-2100 is Collins Aerospace's latest MMR, providing a drop-in solution to all fielded MMRs. The GLU-2100 has a robust hardware baseline that supports current navigation capabilities (ILS, GLS CAT I, GNSS, SBAS navigation, VOR and Marker Beacon) and software-only growth to future navigation capabilities (SBAS LPV, GLS CAT II/III, RF Interference detection and mitigation, multi-frequency and multi-constellation). The GLU-2100 is certified on most air transport platforms and readily available.

PRODUCT FEATURES

- Direct drop-in replacement to other multi-mode receivers
- Rule compliant position source for ADS-B Out (AC 20-165B)
- Integrated aircraft navigation solution
- Robust HW for software-only growth to all foreseeable navigation capabilities (GLS CAT II/III, LPV, RF Interference Detection and Mitigation, Dual-Frequency/Multi-Constellation, LPV "Everywhere")
- Certified to TSO-C34e, TSO-C35d Class A, TSO-C36e Class B, TSO-C40c, TSO-C145d Class Beta 3, TSO-C161a and TSO-C162a
- Development in support of DO-178C Level A, DO-254 Level A, ARP4754 Rev A and DO-160G

PRODUCT AVAILABILITY

- Production capability supports in excess of 3,000 units per year
- Increase (ramp-up) could be supported if demand presents itself

INSTALLATION APPROVALS

- GLU-2100 is Type Certified on Boeing 737-NG, 737-MAX, 747-8, 767, 777 and on Airbus A32X and A330
- Service Bulletins are available for most Boeing platforms and planned for Airbus platforms in 2021
- Collins Supplemental Type Certifications (STCs) are available on most Boeing platforms and planned in 2021 for Airbus platforms

GPS-4000S

The GPS-4000S, available since 2003, is SBAS capable and supports RNP procedures and SBAS LPV approaches. The GPS-4000S is an integrated part of the Collins Proline architectures on many regional and business jet aircraft and on the Airbus A220. The GPS-4000S is a drop-in replacement to previous GPS-4000 and GPS-4000A implementations.

PRODUCT FEATURES

- Low-cost, standalone solution for forward fit and retrofit
- Rule compliant position source for ADS-B Out (AC 20-165B)

- Robust HW design to support future growth capabilities
- Certified to TSO-C145d Class Beta 3
- Development in support of DO-178C Level A, DO-254 Level A and DO-160G
- Highly reliable

PRODUCT AVAILABILITY

- Production capability supports approximately 1,500 units per year
- Increase (ramp-up) could be supported if demand presents itself

INSTALLATION APPROVALS

- OEM Type Certification on multiple air transport, business jet and regional platforms
- Service Bulletin and Supplemental Type Certification available on multiple business jet and regional platforms and on multiple air transport platforms as a stand-alone solution

Appendix H: Honeywell GNSS Solutions

The following are the functional capabilities of the Honeywell IMMR:

- SA-Aware GNSS Receiver with enroute GPS Position, Velocity, and Time (PVT)
- Instrument Landing System (ILS) Receiver (Category IIIb)
- GNSS Landing System (GLS Cat I) Lateral and Vertical Deviations, Ground Based Augmentation System (GBAS) station identification, and GBAS audio
- Satellite Based Augmentation System (SBAS) station identification, and SBAS audio
    - US WAAS, European EGNOS, Indian GAGAN Augmentation of GPS
    - LPV/APV Approach Capability for precision-like lateral and vertical guidance
- Maintenance data for an on-board Central Maintenance Computer (CMC) conforming to aircraft OEM requirements
- Integrated VHF Omni Bearing Range (VOR) and Marker Beacon receivers (software selectable option)
- "On-wing" data loadable

There are two growth options for the Honeywell IMMR

- GLS Category II/III and multi-constellation multi-frequency GNSS
- Anti-Jamming and Anti-Spoofing for GNSS

The Honeywell IMMR is not compatible, interchangeable, or intermixable with old MMR (RMA-55B) if both are present on the same aircraft.

The Honeywell IMMR is fully interchangeable and intermixable if two IMMRs are present on the same aircraft.

Honeywell can meet foreseen market demand for IMMR shipments.

The following are the STC Holder and Aircraft which are certified with the Honeywell IMMR.

STC Holder	Aircraft	MMR/GPS	Transponder	Airworthiness
LHT (IMMR)/Fokker (TRA-100B)	B767-200/ -300/ -300F/ -400ER	IMMR	TRA-100B	EASA/TCCA IMMR/TRA-100B
H4A	B777-200/-200LR/-300/-300ER/-300F	IMMR	TRA-100B	EASA
Honeywell	B757-200/-200PF/-200CB	IMMR	TRA-100B	FAA/EASA
Honeywell	B757-300	IMMR	TRA-100B	FAA/EASA
Carlisle Interconnect	A319/320/321	IMMR	TRA-100B	FAA
Canard Aerospace	B737-600/-700/-700C/-800/-900/-900ER	IMMR	TRA-100B	FAA