Office of Inspector General

Audit Report

ADS-B BENEFITS ARE LIMITED DUE TO A LACK OF ADVANCED CAPABILITIES AND DELAYS IN USER EQUIPAGE

Federal Aviation Administration

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Memorandum

U.S. Department of Transportation
Office of the Secretary
of Transportation
Office of Inspector General

Subject: **ACTION:** ADS-B Benefits Are Limited Due to a Lack of Advanced Capabilities and Delays in User Equipage
Federal Aviation Administration
Report No. AV-2014-105

Date: September 11, 2014

From: Matthew E. Hampton
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Reply to Attn. of: JA-10

To: Federal Aviation Administrator

Since fiscal year 2004, the Federal Aviation Administration (FAA) has been developing the Next Generation Air Transportation System (NextGen) to increase the safety and efficiency of the National Airspace System (NAS). Central to FAA's NextGen plans is its goals to transition from a ground-based radar system to a satellite-based system for monitoring and managing air traffic. To execute this transition, FAA is developing the Automatic Dependent Surveillance-Broadcast (ADS-B) system,[1] which is expected to leverage new and existing technologies to provide aircraft information to pilots and air traffic controllers during all phases of flight. Full implementation of ADS-B requires the installation of a nationwide network of ground-based radio stations, aircraft equipped with ADS-B rule-compliant avionics,[2] and the integration of ADS-B data into FAA's air traffic control automation systems.

FAA plans to spend approximately $1.7 billion on ADS-B through 2014, and an additional $1 billion between 2014 and 2020. In October 2010,[3] we reported that FAA faces significant risks and challenges in finalizing ADS-B's technical requirements, managing its cost and schedules, and encouraging airspace users to equip with ADS-B avionics.

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[1] ADS-B is considered "automatic" because no external interrogation is required and "dependent" because it relies on equipment on board aircraft to transmit flight information to controllers and pilots.
[2] To be rule-compliant with FAA's *ADS-B Out* mandate ADS-B avionics must meet minimum operational performance standards as defined by the RTCA, a Federal advisory committee. RTCA standards documents DO-260B for major air carriers operating in the 1090 MHZ frequency, and DO-282B for general aviation users operating in the 978 MHZ frequency.
[3] *FAA Faces Significant Risks in Implementing ADS-B Program and Realizing Benefits* (OIG Report Number AV-2011-002), October 12, 2010. OIG reports are available on our Web site at http://www.oig.dot.gov/.

At the request of the Chairman and Ranking Member of the House Committee on Appropriations, Subcommittee on Transportation, Housing and Urban Development, and Related Agencies, we conducted a follow-up audit on FAA's progress in implementing ADS-B. This follow-up audit also addresses a mandate from the FAA Modernization and Reform Act of 2012[4] that we conduct a review of the ADS-B program. Accordingly, we (1) assessed FAA's progress toward deploying and testing the ADS-B ground system; (2) identified the capabilities and benefits ADS-B will provide to users; and (3) estimated ADS-B's current cost, schedule, and planned benefits as measured against the original program goals.

We conducted this audit in accordance with generally accepted Government auditing standards. Exhibit A details our scope and methodology.

RESULTS IN BRIEF

FAA has deployed the ADS-B ground infrastructure, but controller and pilot use of ADS-B information throughout the NAS remains years away. As of April 2014, FAA reported that the ADS-B ground infrastructure has been completed with the deployment of 634 ground radio stations. However, only limited ADS-B services are being provided to pilots and air traffic controllers, due in part to the fact that FAA has yet to complete modernization of its air traffic automation systems to accommodate ADS-B technology. In addition, FAA's operational testing identified problems related to the display of ADS-B data on FAA's air traffic control automation systems. According to FAA, a lack of sufficient numbers of users who have equipped with ADS-B avionics makes it difficult to test the entire system—ground infrastructure, aircraft avionics, and controller automation—to ensure it can be used to safely manage air traffic in congested airspace. Finally, FAA has not yet fully developed a system to monitor the performance and operational safety of the ground equipment and help avoid and resolve outages.

While ADS-B will provide some useful services—particularly in areas with no radar coverage—the system's initial capabilities and benefits are limited. For example, ADS-B's weather and traffic broadcast services are primarily designed for general aviation users, and FAA warns that pilots should not rely on ADS-B information to separate themselves from and avoid other aircraft. According to FAA, airspace users will gain the most benefits with the advanced capabilities of *ADS-B In*,[5] which is expected to provide pilots with enhanced merging and spacing capabilities for airport arrivals, including for closely spaced runways. However, requirements for *ADS-B In* advanced capabilities continue to evolve, creating significant challenges related to developing and certifying *ADS-B In* avionics, maturing advanced capabilities, and partnering with airlines to verify and

[4] P.L. 112–95, FAA Modernization and Reform Act of 2012, signed into law on February 14, 2012.
[5] *ADS-B In* capability allows for the display of flight information in the cockpit, such as allowing pilots to "see" other aircraft and obtain critical information sent from ADS-B ground infrastructure.

validate benefits and gain experience through demonstration projects. As a result, FAA is not well positioned to mandate the use of *ADS-B In* as directed by Congress for the foreseeable future.

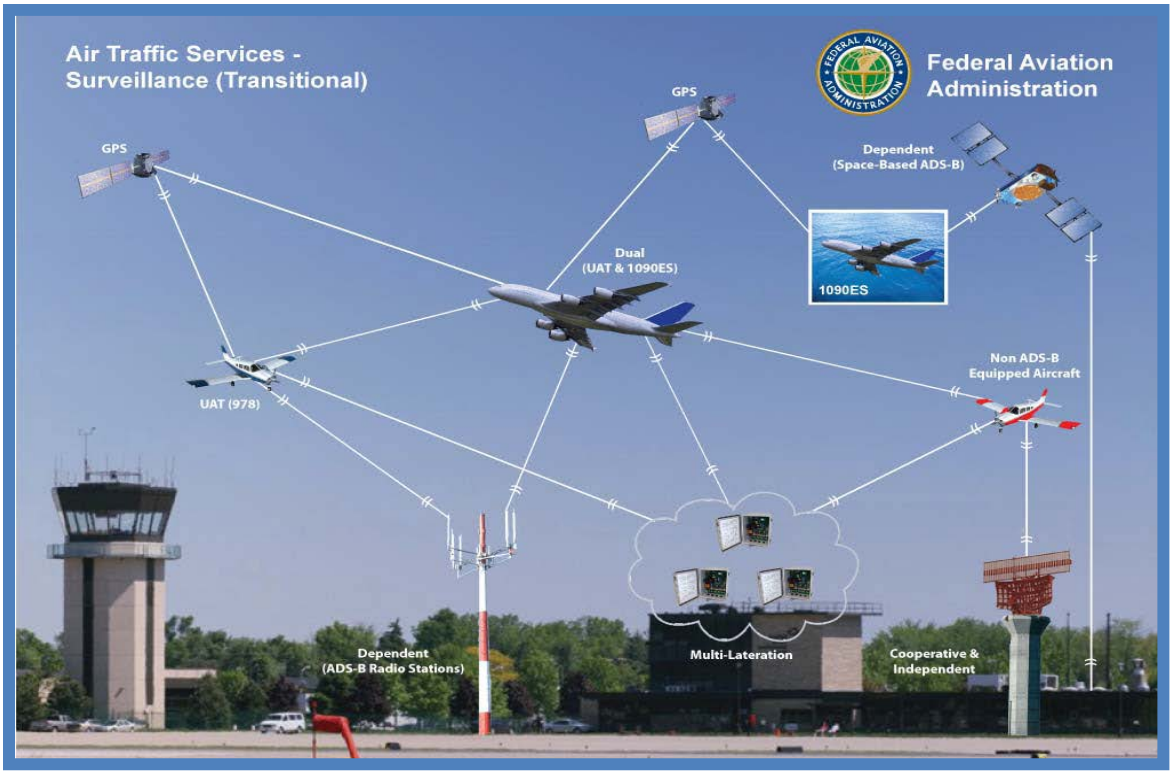
The final cost and timeline needed to fully implement ADS-B—and achieve the extent of its benefits—remain uncertain. FAA currently estimates the cost of the program (through 2035) to be $4.5 billion, an increase of $400 million from original estimates. Ongoing adjustments to key program activities further increase the risk of future cost and schedule growth. Ultimately, FAA determined that the total costs for the current ADS-B program (*ADS-B Out* and current broadcast services), including funding that has already been spent, now outweigh the projected benefits of the program by as much as $588 million. FAA states that future investment decisions will focus more on the advanced capabilities of ADS-B and significantly improve the cost/benefit ratio for the program, but it remains uncertain how and when FAA will implement these capabilities and at what cost.

We are making a series of recommendations to assist FAA to better manage risks and reduce uncertainty with the implementation of the ADS-B program.

BACKGROUND

ADS-B is designed to use satellite-based technology, including global positioning systems (GPS), and a network of ground stations to transmit position information more frequently and accurately than ground-based radars (see figure 1). Specifically, ADS-B is expected to provide reports once every second, compared to ground-based radar that generate reports once every 5 to 12 seconds, and unlike ground-based radar, ADS-B's accuracy does not change based on the distance between the aircraft and the sensor. FAA anticipates that ADS-B will ultimately replace ground-based radar because ADS-B-equipped aircraft can provide controllers and pilots in other aircraft with faster updates of important flight information, such as aircraft identification, position, altitude, direction, and speed.

Figure 1. ADS-B Schematic



Source: FAA

ADS-B consists of two services: *ADS-B Out* and *ADS-B In*.

- ***ADS-B Out*** will allow aircraft to broadcast flight position data to controllers on the ground. *ADS-B Out* is expected to improve aircraft tracking, especially in areas where radar is ineffective due to terrain and other ground barriers, impractical, or cost prohibitive.

- ***ADS-B In*** will display flight information in the cockpit, such as the location of other aircraft. Allowing pilots to "see" nearby aircraft and obtain other critical information sent from ADS-B's ground infrastructure is expected to further enhance safety.

FAA is planning to implement two *ADS-B Out* and six *ADS-B In* applications in the near term. (See exhibit B for a full list of ADS-B's initial applications and their capabilities.) According to FAA, future applications will be defined as the ADS-B program matures and requirements are identified for capabilities that provide benefits to FAA and airspace users.

In May 2010, FAA published the final rule mandating that most NAS users equip with *ADS-B Out* avionics by 2020.[6] To accelerate NextGen and achieve the full range of benefits, the FAA Modernization and Reform Act of 2012 directed FAA to begin a rulemaking process for *ADS-B In* with the goal of mandating the new technology in 2020 for aircraft operating in capacity-constrained airspace. FAA has established an internal board to define *ADS-B In* requirements and is currently exploring various rulemaking options for ADS-B as well as other NextGen technologies.

In 2007, FAA awarded a contract to ITT Corporation for $1.8 billion—if all options are exercised through 2025—to develop the ADS-B ground infrastructure and begin broadcasting services. FAA's contract with ITT is a service-based contract, meaning the Agency will not own the ADS-B ground infrastructure—a departure from FAA's traditional approach to major acquisitions where the Government owns the system. In 2010, we also reported that the ADS-B contract structure bundles and comingles tasks and costs, making it difficult for decision makers to track costs.[7] We also reported that basic management controls over the ADS-B contract were lacking.

DESPITE PROGRESS WITH THE GROUND INFRASTRUCTURE ADS-B REMAINS YEARS AWAY FROM FULL IMPLEMENTATION

FAA has deployed the ADS-B ground infrastructure, but the ability for controllers and pilots to use ADS-B information throughout the NAS remains years away. Notably, FAA has yet to resolve significant hazards identified during operational testing or conduct more rigorous testing of the entire system to determine whether all ADS-B elements will perform as expected. As a result, FAA has not authorized the exclusive use of ADS-B information to manage air traffic across the NAS. Further, the Agency's system for monitoring the performance of the ADS-B signal remains under development.

FAA Has Made Progress Deploying the ADS-B Ground Infrastructure But Has Not Sufficiently Tested the Entire System

Since awarding the ADS-B contract in August 2007, FAA has primarily focused on deploying the nationwide ground infrastructure for receiving and broadcasting information. In April 2014, FAA reported that the ADS-B ground infrastructure was complete, with 634 ground radio stations deployed—a reduction from FAA's original projection of 792 radio stations.[8] However, the ADS-B program office has since identified coverage gaps, and FAA identified the need for an additional

[6] 14 CFR Part 91, Automatic Dependent Surveillance - Broadcast (ADS–B) Out Performance Requirements To Support Air Traffic Control (ATC) Service.
[7] See footnote 3.
[8] The current ground infrastructure is designed to provide ADS-B information to air traffic controllers and pilots throughout the contiguous United States, Gulf of Mexico, and Alaska.

200 radio stations. Specifically, FAA's fiscal year 2014 budget request identified $258 million in additional funding for what the program office describes as new requirements to address the coverage gaps.[9]

Despite FAA's progress in deploying the ground infrastructure, until users purchase and install new *ADS-B Out* avionics, the ground infrastructure provides only limited benefit. While the current ground infrastructure is designed to provide ADS-B information to air traffic controllers and pilots throughout the contiguous United States, Gulf of Mexico, and Alaska, FAA estimates that only 3 percent of major air carriers and 10 percent of general aviation users will be equipped by the end of fiscal year 2014. Moreover, airspace users are not required to equip with *ADS-B Out* avionics until 2020.

In addition, ADS-B's ground infrastructure will not provide benefits until FAA upgrades or replaces the automation systems that controllers rely on to manage air traffic. FAA currently estimates that ADS-B will be deployed at 230 locations—which include 24 en route facilities (20 in the contiguous United States, and 4 in Alaska, Hawaii, and the U.S. territories); 159 terminal facilities; 44 airports; and 3 oceanic sites.[10] Until FAA modernizes the automation systems at these locations, controllers will not be able to use ADS-B to safely separate air traffic. The Agency does not plan to complete these upgrades until 2019.

FAA Has Not Fully Resolved Problems Identified in ADS-B Operational Testing

Between 2010 and 2013, FAA conducted a series of independent operational assessments at the program's four key sites[11] and identified problems related to the display of ADS-B data on FAA's air traffic control automation systems. For example, at the Louisville and Philadelphia sites, ADS-B dropped or never displayed targets—electronic indicators of an aircraft's current location on controller displays. In addition, ADS-B targets would split on controller displays, resulting in false alerts about potential separation losses between aircraft. While the assessment did not identify the root causes of the problems, the team concluded that the two terminal automation systems that they tested[12] were not operationally ready to accommodate ADS-B. Despite these ongoing weaknesses,

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[9] Federal Aviation Administration FY 2014 President's Budget Submission, Section 7, Immediate Transportation Investment (ITI), ADS-B Radio Station Expansion.

[10] En route facilities control high altitude air traffic above 18,000 feet, terminal control facilities control air traffic from the surface up to 10,000, and airports control air traffic on the airport surface up to 4,000 feet within a 5 nautical mile radius of the airport.

[11] The assessments focused on how well controller automation systems in terminal facilities and air traffic control centers could process and display ADS-B information for managing aircraft at the key sites which include facilities in Louisville, Philadelphia, Houston, and Alaska. These assessments provide FAA decision makers with an independent determination of operational readiness in support of production and in-service decision.

[12] These two terminal air traffic control systems are the Common Automated Radar Terminal System IIIE (CARTS IIIE) and Standard Terminal Automation Replacement System (STARS).

FAA declared the sites ready for initial operations and accepted the system from the contractor.

Regardless, other decisions that are critical to resuming operational testing have yet to be made.[13] For example, FAA has not completed required safety certifications for each of its air traffic control systems to allow the use of ADS-B surveillance data in radar-controlled airspace without radar. In addition, FAA has yet to develop and implement rules and procedures to allow controllers to use ADS-B exclusively to separate and control air traffic in congested airspace. These rules and procedures cannot be developed until technical issues are resolved. In the meantime, FAA's current policy states that controllers can only use ADS-B services for separating aircraft if another surveillance source such as radar is "fused" with ADS-B data.

FAA Has Not Sufficiently Tested the Entire ADS-B System

Comprehensive testing of all ADS-B elements—ground infrastructure, avionics, and controller automation systems—is critical to determine whether the system will improve air traffic flow and ensure that it does not inadvertently introduce new safety hazards. To date, FAA has not conducted this end-to-end[14] testing. Instead, it has focused on operational testing on specific air traffic automation systems and ADS-B-related problems. For example, FAA's 2010 operational assessments focused exclusively on how well FAA automation systems could process and display ADS-B information—not on whether identified problems were traceable to aircraft avionics, the ADS-B ground system, FAA automation systems, or a combination of these components.

According to FAA, end-to-end testing requires a significantly higher level of aircraft equipage to determine whether the system is meeting operational and technical requirements. Based on FAA's estimate, sufficient numbers of aircraft are not expected to be equipped with *ADS-B Out* avionics until at least 2018.

In addition, FAA continues to face security challenges related to cyber threats and vulnerabilities of using ADS-B to manage air traffic, including the security of the ADS-B infrastructure and aircraft avionics. Based on concerns raised by the Department of Defense and airspace users, FAA plans to conduct detailed vulnerability testing of ADS-B that will examine potential dangers, such as

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[13] In March 2013, the assessment team completed a follow-up evaluation of the integration of ADS-B with the En Route Automation Modernization (ERAM) system at the Houston Center, which controls air traffic in radar and non-radar airspace in the Gulf of Mexico. The team reported that they were not able to independently assess the resolution of the problems identified in the earlier tests and that ADS-B could be used to control traffic in *only* the non-radar airspace in the Gulf of Mexico.

[14] End-to-end testing refers to testing of component-based systems: ground systems, air traffic automation system, and avionics. It verifies that the each integrated component works correctly as part of the overall system, and that the components of the system work as intended.

jamming of ADS-B data links and spoofing.[15] This assessment will result in action plans for ways to improve security. It could also significantly impact FAA plans for implementing and using ADS-B throughout the NAS. (We are conducting a separate audit to review ADS-B security concerns.[16])

FAA Has Yet To Fully Develop Its ADS-B Monitoring System

FAA does not own, operate, or maintain the ADS-B ground infrastructure and relies heavily on the contractor's system for monitoring ADS-B signals. To provide critical oversight of this component, FAA is developing and deploying the Surveillance Broadcast Services (SBS) Monitor—a system intended to assess the performance and operational safety of the ground equipment at each ADS-B site to help avoid and resolve outages.

In August 2011[17] we reported that FAA was gaining valuable experience in using the SBS Monitor but faced challenges related to the lack of staffing requirements, gaps in communication, and unclear procedures for resolving ADS-B outages. Other issues included difficulties with establishing real-time notification of ADS-B service status and training. While FAA was responsive to our concerns, the Agency has yet to determine the level of staffing it will need to adequately analyze the large amount of real-time information provided by the ADS-B ground station.

In addition, the SBS Monitor still lacks the capability to fully assess and report on ADS-B system performance. For example, in April 2013, the SBS Monitor did not detect ground station outages in Alaska that resulted in dropped signals from ADS-B equipped aircraft and the loss of information on controller displays. The problem was only discovered through communications between controllers and pilots. Similarly, the SBS Monitor did not detect that the ADS-B ground system was transmitting outdated weather information to pilots. Instead, FAA troubleshooting found the problem.

According to SBS Monitor officials, additional development will be required to improve the system's ability to monitor the health of ADS-B data transmission. Specifically, FAA has an ongoing effort to integrate its Wide Area Augmentation System[18] with the SBS Monitor to improve performance and reduce false alarms.

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[15] By its nature ADS-B is an unsecure system that lacks the encryption to keep its communications private and the authentication necessary to prevent spoofed or faked communications from mixing with real ones, potentially allowing hackers to fabricate or control data and even entire aircraft.

[16] OIG Announcement Memo, "Security Controls of the Automatic Dependent Surveillance-Broadcast System," January 23, 2013. Our audit objective is to evaluate how security issues are being addressed in the overall design and implementation of the ADS-B system.

[17] *FAA Oversight Is Key For Contractor-Owned Air Traffic control Systems That Are Not Certified* (OIG Report Number AV-2011-149), August 4, 2011.

[18] FAA's Wide Area Augmentation System is a satellite-based navigation system that augments DOD's GPS satellite signals.

FAA officials also believe that further work will be needed to add capabilities to monitor the quality of the information transmitted, in addition to service output.

FAA'S CURRENT LACK OF ADVANCED CAPABILITIES AND BENEFITS HAVE DISCOURAGED USER INVESTMENT IN ADS-B

The successful implementation of ADS-B depends on FAA's ability to deliver capabilities that encourage airspace users to equip with ADS-B avionics. While ADS-B provides some useful services, these capabilities have been limited, discouraging some users from investing in ADS-B. At the same time, requirements for *ADS-B In's* advanced capabilities continue to evolve, creating significant challenges related to certifying ADS-B avionics, maturing advanced capabilities, and partnering with airlines to verify and validate benefits and gain experience through demonstration projects.

ADS-B Provides Some Useful Services, but Benefits Likely Will Remain Limited by the 2020 Equipage Mandate

ADS-B's current capabilities provide some services and applications for users equipped with initial ADS-B avionics. (See exhibit B for a list of ADS-B's initial capabilities and the status of their usage.) For example, ADS-B is proving beneficial in areas with limited or no radar coverage, such as locations in Alaska and the Gulf of Mexico. In the Gulf, ADS-B has allowed air traffic controllers at Houston Center to route equipped low-altitude helicopters directly to their destination during bad weather. JetBlue Airlines is also testing a new ADS-B operational procedure in the Gulf of Mexico that allows flights between Miami and San Francisco to be rerouted to avoid bad weather, reduce flight time, and save fuel.

However, FAA estimates that only 3 percent of major air carriers and 10 percent of general aviation users will be equipped with ADS-B avionics by the end of fiscal year 2014. Further, ADS-B's current capabilities are limited. For example, while properly equipped general aviation users can receive weather and other traffic information to improve their situational awareness using ADS-B broadcast services—that is, awareness of their current location and the location of other nearby aircraft—FAA notes that these services are for "advisory use only." In other words, pilots should not and cannot rely on ADS-B information to separate themselves from and avoid other aircraft.

Despite this warning, FAA's outreach may not be sufficient to ensure pilots use ADS-B's broadcast services appropriately. According to the Aircraft Owners and Pilots Association (AOPA), some general aviation pilots are unaware of ADS-B's limitations and how these services can and should be used. For example, pilots relying on ADS-B data have reported that they inadvertently flew their aircraft

into restricted airspace that was either unmarked or incorrectly located on their ADS-B devices. Subsequently, FAA cited these pilots with violations. Based on a limited review of the National Aeronautics and Space Administration's (NASA) Aviation Safety Reporting System,[19] we found eight incident reports filed by pilots from August 2012 through May 2013 that identified some type of issue relating to *ADS-B Out* advisory services (see exhibit D). Concerns such as these not only suggest significant safety risks, but could degrade users' confidence in the system and the industry's willingness to invest.

Major air carriers have been especially reluctant to invest in ADS-B's costly avionics because they currently have little, if any, benefits for them. While major carriers typically take off and land in the NAS's most crowded airspaces—and, therefore, have the most to gain from ADS-B's expected benefits—the airline industry's on-board weather radar, electronic flight information systems, and collision avoidance systems provide the same information that ADS-B broadcast services currently offer. As the program advances, FAA expects ADS-B to provide major carriers with more benefits. For example, FAA expects *ADS-B Out* will eventually provide "radar-like" separation services for airlines. Coupled with new automation for air traffic control management, this could allow for more efficient merging and spacing of aircraft within existing separation standards and improve the detection of conflicts between aircraft. However, FAA has not fully quantified these projected ADS-B benefits or determined how to use new procedures to enhance airspace capacity and reduce delays. Without this information, air carriers will likely remain reluctant to invest in ADS-B.

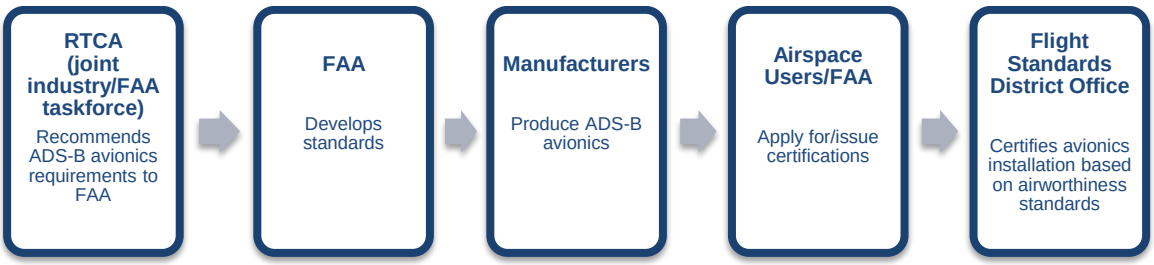
FAA's Certification Process for ADS-B Avionics Is Lengthy and Lacks Sufficient Oversight

Before users can equip with ADS-B avionics, FAA must certify the avionics design as well as its manufacturing and installation process (see figure 2). According to industry stakeholders, certification of avionics design and manufacturing process has been time-consuming. For example, FAA did not approve the proposed manufacturing design for *ADS-B Out* avionics until 2012—3 years after it approved the system's minimum operating standards. The avionics manufacturers we spoke with agreed that FAA can take from 3 to 5 years to approve the avionics' design and manufacturing process. In addition, FAA must approve any modifications that aircraft operators make to ensure the certified avionics work with their aircraft's unique requirements and design features, and FAA must also approve operators' installation of the avionics.[20] This additional certification often takes 18 months or more.

[19] NASA's ASRS database is the world's largest repository of voluntary, confidential safety information provided by aviation's frontline personnel, including pilots, controllers, mechanics, flight attendants, and dispatchers.

[20] This refers to the Supplemental Type Certification (STC) process that allows users to make modifications and install new equipment onto their specific aircraft type and configuration.

Figure 2. ADS-B Avionics Certification Process



Source: FAA

Since the final rule on ADS-B was published in 2010, FAA has begun certifying and approving *ADS-B Out* avionics design and installation based on the performance standards established in the rule. However, the size of the ADS-B effort is significant—FAA estimates that about 18,000 commercial and 223,000 general aviation aircraft will be impacted—and as more and more airspace users begin to modify their aircraft and install new ADS-B avionics to meet FAA's 2020 mandate, FAA will be challenged to maintain sufficient oversight of the industry.

FAA certification and flight standards officials have already identified problems that could hinder the airline industry's efforts to meet FAA's mandate. Notably, these officials raised concerns about regional inspectors' understanding of FAA's certification and installation policy, and that a lack of understanding has led to poor implementation. For example, FAA headquarters officials discovered that a regional office approved the installation of ADS-B avionics on as many as 40 of an operator's aircraft, only to learn that the avionics had not been certified. Airline industry officials have similarly raised concerns about meeting FAA's 2020 mandate. Specifically, these officials noted that (1) rule-compliant avionics are just becoming available and are in short supply, (2) the aircraft repair and avionics industry may not be able to handle the capacity of ADS-B modifications and installations, (3) compatibility issues between ADS-B and existing on-board GPS and navigation systems may require avionics replacements, and (4) long-term agreements that some airlines have entered into with specific avionics manufacturers may create legal conflicts.

These delays and setbacks make the airline industry's required financial investment in ADS-B potentially even more costly. FAA currently estimates that it will cost all airspace users about $4 billion to purchase and install new rule-compliant *ADS-B Out* avionics. However, these estimates generally exclude costs related to certification delays and technical errors, as well as costs associated with taking aircraft out of service for the avionics installation.

Requirements for *ADS-B In's* Advanced Capabilities Continue to Evolve

Most NextGen benefits and new air-to-air surveillance capabilities rely on *ADS-B In* and the cockpit display of the information *ADS-B In* generates. However, significant development and operational testing of this new technology remain before users can obtain these benefits. Furthermore, FAA's 2010 decision to adopt less stringent performance requirements for *ADS-B Out* may further hinder progress in achieving *ADS-B In* benefits because the more advanced elements of *ADS-B In* may require changes to the air and ground components of the system.

At its most basic level, *ADS-B In* is designed to enhance a flight crew's situational awareness of nearby aircraft. For the near term, FAA is focusing on capabilities that allow pilots to maintain visual separation between aircraft in generally good weather conditions. Future and more beneficial advanced *ADS-B In* applications are expected to provide for operations on more closely spaced parallel runways and air routes, and allow for advanced in-flight maneuvers such as aircraft crossing and passing one another. These applications could boost airport arrival rates.

The initial near-term *ADS-B In* capabilities that FAA is pursuing are consistent with recommendations made by several aviation rulemaking committees (ARC). For example, FAA is currently defining requirements for the Flight Deck Based Interval Management and Spacing System—a new system expected to help pilots maintain proper spacing between flights during routine operations in good to marginal weather without changing the roles of pilots or controllers. FAA is also developing new procedures for allowing properly equipped aircraft with trained flight crews to climb and descend through various flight levels over the ocean. FAA chose these capabilities, in part, because they are not expected to require changes to ADS-B's air and ground components.

However, operational and procedural issues have challenged FAA's efforts to fully define and stabilize the requirements for *ADS-B In's* more advanced capabilities. For example, a 2011 ARC report stated that FAA's *ADS-B In* policies and equipment standards for certification, operational approval, and ground automation were inadequate for an investment decision.[21] These shortcomings remain and complicate FAA's rulemaking efforts—a process that the FAA Modernization and Reform Act of 2012 directed FAA to complete over the next several years, with the goal of mandating *ADS-B In* equipage on aircraft operating in capacity constrained airspace by 2020. While it remains unknown when FAA will stabilize *ADS-B In's* requirements—or fully define its costs and benefits—it is unlikely that FAA will be in position to mandate *ADS-B In* equipage in the

[21] *A Report from the ADS–B In Aviation Rulemaking Committee to the Federal Aviation Administration*, Sept. 30, 2011.

foreseeable future given the complexity of the challenges that need to be addressed.

The September 2011 ARC report also cautioned that plans for *ADS-B In* are not effectively linked to other NextGen efforts that require industry investment, such as data link communications for pilots and controllers—which will impact *ADS-B In* capabilities. The report further stated that airspace users need a better understanding of the interdependencies among NextGen technologies and whether benefits increase if technologies are bundled together. In response, FAA is exploring how these various technologies for communication, navigation, and surveillance can be bundled in specific 5- to 7-year timeframes.

FAA Has Partnered With Airlines To Demonstrate ADS-B Capabilities and Potential Benefits

FAA has entered into agreements with several U.S. airlines to develop and demonstrate *ADS-B In* applications and procedures—a necessary step given the many unknowns with developing the new cockpit technology. As part of these agreements, FAA is providing funding to each airline for purchasing and installing ADS-B avionics.[22]

The demonstration projects cover a variety of ADS-B's planned capabilities. For example, US Airways installed *ADS-B Out* and *In* avionics and cockpit display equipment[23] in its Airbus A330 aircraft to assess (1) the use of cockpit displays in maintaining proper spacing between aircraft on arrivals and (2) in-trail procedures for oceanic routes, which allow airplanes to move to optimal operational altitudes. Similarly, FAA has partnered with United Airlines to equip 110 aircraft with *ADS-B Out* avionics by 2017 to demonstrate the potential benefits of using *ADS-B* in the Gulf of Mexico to reduce separation between high-altitude aircraft in non-radar airspace from 120 to 5 nautical miles. Table 1 shows the status of FAA's demonstration projects and the types of capabilities carriers are pursuing.

[22] FAA has funded approximately $49 million to date on the demonstration projects.

[23] As part of the agreement FAA paid US Airways to install rule-compliant *ADS-B Out and In* avionics, Class 3 electronic flight bags, and software suites in 20 of their Airbus A330 aircraft to participate in the demonstration program.

Table 1. Carrier Status of ADS-B by Demonstration Project

In-Trail Procedures: Enables ADS-B equipped aircraft to climb or descend through altitudes where current non-ADS-B separation standards would prevent desired altitude changes.	
United	• Aircraft and operators guidance has been complete • Plans to upgrade 12 aircraft to ADS-B rule-compliant avionics in 2015
US Airways	• Aircraft and operators guidance has been complete
Merging and Spacing: Allows pilots and air traffic controllers to achieve and maintain desired spacing between aircraft.	
US Airways	• Plans to upgrade 20 aircraft
UPS	• Plans to remove some of the ADS-B demonstration equipment by 2014 and end participation
Cockpit Display of Traffic Information Assisted Visual Separation: Provides pilots a cockpit display of ADS-B information improving their awareness of other traffic.	
US Airways	• Aircraft and operator guidance completed for airborne and ground use of Cockpit Display of Traffic Information
Flight Interval Management Spacing: Enables flight crews to establish and maintain precise spacing relative to a preceding aircraft, which provides additional fuel savings and optimized descent opportunities.	
US Airways	• Avionics standards for the flight deck capability are scheduled to be completed in 2014
East Coast Routes: Allows aircraft to fly in two major routes off the East Coast in the event that typical radar coverage is not available.	
Jet Blue	• Under development; 35 aircraft have been equipped to fly in two major routes off the East Coast
High Altitude Separation Reduction for Gulf of Mexico and East Coast Routes: Demonstrates the potential to accrue benefits in revenue service in the Gulf of Mexico and along East Coast offshore routes by reducing separation from 120 nautical miles (10 to 15 minutes in trail) to 5 nautical miles in non-radar airspace using ADS-B.	
United	• Plans to equip 110 aircraft by 2017, with another 136 to follow in later years.

Source: FAA

These demonstration projects should enhance FAA's ability to better define ADS-B requirements, determine whether the system will operate as intended, and achieve desired goals. For the near-term, however, only those airlines and aircraft participating in the project and funded by FAA will benefit. FAA does not expect all elements of the current demonstrations to be completed until 2017 or later.

ADS-B OVERALL COSTS, SCHEDULE, AND BENEFITS REMAIN UNCERTAIN AS FAA CONTINUES PROGRAM IMPLEMENTATION

The final cost and timeline to complete ADS-B implementation and provide benefits for FAA and airspace users remain uncertain. FAA's cost and schedule continue to evolve; for example, FAA has increased its cost estimates for the

program by approximately $400 million since the original baseline estimate. Additionally, FAA has approved funds to pay the contractor to broadcast ADS-B signals at locations that may not be using them, resulting in some potentially unnecessary costs. Finally, FAA continues to adjust expected ADS-B benefits due to slower than expected user equipage, and the costs for the current ADS-B program now outweigh the potential benefits to users.

FAA's Total Estimated Costs To Fully Implement ADS-B Exceed Original Estimates

According to FAA, the Agency is funding ADS-B through a segmented approach to reduce the risk of cost growth and schedule delays, with each segment funded for a set timeframe. In August 2007, FAA approved $1.68 billion for ADS-B segments 1 and 2 to deploy the system's ground infrastructure by 2013 and implement the initial baseline services and applications by 2014.[24] Five years later, in May 2012, FAA approved an additional $960 million for a third ADS-B segment to continue implementing the initial capabilities, which increased the total cost to $2.7 billion through 2020.[25] While FAA originally reported the Agency was planning to complete ADS-B implementation in four segments, it is currently unclear how many segments will be required before ADS-B is fully implemented and at what cost.

According to ADS-B program officials and our analyses, the increase in estimated costs for FAA to implement ADS-B baseline services and applications is due to changes in the program's scope and requirements. For example:

- FAA required an additional $100 million for ground infrastructure upgrades to support ADS-B rule-compliant avionics and to enhance security.
- FAA did not fully capture costs to acquire ADS-B services at nine additional airports in the original estimate, resulting in an increase to the cost of $116 million.
- FAA added $162 million to budget for the potential of maximum performance incentives for the prime contractor through 2025. These incentives will be paid via a percentage (up to 7 percent) of contractor fees for ADS-B.

[24] In fiscal year 2008, Congress provided an additional $9.3 million to conduct demonstrations with select industry partners to assess ADS-B's capability to provide position indications and alerts to aircraft operating on the airport surface. Additionally, in fiscal year 2009 Congress provided another $6.8 million to assess ADS-B's ability to provide 3-nautical-mile separation standards in the en route (high altitude) environment, as well as $13.6 million in funds to incorporate ADS-B services in Colorado.

[25] This increase includes FAA's plans to spend $58 million for efforts to expand ADS-B services in the Gulf of Mexico and to implement an *ADS-B In* application—designated as In Trail Procedures—which uses ADS-B to improve situational awareness of flight crews and enables them to perform desired flight level changes on a more frequent basis in oceanic or non-radar airspace.

- FAA underestimated the cost to upgrade FAA's air traffic control automation platforms at the five ADS-B key sites, more than doubling the estimated cost from about $131 million to over $300 million.

Table 2 lists FAA's approved funding for key program activities supporting ADS-B implementation through 2020 and demonstrates how FAA has added costs to complete these key activities.

Table 2. ADS-B Estimated Costs for Key Program Activities (Dollars in Millions)

Key Program Activities Supporting ADS-B Implementation	2007 Baseline Segments 1 and 2 FY 2007-2014	2012 Baseline Segment 3 FY 2014-2020	Total
Ground infrastructure development and upgrades	$707.9	$19.4	$727.3
Upgrades to FAA automation platforms	305.0	5.6	310.6
Avionics development, testing, and certification for *ADS-B Out* and *ADS-B In*	45.7	1.3	47.0
Operational procedures development and implementation supporting *ADS-B Out* and *ADS-B In* services and applications	40.7	172.8	213.5
Subtotal	**$1,099.3**	**$199.1**	**$1,298.4**
Service Subscription Charges	612.1	761.3	1,373.4
Total	**$1,711.4**[a]	**$960.4**	**$2,671.8**

[a] FAA approved $1.68 billion in 2007, and added $30 million in 2011, increasing the total to $1.71 billion.
Source: FAA Program Office

When FAA baselined segment 3, the Agency also updated its estimate for ADS-B's total program costs. Currently, FAA estimates that, through fiscal year 2035, the program will cost $4.5 billion—which includes an increase of $400 million more in baseline services than it estimated in 2007. However, ongoing adjustments to key program activities raise questions about the reliability of FAA's $4.5 billion total estimate for the program. As we previously reported, FAA's decision to identify and baseline segments of ADS-B's development and implementation as the system matures leaves the Agency with no clear end-state.[26] Further, this approach has allowed the Agency to modify the program's scope and requirements, which increases the risk of future cost and schedule growth.

[26] *Status of Transformational Programs and Risks To Achieving NextGen Goals* (OIG Report Number AV-2012-094), April 23, 2012.

FAA May Be Paying for ADS-B Services That Are Not Being Used

A large percentage of FAA's current ADS-B costs may be for services that are not yet being used. Specifically, FAA is paying contractor fees to maintain and broadcast the ADS-B signal, known as service subscription fees. Through 2014, FAA will have paid the prime contractor over $600 million in service subscription fees. However, because the rate of user equipage has been lower than the Agency originally projected, controller and pilot use of ADS-B services has also been lower than expected. Moreover, the Agency does not plan to update all controller automation systems to support ADS-B services until 2015 and possibly as late as 2019.

While FAA acknowledges ADS-B use has been and will continue to be limited, the Agency plans to pay the contractor to maintain and broadcast ADS-B surveillance services in the contiguous United States, Alaska, and the Gulf of Mexico in the terminal and en route environments, as well as at 44 airports—regardless of whether services are being used at all locations. However, the ADS-B contract contains an option that provides the Agency with the flexibility not to turn on ADS-B services in locations where there are insufficient users. Through 2020, FAA approved an additional $760 million in subscription fees increasing the total to almost $1.4 billion—or 51 percent of the total costs FAA approved to support ADS-B implementation. FAA plans to pay about $90 million each year for ADS-B broadcast services, but could potentially save as much as $45 million per year if it only pays for services at locations with updated automation systems, and where users are equipped to use them.[27]

Current Cost Estimates for ADS-B Outweigh Its Benefits

To demonstrate that the benefits of ADS-B avionics outweigh the costs—and thereby encourage users to equip with these avionics by 2020—FAA generally conducts a benefit-cost ratio analysis.[28] However, ADS-B's costs now outweigh its estimated benefits.

In 2007, FAA estimated ADS-B benefits for FAA and users would total roughly $7 billion[29] through 2035. However, in 2012, FAA revised the estimate and now reports that the ADS-B benefits will total about $5.9 billion from 2007 to 2035. According to FAA, this reduction is due in part to the fact that users are not purchasing and equipping with ADS-B avionics as quickly as the Agency originally projected. Table 3 highlights the changes in projections for FAA and user benefits, with all dollars converted to present value 2012 dollars.

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[27] FAA can realize these savings until at least 50 percent of its automation systems have been updated and users equip.

[28] The benefit-cost ratio is determined by dividing the projected benefits of a program by the projected costs. A benefit-cost ratio is a standard criterion for deciding whether a program should go forward. A ratio of greater than 1 indicates the program is viable.

[29] Total benefits are adjusted to reflect present value 2012 dollars.

Table 3. Variances in FAA and User Benefits for ADS-B Baseline Services and Applications (Dollars in Millions)

	Aug 2007[a]	May 2012[a]	Variance
FAA Benefits			
Cost avoidance	$633.5	$413.0	($220.5)
Total FAA Benefits	**$633.5**	**$413.0**	**($220.5)**
User Benefits			
Safety	$1,797.5	$2,073.2	$275.7
Aircraft operator cost savings	2,962.7	1,720.4	(1,242.3)
Passenger value of time	1,643.1	1,643.4	0.3
Other benefits	36.5	36.6	0.1
Total User Benefits	**$6,439.8**	**$5,473.6**	**($966.2)**
Total Benefits	**$7,073.3**	**$5,886.6**	**($1,186.7)**

[a] Numbers are estimated in present value 2012 dollars.
Source: ADS-B Business Manager

While FAA's cost analysis indicates a positive benefit-cost ratio of 1.2, it does not factor in program investments made through fiscal year 2013. When factoring in these sunk costs, the return on investment drops below 1 (see table 4).

Table 4. ADS-B Risk-Adjusted Cost and Benefits in Present Value Dollars

	Without Sunk Costs	With Sunk Costs
Costs	$4,766.5	$6,577.1
Benefits	5,667.8	5,989.5
Net Cash Flow	901.3	(587.6)
Benefit/Cost Ratio	1.2	(0.9)
Payback	2032	NA[a]

[a] FAA will not recoup its capital investment through ADS-B third segment.
Source: FAA May 2012 SBS Business Case Analysis Report (BCAR)

According to FAA, future ADS-B capabilities will increase the estimated benefits and restore a positive benefit-cost ratio for the program. For example, the Agency is pursuing approval for additional *ADS-B In* applications per the ARC recommendations. FAA is also investigating a different service provider for ADS-B to obtain surveillance services specifically in oceanic airspace. FAA officials expect that these additional applications could significantly increase the benefit-cost ratio and result in a positive net present value of $1 billion or more when future segments of the ADS-B program are approved—improving the

overall business case for ADS-B. However, it is uncertain when future segments will be approved and how much they will ultimately affect ADS-B's cost-benefit ratio.

CONCLUSION

ADS-B is expected to improve safety, capacity, and efficiency in the NAS. Although FAA has made progress by completing the ground infrastructure, the Agency has yet to determine what the program will cost, how long it will take to fully implement, or what capabilities and benefits the system will ultimately provide air traffic controllers and pilots. Until FAA conducts comprehensive testing of ADS-B's overall performance, determines how it will be used to support new capabilities for managing air traffic in complex and congested airspace, and establishes future baselines for the total program, the Agency may not be able to fully justify taxpayers' and users' investment in ADS-B.

RECOMMENDATIONS

To ensure ADS-B is operationally suitable, safe to deploy in the NAS, and a viable program, we recommend that FAA continue to work on our previous recommendations and take additional actions to:

1. Resolve performance problems identified during FAA's independent operational testing on ADS-B. Also, conduct end-to-end testing of the ADS-B system to determine how it can be used by controllers and pilots to safely manage and separate traffic in the NAS during all phases of flight.

2. Develop a schedule and plan to expedite the continued development and deployment of SBS Monitor and ensure that the system is adequately staffed and funded so it can effectively access the performance and integrity of the ADS-B system now and as it evolves.

3. Develop and implement a plan to improve communications with the aviation community to ensure it understands the intended use of ADS-B services and applications being provided, including that ADS-B initial capabilities are for advisory use only.

4. Determine when FAA will be in a position to introduce and support *ADS-B In* capabilities for congested airports, and identify the changes that may be required for ADS-B ground and air components for using advanced *ADS-B In* capabilities.

5. Develop a clearly defined and expedited schedule for determining the end-state for the ADS-B program with cost and schedule baselines, and provide written notification to Congress and other decision makers so that they have more complete information on the total program cost, schedule, and expected services.

6. Determine whether cost savings could be realized by delaying payment of subscription fees for ADS-B services at locations where (a) users are not equipped with rule-compliant avionics to provide and receive ADS-B services at those locations, and (b) air traffic control automation systems have not been modernized to support ADS-B services.

AGENCY COMMENTS AND OFFICE OF INSPECTOR GENERAL RESPONSE

We provided FAA with our draft report on July 28, 2014, and received the Agency's formal response on August 22, 2014. FAA's response is included in its entirety as an appendix to this report. In its response, FAA stated that it generally concurs with our recommendations, with the exception of recommendation 6. However, FAA did not provide specific information on all of its planned actions or completion dates as requested in our draft report. The Agency stated it will provide a detailed response to each recommendation at a later date. Therefore, recommendations 1, 2, 3, 4, and 5, will remain open and unresolved, until FAA provides further information on its planned actions and completion timeframes.

For recommendation 6, FAA stated it does not concur because the ADS-B contract does not allow for selective payment or shutdown of selective service volumes.[30] However, as stated in our report, the contract specifically contains an option that provides FAA with the flexibility to selectively activate ADS-B services at specific locations. As we reported, this contract option could have the potential to save the Agency a significant amount of funds until ADS-B is in widespread use at all locations in the NAS. Therefore, we ask that the Agency reconsider its position on this recommendation.

ACTIONS REQUIRED

We consider all six recommendations open and unresolved and, in accordance with DOT Order 8000.1C, we request that FAA provide, within 30 days of this report, the additional information requested above.

[30] Service volumes are essentially locations (e.g., en route facilities) within which a set of ADS-B Services are provided.

We appreciate the courtesies and cooperation of FAA representatives during this audit. If you have any questions concerning this report, please call me at (202) 366-0500 or Kevin Dorsey, Program Director, at (202) 366-1518.

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cc: DOT Audit Liaison, M-1
FAA Audit Liaison, AAE-100

EXHIBIT A. SCOPE AND METHODOLOGY

We conducted this performance audit between May 2012 and July 2014. The audit was performed in accordance with generally accepted Government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

At the request of the Chairman and Ranking Member of the House Committee on Appropriations, Subcommittee on Transportation, Housing and Urban Development and Related Agencies, we examined FAA's plans and progress to date for implementing ADS-B. Specifically, our objectives were to assess (1) FAA's progress deploying and testing the ADS-B ground system, (2) the capabilities and benefits ADS-B will provide users; and (3) ADS-B current cost, schedule, and planned benefits as measured against the original program goals.

To achieve our objectives, we analyzed program documentation, contract data, budget data, acquisition documents, cost and schedule documents, and other documentation provided by FAA, to include reviewing FAA's ADS-B budget and cost estimates and ADS-B strategy documents for reasonableness and cost effectiveness.

In addition, we interviewed key FAA and ADS-B program officials at FAA Headquarters in Washington, DC, and the FAA William J. Hughes Technical Center in New Jersey, and FAA's Mike Monroney Aeronautical Center in Oklahoma City. We also met with and interviewed industry officials, airline representatives, avionics manufacturers, and other stakeholders. We interviewed and visited ITT Corporation officials to discuss the status of the system's development, installation, and implementation and air traffic controllers at various facilities across the country, industry officials, avionics manufacturers, and aviation stakeholders. We also visited and interviewed helicopter operators in the Gulf of Mexico and met with ADS-B demonstration partner airline representatives.

EXHIBIT B. *ADS-B OUT* AND *ADS-B IN* APPLICATIONS AND THEIR STATUS AS OF APRIL 2014

Description	Goal	Status as of April 2014
ADS-B Out Services		
ATC Surveillance Requires aircraft and vehicles on the airport surface to equip with ADS-B to broadcast their identification and position to Air Traffic Control (ATC) automation systems.	To improve safety and increase capacity by allowing ATC to use ADS-B to assist pilots with navigation, aircraft, separation, and to issue safety alerts and traffic advisories.	Available to controllers at limited air traffic locations and pilots if users are equipped.
Ground-Based Interval Management Spacing (GIM-S) Planned capability for ATC En Route centers. Automation systems are updated with spacing and metering tool, using ADS-B for optimized profile descents.	To achieve optimal spacing intervals between arriving aircraft.	In development, testing schedule at key site in July 2014. Could be available at first site in September 2014.
ADS-B In Applications		
Traffic Situation Awareness—Basic: Flight crews will use cockpit displays to increase awareness of other aircraft within operational vicinity	To enhance pilots' awareness of other aircraft.	Available to pilots if properly equipped with *ADS-B In* avionics.
Airport Traffic Situation Awareness (ATSA): Flight crews will use cockpit displays to increase awareness of other aircraft/vehicle on the airport surface.	To reduce the potential for aircraft and surface vehicle deviations, errors, &collisions.	Limited availability. Air traffic procedures are required.
Visual Separation on Approach: Allows aircraft to perform approach procedures with its own visual separation from preceding aircraft.	To assist the flight crew with achieving and maintaining visual contact with relevant traffic and maintaining appropriate distance from the aircraft ahead of it.	Not available. Air traffic procedures required.
Cockpit Display of Traffic Information Assisted Visual Separation (CAVS): Provides pilots a cockpit display of ADS-B information improving awareness of other traffic.	To enable pilots to determine and maintain safe separation, just as in visual separation.	Not available. Air traffic procedures are required.
Traffic Situation Awareness with Alerts (TSAA): Provides alerts to General Aviation pilots of conflicting airborne traffic.	Reduce the risk of airborne-to-airborne encounters.	Not available. FAA is developing performance standards for operational use.
Weather and NAS Situation Awareness: Provides weather and other aeronautical information to GA pilots.	Enhanced weather information for GA pilots.	Available to pilots if users are equipped.

Source: FAA

Exhibit B. ADS-B OUT and ADS-B In Applications and Their Status as of April 2014

EXHIBIT C. ADS-B IOT&E AND IOA ASSESSMENTS

Location, Date	System	ADS-B Hazard Examples
Preliminary IOT&E		
Houston Mar. 19, 2010	Host Computer System (replaced by ERAM)	• Aircraft targets dropped or not displayed • Partial loss of service due to unscheduled radio station outages • Service processes not clearly defined
Philadelphia May 14, 2010	STARS	• Reinforcement lost, acquired late, or never acquired • Frequent radio station outage • Limited G1 hardware capacity to process data
Alaska Center June 18, 2010	Wide Area Multilateration, ADS-B/MEARTS	• Outages to primary power sources • WAM service availability • Required operational range of ZAN Sector 8 display causes targets to overlap with SV-178
Louisville July 16, 2010	CARTS IIIE	• Reinforcement lost, acquired late, or never acquired • Target jumps; multiple split targets generated conflict alerts
Combined IOT&E		
Key Sites Sept.10, 2010	Integrated Platforms	• ADS-B/ARTS IIIE integrated platform not operationally ready at terminal facilities with ADS-B–only coverage areas • ADS-B/ARTS IIIE fusion tracker integration not operationally ready for ARTS IIIE terminal facilities • ADS-B/STARS integrated platform not operationally ready for terminal facilities (a) with ADS-B-only coverage areas or (b) that do not and will not rely solely on ADS-B for surveillance • An operational readiness assessment not required at Houston because the ADS-B/Host integrated platform will remain an IOC and not be deployed to another facility • ADS-B/MEARTS data insufficient to render an operational readiness assessment • Insufficient number of equipped aircraft to assess
IOA Follow-Up		
Philadelphia, Houston Terminal facilities November 28, 2012	STARS	• Target jumps at I90 (Houston) • Conflict alerts longer than actual conflict (Houston) • Limited G1 hardware capacity to process data • Insufficient number of equipped aircraft to assess
Early IOA		
Houston Center March 1, 2013	ERAM	• Radio station status messages and indicators not indicative of coverage • Lack of communication coverage for some surveillance areas could result in reduced ATC services • Incomplete or inaccurate call signs are displayed on the Main Display Monitor for some Visual Flight Rules aircraft • Insufficient number of equipped aircraft to assess

Source: FAA Independent Operational Test and Evaluation and Independent Operational Assessment Reports

EXHIBIT D. GENERAL AVIATION PILOT REPORTS OF ADS-B RELIABILITY AND ACCURACY ISSUES

Timeframe	Pilot Synopsis
August 2012	Cessna 182 Skylane pilot reports being intercepted by an F16 south of Chicago then informed after landing that he had flown through a Temporary Flight Restriction[31] (TFR) that was shown as expired on his GPS display. Cessna 210 pilot reports inadvertently entering a TFR which apparently moved from its original Notice to Airman position and did not appear on an iPad using Stratus *ADS-B In*. Cessna 172 Skyhawk instructor with student reports being advised of traffic close behind during approach by ADS-B and elects to perform a go-around. The traffic behind had been cleared for a low approach and apparently had the reporter in sight.
September 2012	Cessna 182 Skylane pilot reports inadvertently entering a TFR established for an air show that was not published as a Notice to Airman and did not appear on an iPad with ADS-B. Houston I90 TRACON Controller voiced concern regarding the weather availability on the STARS displays. The reporter suggested the possibility of displaying ADS-B weather information on the STARS displays.
November 2012	Cleveland TRACON Controller described a loss of separation event, claiming the new "Fusion" radar software sometimes displays inaccurate ground speeds.
December 2012	Two aircraft departed Prescott Arizona, Ernest A. Love Field, Runway 21L in good weather, and one mile apart. The pilots reported that they had a near miss because air traffic control cleared the lead aircraft, then in a left turn, to make a spacing turn resulting in that aircraft turning directly into the second aircraft.
January 2013	A Raleigh-Durham Airport Controller described a developing conflict when radar targets were not accurately tracking, suggesting the FUSED/ADS-B radar was causing the anomaly.

Source: NASA's ARSR Database

[31] Temporary Flight Restrictions (TFRs): TFR text and graphic reports, prescribes procedures used to obtain, format, and disseminate information on unanticipated or temporary changes to components of or hazards in the NAS until the associated aeronautical charts and related publications have been amended.

EXHIBIT E. MAJOR CONTRIBUTORS TO THIS REPORT

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Federal Aviation Administration

Memorandum

Date: August 22, 2014

To: Matthew E. Hampton, Assistant Inspector General for Aviation Audits

From: H. Clayton Foushee, Director, Office of Audit and Evaluation, AAE-1

Subject: Federal Aviation Administration's Response to Office of Inspector General Draft Report: ADS-B Benefits Are Limited Due to a Lack of Advanced Capabilities and Delays in User Equipage

The Federal Aviation Administration (FAA) recently achieved a major milestone by completing the ADS-B ground station infrastructure nationwide and ahead of schedule. The implementation of services at the 24 enroute and offshore sites, 159 terminal sites, and 44 surface advisory sites is also progressing on schedule. As implementation progresses in more areas, culminating in nationwide coverage, controllers will be able to accommodate increasingly greater traffic volumes, delays will be significantly reduced, and significant fuel savings and accompanying environmental benefits will be achieved.

The FAA has reviewed the draft report and offers the following comments in response to the Office of Inspector General's findings and recommendations:

- Surveillance and Broadcast Services (SBS) monitor development and deployment is planned. In addition, the program has asked an independent party to conduct an assessment of recent outages.
- The Agency is always working to make further improvements, current outreach activities provide communications with the aviation community to ensure that it understands the intended use of ADS-B services and applications being provided.
- The FAA has increased the availability of service and expanded coverage, as planned in the baseline. The dependency upon avionics is driven by the timetables established in the rule on mandatory equipage, and more benefits would be apparent if operators chose to equip early. The FAA cannot require operators to equip until 2020.
- ADS-B cost and schedule baselines will be revisited periodically as the program returns to the Joint Resources Council as each baseline segment expires.

Upon preliminary review of the draft report, the FAA generally concurs with most of the recommendations except number six. The FAA does not concur with this recommendation because the contract does not allow for selective payment or shutdown of selective service

volumes at the locations suggested and based upon aircraft equipment. The FAA's Service Contract does afford us the opportunity to consider modification of service volumes and availability to fit any evolving need of the agency. The Agency will provide a detailed response to each recommendation after the publication of the final report.

We appreciate this opportunity to offer additional perspective on the OIG draft report. Please contact H. Clayton Foushee at (202) 267-9000 if you have any questions or required additional information about these comments.