FAA NEEDS TO RESET EXPECTATIONS FOR LAAS BECAUSE CONSIDERABLE WORK IS REQUIRED BEFORE IT CAN BE DEPLOYED FOR OPERATIONAL USE

Federal Aviation Administration

Report Number: AV-2003-006
Date Issued: December 16, 2002

Memorandum

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

Subject: ACTION: FAA Needs to Reset Expectations for LAAS Because Considerable Work Is Required Before It Can Be Deployed for Operational Use AV-2003-006

Date: December 16, 2002

From: Alexis M. Stefani
Principal Assistant Inspector General for Auditing and Evaluation

Reply to Attn. of: JA-10

To: Federal Aviation Administrator

This report presents the results of our audit on the progress to date with the development and deployment of the Federal Aviation Administration's (FAA) Local Area Augmentation System (LAAS). Our objectives were to determine program costs, schedule and risk, and explore key issues affecting the successful development and deployment of LAAS.

LAAS is a precision approach and landing system that relies on the Global Positioning System to broadcast highly accurate information to aircraft on the final phases of flight. This new system enjoys considerable industry support and is intended to play an important role in FAA's Operational Evolution Plan, which represents the agency's blueprint for enhancing the capacity of the National Airspace System over the next decade.

Specifically, LAAS is expected to enhance airport capacity by increasing the number of aircraft that can land under all weather conditions and provide for more flexible approaches to airports. In addition, LAAS is considered by FAA and industry to be an enabling technology[1] for reducing accidents and incidents on airport runways and taxiways. However, LAAS is not the same program that was planned 3 years ago, and it is time to reset expectations for LAAS with respect to when new landing systems can be delivered, how much the effort will cost, and what benefits can be obtained.

[1] LAAS is an enabling technology because it can provide highly accurate and reliable inputs to other technologies such as Automatic Dependent Surveillance-Broadcast and in-cockpit moving maps.

We periodically discussed this report with FAA's Associate Administrator for Research and Acquisitions as well as other program officials, and their comments have been incorporated as appropriate. In preparing this report we considered FAA's November 19, 2002 comments to our October 3, 2002 discussion draft report.

The Associate Administrator for Research and Acquisitions stated that our draft report was useful and timely because it raised critical questions that will directly affect the overall cost and schedule of LAAS and how the system will be certified as safe for pilots to use. FAA delayed awarding a contract for LAAS and has promised to take actions to address our concerns.

FAA now intends to award a development contract for LAAS Category (CAT) I in the next several months. FAA is also restructuring the developmental portion of the contract to help ensure that all design work, particularly the system integrity design, is successfully completed before any software coding or hardware procurements can commence. In addition, FAA agreed with our recommendation to limit LAAS production (beyond the six systems currently planned) until integrity issues are successfully resolved and one system has been certified as safe for pilots to use. FAA stated that the Joint Resources Council—a key agency decision making body for acquisitions—will make a decision on how to proceed with LAAS before exercising options for additional systems.

Although FAA concurred with our recommendation to determine the right skill mix to manage LAAS and resolve questions about integrity, the agency's proposed action does not address the intent of our recommendation. FAA officials stated that they have had a LAAS Integrity Panel in place since 1996. We agree, but point out that FAA has not formally tasked the panel to work on the LAAS CAT I acquisition to examine integrity issues. This panel needs to be invigorated to help prevent past problems with other modernization efforts. We request that FAA provide a target date for tasking the panel to begin working on the CAT I acquisition.

FAA partially agreed with our recommendation to initiate quarterly reports to Congress and report additional information on LAAS pertaining to, among other things, updated cost and schedule baselines, the status of CAT II/III research and development efforts, progress in resolving integrity concerns, and changes to LAAS requirements. FAA stated it will provide an end-of-the-year LAAS status report to Congress that addresses the LAAS efforts in the fiscal year 2002 LAAS appropriation language. However, LAAS program officials also indicated they will provide the FAA Administrator with quarterly status reports that addresses the areas identified in our recommendation. We believe providing the reports to the FAA Administrator with additional information (cost and schedule and progress

on resolving integrity concerns) are an important step and address the intent of our recommendation.

In accordance with Department of Transportation Order 8000.1C, we request that FAA provide target dates for completing actions in response to our recommendation regarding the skill mix to manage LAAS and address concerns about integrity. Please provide your revised response addressing our concerns within 30 days.

We appreciate the courtesies and cooperation provided by your staff during the review.

#

Executive Summary

FAA Needs to Reset Expectations for LAAS Because Considerable Work Is Required Before It Can Be Deployed for Operational Use

Federal Aviation Administration

Report No. AV-2003-006 **December 16, 2002**

OBJECTIVES

The objectives of the audit were to determine program costs, schedule and risk, and explore key issues affecting the successful development and deployment of the Local Area Augmentation System (LAAS).

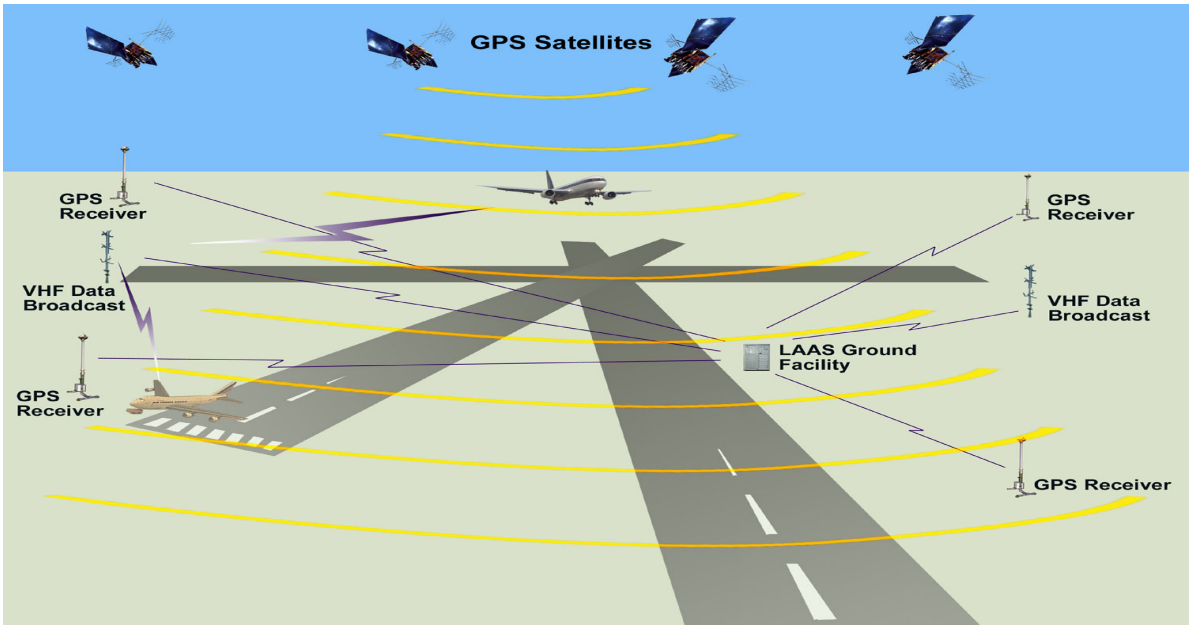
BACKGROUND

LAAS is a key initiative in the Federal Aviation Administration's (FAA) plans to transition away from ground-based to satellite-based navigation and landing systems. LAAS is being developed specifically to provide augmentation to the Global Positioning System (GPS) satellites to support all-weather Category (CAT) I, II, and III precision approach and landing capability[1] to aircraft operating within a 20 to 30 mile radius of an airport. In March 2002, FAA estimated that 180 LAAS systems would be needed at a cost of $813.2 million with LAAS CAT I deployment to begin in 2004.

LAAS consists of both ground and air components. LAAS ground components include four or more GPS reference receivers, which monitor and track GPS signals; very high frequency transmitters for broadcasting the LAAS signal to aircraft; and ground station equipment, which generates precision approach data and is housed at or near an airport. Airspace users will have to equip with new avionics to obtain benefits. LAAS system components are depicted below.

[1] CAT I precision approach has a 200 foot ceiling/decision height and visibility of 1/2 mile.
CAT II precision approach has a 100 foot ceiling/decision height and visibility of 1/4 mile.
CAT III precision approach and landing has a decision height less than 100 feet down to the airport surface.

LAAS Components



Congress has encouraged an aggressive public-private cooperative acquisition strategy for the new technology. This approach was expected to reduce risks, share development costs, and ultimately accelerate the implementation of the new precision approach and landing system. Congress has appropriated approximately $98 million[2] for LAAS and related research and development efforts through fiscal year 2002, and directed FAA to report quarterly to the House and Senate Committees on Appropriations regarding progress towards developing and implementing LAAS.

RESULTS

In September 1999, FAA and the aviation community decided to accelerate the development of LAAS because of its potential to enhance airport capacity and increase the margin of safety. At that time, FAA planned to take advantage of industry-developed technology and eventually procure "commercial-off-the-shelf" LAAS systems developed under Government/Industry Partnerships. This is no longer the case, as FAA is shifting to a more traditional acquisition where the Government will bear all the remaining costs to develop and deploy the new system, except for the cost to equip aircraft with LAAS avionics. While the partnerships were instrumental in developing components of LAAS ground

[2] The $98 million includes funds for LAAS development and amounts appropriated for LAAS under the "Next Generation Landing Systems" budget item.

systems and shaping technical standards, considerable work remains to transition from prototype to production systems.

LAAS is not the same program that was planned 3 years ago, and it is time to reset expectations for LAAS with respect to when CAT I/II/III systems can be delivered, how much the effort will cost, and what benefits can be obtained. FAA needs to take steps now to avoid parallels between LAAS and the problems the agency experienced with the Wide Area Augmentation System (i.e., schedule slips, cost growth, and diminishing benefits). The principal issues with LAAS deal with expectations on three fronts—when the new system will be delivered, how much it will cost, and when new procedures will be available that can be used in conjunction with LAAS to boost airport arrival rates.

FAA misjudged the technological maturity of LAAS. It now appears that full production LAAS CAT I systems will be delivered in 2005 (2 years later than planned), as much development work is still required before CAT I can be deployed. The more demanding and highly desirable CAT II/III services (which include "auto landings" under all weather conditions) were planned to be operational in 2005 but are now considered a research and development effort. FAA has not set a date for when CAT II/III services will be available.

Moreover, program costs we reviewed are not reliable. An April 2002 FAA acquisition document estimates that $456.5 million will be required for 50 CAT I systems. This is in contrast to the latest LAAS program cost estimate of $813.2 million for 180 CAT I/II/III systems. In essence, the $456.5 million figure suggests that FAA will procure less than one-third of the total number of systems for approximately three-fifths of the total estimated program costs.

Further, key assumptions about the benefits of LAAS are no longer valid. For example, because of concerns about intentional and unintentional interference with GPS signals, existing Instrument Landing Systems (ILS) will not be phased out as planned. There are 1,275 ILS[3] installed at 671 airports in the continental United States. In addition, an important benefit of LAAS CAT I services, particularly to large airlines, was the ability to allow aircraft to fly more flexible (curved and segmented) approaches thereby realizing user savings in fuel and flight time. However, FAA has yet to determine when these services will be provided, but expects to have cost and schedule estimates for the new procedures by April 2003.

Large commercial passenger and cargo airlines have expressed considerable support for LAAS and will be the primary beneficiaries of the new technology. However, the cost for airspace users to purchase and install LAAS avionics is

[3] There were 1,158 CAT I ILS systems and 117 CAT II/III ILS systems in the National Airspace System as of June 2002.

uncertain. In 1999 FAA estimated the cost to equip with LAAS avionics to range from $28,000 to $35,000,[4] exclusive of the cost to take aircraft out of revenue service. This estimate needs to be updated, and FAA intends to update LAAS avionics costs by December 2003. While LAAS is planned to provide precision approach capabilities simultaneously to multiple runways, airspace users may find little incentive to equip if they obtain the same service for LAAS as they do an ILS (i.e., straight-in look-alike service) approach. Aviation officials suggested that decisions to invest in LAAS avionics will depend on when curved and segmented approaches can be available.

We believe that FAA has significant opportunities to avoid the problems that plagued the Wide Area Augmentation System (WAAS). FAA needs to develop an acquisition strategy that is commensurate with the maturity of LAAS. Part of this strategy includes determining exactly how to verify that a LAAS design (both ground station and avionics) is in compliance with the integrity requirements[5] and agreeing on the best approach (i.e., analyses, operational test, simulation modeling or some combination) to certify the system as safe.

FAA agreed with our analysis and has promised to take corrective action. FAA now intends to award a development contract for LAAS CAT I in the next several months and is restructuring the developmental portion of the contract to help ensure that all design work, particularly the system integrity design, is successfully completed before any software coding or hardware procurements can commence. In addition, FAA agreed to limit LAAS production (beyond the six systems currently planned) until integrity issues are successfully resolved and one system has been certified as safe for pilots to use.

Despite Progress With LAAS Development, It Has Not Met Expectations and FAA Is Now Pursuing the Technology as a Traditional Acquisition

Progress has been made with the Government/Industry Partnerships, which resulted in a number of prototypes. LAAS prototypes have proven to be accurate and may prove useful as a platform for addressing a number of safety concerns, including preventing runway incursions. However, work to date has focused largely on meeting CAT I performance goals—particularly the accuracy requirement (demonstrating that precision approaches could be flown with 200 foot decision heights and 1/2 mile visibility). For the more demanding CAT II/III services, full-scale development was planned to begin in 2003 and initial

[4] Cost estimates were based on per unit equipage cost to air carriers for a Multi-Mode Receiver, which includes both LAAS and WAAS.

[5] Integrity refers to the ability of LAAS to provide timely warnings to pilots when the system should not be relied upon.

operational capability was expected in 2005; however, these services are now considered a research and development effort with an uncertain completion date.

When the Government/Industry Partnerships were created in 1999, the goal was for industry to bear the risk and cost of development. FAA would procure, install, and maintain the new landing systems. The partnerships would provide systems to FAA as well as other entities—airports (both domestic and foreign)—willing to invest in the new systems. However, FAA is now changing direction and will pursue LAAS as a traditional acquisition because the agency wants to complete development of CAT I systems and firm up implementation schedules. Additionally, FAA officials believe LAAS CAT I prototypes are at least 18 months away from meeting FAA safety and performance requirements.

Much work remains to transition LAAS (for CAT I services) from developmental/prototype systems to production systems that can meet FAA requirements. This is evident by the fact that FAA is moving forward with a *full-scale development* contract for CAT I LAAS, meaning that design and development work (hardware, software, and algorithm development) is still required before systems can be fielded and used safely.

Key Risks for LAAS Focus on Finalizing Requirements and Certifying LAAS as Safe for Pilots to Use

We found that the major cost and schedule drivers for LAAS are establishing definitive requirements for the new technology, determining how the system design should be verified to meet the integrity requirements, and determining how to certify LAAS as safe for pilots to use. These concerns are interrelated and will have a direct bearing on hardware, software and algorithm development and how quickly LAAS can be deployed for operational use.

LAAS requirements continue to evolve. Specifically, FAA added 113 new requirements that were not part of the specification used by the Government/Industry teams to develop the LAAS CAT I prototypes. For example, the LAAS ground system requires a new GPS receiver (which is needed to help meet its overall integrity requirements), and major software upgrades—between 400,000 and 1 million lines of software code—will need to be developed and tested.

By far, the biggest cost and schedule driver focuses on how FAA will certify LAAS as safe for pilots to use. This is also the least understood program element and involves both air and ground components. The key to certification is LAAS *integrity*—the ability of the system to alert the pilot in a timely manner when the system should not be used. The partnerships have been reluctant to examine this

issue in detail because requirements continue to evolve and FAA has not decided on an approach for certifying the system as safe.

LAAS Is at a Critical Juncture, and There Are Significant Opportunities to Avoid Problems That Plagued WAAS

It is important not to repeat mistakes that were made with WAAS, which resulted in a 3-year slip and cost overruns totaling millions of dollars. Problems with WAAS were traceable to vexing technical problems, unrealistic cost and schedule estimates, and concurrent development and production activities, as well as the fact that FAA made decisions about the overall design of the system without determining how the system would be certified as safe for pilots to use. FAA needs to take a number of steps.

- *First, FAA Needs to Develop an Effective Acquisition Strategy for LAAS*. FAA is working to develop an approach for LAAS and intends to procure a limited number of CAT I systems, including six systems for airports, as a precursor to a much larger deployment (between 15 and 40 production systems per year). Given the complex nature of the acquisition, FAA should give serious consideration to limiting the number of airports where it places LAAS CAT I systems as development activities continue. We note that a similar approach proved to be a key reason why the Free Flight Phase 1 initiative met with success. FAA should withhold funds for additional locations beyond the six systems planned until a clearly defined process has been established for certifying LAAS as safe and at least one system has been certified.

  In addition to addressing the risks discussed in this report, FAA's acquisition strategy should also focus on bringing the correct *skill mix* (from inside and outside FAA as well as the scientific community) to bear on the integrity issues in a timely fashion and determining what constitutes a definitive methodology for verifying compliance with LAAS integrity requirements. FAA waited until the 11th hour and only after serious problems surfaced to obtain the necessary expertise for WAAS. This expertise will be needed to deliver LAAS CAT I services and becomes even more critical as work proceeds on CAT II/III services. While FAA has a LAAS Integrity Panel (LIP) to assist with its research and development activities, the agency must formally task the panel to work on integrity issues specifically for the CAT I acquisition.

- *Second, LAAS Costs and Schedule Are Not Reliable and Need to Be Revisited.* LAAS program cost estimates (ranging from $600 million to $800 million) are not reliable, and schedules we reviewed are aggressive. It

is becoming increasingly clear that the current schedule cannot be met because CAT I is now a full-scale development effort instead of a commercial-off-the-shelf acquisition, and because requirements have not been finalized for CAT I or CAT II/III services. FAA needs to establish more realistic cost and schedule parameters for LAAS.

- *Finally, LAAS Benefits Have Changed Over Time and Need to Be Updated.* A number of assumptions about benefits of the new technology are no longer valid. Specifically, LAAS was originally expected to allow for shorter and more flexible curved and segmented approaches to airports than provided by current systems. However, the new system will only provide straight-in ILS look-alike service when initially deployed, and it is uncertain when advanced procedures for the more flexible approaches can be implemented. In April 2003, FAA expects to have a better handle on when the new procedures will be available.

  Another important benefit of LAAS focused on the operation and maintenance savings that would result from decommissioning ground-based navigation systems, such as ILS. In effect, FAA planned to replace existing systems without a back-up of some type. This is no longer the case. FAA is working with the Department of Transportation to determine the appropriate mix of back-up systems to mitigate the effects of intentional and unintentional interference on satellite-based systems.

  The benefits of LAAS cannot accrue without airspace users purchasing and installing new avionics. However, airspace users may have little incentive to equip if they obtain the same service from LAAS as they do an ILS. Based on discussions with aviation officials, it appears that the decision to invest in LAAS avionics will depend on when curved and segmented approaches can be available. FAA cannot expect airspace users to invest in LAAS until a much clearer picture of benefits emerges. Given these changes and the fact that the last benefit analysis was done 3 years ago, FAA needs to rethink LAAS benefits and clearly articulate when new systems and new procedures will be available.

Reporting to the Congress on LAAS

In the fiscal year 2002 DOT Appropriations Conference Report, the conferees directed FAA to report quarterly to the House and Senate Committees on Appropriations, beginning in fiscal year 2002, regarding progress on several activities, including contract award for CAT I LAAS and initiation of flight evaluations for the development of LAAS approaches (e.g., curved and segmented). FAA has not yet submitted a report under this requirement. However, the agency has indicated that a contract for LAAS CAT I will be

awarded in the next couple of months. FAA officials also indicated that firm dates have not been established with regard to defining advanced procedures, conducting flight evaluations, and collecting data to develop curved and segmented approaches; however, these efforts will take considerable time.

In addition to the activities spelled out in the Conference agreement, FAA should include in its report information on LAAS pertaining to (1) updated cost and schedule baselines, (2) status of CAT II/III research and development efforts, (3) progress on developing advanced procedures, (4) progress toward resolving LAAS integrity concerns, and (5) changes to LAAS requirements.

RECOMMENDATIONS

We are recommending that FAA develop an overall acquisition strategy that is commensurate with the maturity of LAAS, uncertainty about how it will be certified as safe, and how quickly progress can be made in meeting the demanding CAT II and III approaches. FAA needs to:

- ensure that the agency has the appropriate skill mix, with respect to safety and certification issues, to manage the effort and help determine the best approach for certifying LAAS as safe.

- withhold funds for additional locations beyond the six systems planned until a clearly defined process has been established for certifying LAAS as safe and at least one system has been certified.

- revise LAAS cost, schedule, and benefits and provide a clear understanding of where LAAS will be deployed and when services (including curved and segmented approaches) will be available.

- initiate quarterly reporting to Congress and report information on LAAS pertaining to (1) updated cost and schedule baselines, (2) status of CAT II/III research and development efforts, and (3) progress on developing advanced procedures.

We make additional recommendations in the body of this report.

MANAGEMENT COMMENTS AND OFFICE OF INSPECTOR GENERAL RESPONSE

On November 19, 2002, FAA provided written comments (see Appendix) to our October 3, 2002 discussion draft report. We incorporated the comments into the final report where appropriate and made a number of technical adjustments to the report.

The Associate Administrator for Research and Acquisitions stated that our draft report was useful and timely because it raised critical questions that will directly affect the overall cost and schedule of LAAS and how the system will be certified as safe for pilots to use. FAA delayed awarding a contract for LAAS and has promised to take actions to address our concerns.

FAA concurred with our recommendation to develop an acquisition strategy and delay contracting for LAAS CAT II and III until requirements are better defined. FAA also agreed to withhold funds for additional LAAS locations beyond the six systems planned until integrity issues are successfully resolved and one system has been certified; update the acquisition program baseline; and complete the LAAS investment analysis. These corrective actions when implemented will satisfy the intent of our recommendations.

Although FAA concurred with our recommendation to determine the right skill mix to manage LAAS and resolve questions about integrity, the agency's proposed action does not address the intent of our recommendation. FAA stated that it has had a LAAS Integrity Panel in place since 1996. We agree but note that the panel has not been formally tasked to examine integrity issues with the LAAS CAT I acquisition. FAA needs to invigorate this panel to help prevent problems it has experienced with other modernization efforts.

FAA partially concurred with our recommendation to initiate quarterly reports to Congress and report additional information on LAAS pertaining to, among other things, updated cost and schedule baselines, the status of CAT II/III research and development efforts, progress in resolving integrity concerns, and changes to LAAS requirements. FAA stated it will provide an end-of-the-year LAAS status report to Congress that addresses the LAAS efforts in the fiscal year 2002 LAAS appropriation language. LAAS program officials also indicated they will provide the FAA Administrator with a quarterly status report that addresses the areas identified in our recommendation. We believe providing LAAS quarterly reports to the FAA Administrator is an important step in keeping decision makers informed and meets the intent of our recommendation.

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INTRODUCTION

BACKGROUND

The Local Area Augmentation System (LAAS) is a key initiative in the Federal Aviation Administration's (FAA) plans to transition away from ground-based to satellite-based navigation and landing systems. LAAS is being developed specifically to provide augmentation to the Global Positioning System (GPS) satellites to support all-weather Category (CAT) I, II, and III precision approach and landing capability[1] to aircraft operating within a 20 to 30 mile radius of an airport. In March 2002, FAA estimated that 180 LAAS systems would be needed at a cost of $813.2 million with LAAS CAT I deployment to begin in 2004.

LAAS consists of both ground and air components. LAAS ground components include four or more GPS reference receivers, which monitor and track GPS signals; very high frequency transmitters for broadcasting the LAAS signal to aircraft; and ground station equipment, which generates precision approach data and is housed at or near an airport. Airspace users will have to equip with new avionics to obtain benefits.

OBJECTIVES, SCOPE, AND METHODOLOGY

The objectives of the audit were to determine program costs, schedule and risk, and explore key issues affecting the successful development and deployment of the LAAS. We conducted our audit work at FAA Headquarters in Washington, D.C.; FAA regional offices; airport facilities; LAAS prototype sites; and various aviation association facilities. We also collected and analyzed key FAA acquisition documents. The scope and methodology of our review can be seen in detail in Exhibit A. This review was conducted in accordance with the Government Auditing Standards prescribed by the Comptroller General of the United States.

[1] CAT I precision approach has a 200 foot ceiling/decision height and visibility of 1/2 mile.
CAT II precision approach has a 100 foot ceiling/decision height and visibility of 1/4 mile.
CAT III precision approach and landing has a decision height less than 100 feet down to the airport surface.

FINDING AND RECOMMENDATIONS

Progress in developing LAAS has not met expectations, and considerable work remains before LAAS can be implemented in the National Airspace System. LAAS prototypes developed under the aegis of Government/Industry Partnerships have proven to be accurate. However, work to date has focused exclusively on meeting CAT I performance goals. The more demanding CAT II/III approach and landing services are now considered a research and development effort with an uncertain end date. FAA needs to take a number of steps now to reduce risk and prevent past mistakes that were made with its Wide Area Augmentation System (WAAS) program.

Despite Progress With LAAS Development, It Has Not Met Expectations and FAA Is Now Pursuing the Technology as a Traditional Acquisition

FAA and industry have demonstrated that precision approaches can be flown using GPS satellite technology, and have made progress in developing LAAS (for CAT I services) through Government/Industry Partnerships (GIP). Also, GIP teams have pioneered the first GPS/LAAS avionics suite and performed numerous flight tests using prototype LAAS avionics and ground systems to verify that air and ground elements are indeed working together as intended.[2]

Prototype LAAS systems have been in use for flight tests and data collection activities at several airports, including Chicago O'Hare and Salt Lake City International. Figure 1 summarizes the three Government/Industry teams' contributions towards LAAS development.

[2] Industry has developed a number of Special CAT I Differential Landing Systems (SCAT I systems). These contributed to LAAS development under the partnerships.

Figure 1: Contributions of Government/Industry Teams

GIP Team Leaders	GIP Team Contributions
Honeywell Incorporated	Honeywell prototype LAAS ground systems were flight-tested at Memphis International Airport and Chicago O'Hare Airport in cooperation with FAA, Rockwell-Collins, Boeing and FedEx for precision approaches (manual and autolandings). Test results have helped identify potential interference issues and provided valuable field performance and reliability data on LAAS.
Raytheon Company	Raytheon prototype LAAS ground systems were flight-tested at Salt Lake City International Airport and Holloman Air Force Base by Raytheon in cooperation with FAA, Rockwell-Collins, FedEx, Boeing, and U.S. Air Force for precision approaches (manual and autolandings). The purpose of the tests was to verify LAAS coverage requirements and that the LAAS ground system and avionics could operate together.
Thales-Air Traffic Management (ATM)	Thales-ATM prototype systems were flight-tested at Noah's Ark Airport in Kansas City and Blagnac Airport in Toulouse, France, by Thales-ATM (then Wilcox Electric) in cooperation with FAA, National Aeronautics and Space Administration and Boeing, for precision approaches as well as autolandings. The main purpose of these tests was to obtain accuracy data.

LAAS prototypes have proven to be accurate and may prove useful as a platform for addressing a number of safety concerns, including preventing runway incursions. The partnerships were also instrumental in shaping standards and requirements for LAAS, including the revised requirements FAA adopted and published in August 2001.[3]

To date, work has focused exclusively on meeting CAT I performance goals (demonstrating that precision approaches could be flown with 200 foot decision heights and 1/2 mile visibility). Generally speaking, partnerships placed a high priority on meeting accuracy requirements, but less attention has focused on reliability, failure rates, and maintainability. Developers of LAAS have been reluctant to examine these issues because requirements continued to change and FAA had not decided on an approach for certifying the system as safe.

When the Government/Industry teams were created in 1999, the goal was for industry to bear the risk and cost of development. FAA would procure, install, and maintain the new landing systems. The partnerships would provide systems to FAA as well as other entities—airports (both domestic and foreign)—willing to invest in the new systems.[4] *However, as work progressed under the partnerships and requirements became better understood, FAA realized LAAS was not as mature as expected.*

[3] Important technical documents needed to move the technology forward have also emerged from the Government/Industry teams' participation in LAAS development. These documents include LAAS (CAT I) Ground Facility Specification, and Minimum Operational Performance Standards.

[4] FAA designated systems that would be purchased by other entities as "non-Federal systems." These systems would have the same performance standards but would not have the same maintenance requirements.

FAA is now shifting from the Government/Industry Partnership approach to a more traditional FAA acquisition where the Government will bear the remaining cost to develop and deploy the new system. FAA is changing directions because it wants to complete development of CAT I systems and firm up implementation schedules. Also, agency officials believe that current LAAS prototypes (CAT I) are at least 18 months away from meeting FAA safety and performance requirements. For the more demanding CAT II/III services, full-scale development was planned to begin in 2003 and initial operational capability was expected in 2005; however, these services are now considered a research and development effort with an uncertain completion date.

Key Risks Focus on Finalizing Requirements and Certifying LAAS as Safe for Pilots to Use

We found that the major cost and schedule drivers for LAAS are establishing definitive requirements for the new technology, determining how to verify the system design is in compliance with the integrity requirements, and determining how to certify LAAS as safe for pilots to use. These concerns will have a direct bearing on hardware and software development and how quickly LAAS can be deployed for operational use.

Additional Work Required to Transition LAAS (CAT I) From a Developmental to a Production System

Much work remains to transition LAAS (for CAT I services) from developmental/prototype systems to production systems that can provide precision approach services at airports and meet FAA requirements. This is evident by the fact that FAA is moving forward with a *full-scale development* contract for CAT I LAAS, meaning that design and development work (hardware, software, and algorithm development) is still required before systems can be fielded. In addition, the LAAS ground system requires a number of upgrades to meet FAA's revised requirements before it can be deployed for operational use, as shown in the following examples. (See Exhibit B for details.)

- The LAAS ground system requires a *new GPS receiver*, which will have a monitoring function to accurately measure distortions and detect errors transmitted by GPS signals. This will help meet LAAS overall integrity requirements. A requirement has also been added to produce optimal accuracy for the LAAS signal. This new feature will help meet unique siting requirements at airports and coverage requirements.

- The LAAS ground system also requires *major software upgrades*. FAA estimated that the LAAS ground system will ultimately require between 400,000 and 1 million lines of software code. FAA officials told us that the number of lines of code is not the main concern but rather what the software is expected to do in terms of reliability and maintainability. Software will be developed to stringent standards for airborne systems and ground systems—known as "DO-178B"—as outlined by RTCA.[5] After the software upgrades are made, development and test activities are conducted, and then the software must be certified. The Government/Industry teams we interviewed indicated this is a significant effort that could take up to 18 months to complete.

- An upgraded *antenna* is also required to minimize multipath (false errors) effects when broadcasting the LAAS message to aircraft.

Each Government/Industry Partnership team has told FAA that at least a year was needed to upgrade its prototype systems and obtain type acceptance approval from FAA. Type acceptance approval is the method of evaluation FAA uses to verify that a system and its associated documentation meet appropriate technical, safety, and operating requirements. Government/Industry Partnership teams have told FAA that the earliest that LAAS equipment could be provided for approval is early 2003. FAA officials cautioned that past experience indicates the contractor selected to develop a system is likely to deliver production hardware without improved software and algorithms, and historically contractor schedules run 12 to 24 months behind.

Requirements for LAAS Must Be Finalized Before Further Development Occurs

LAAS requirements continue to evolve. FAA and industry officials believe that additional changes are inevitable. In August 2001, FAA added 113 new requirements to the LAAS CAT I specification that were not part of the specification used by the GIP teams to develop their prototype systems. New requirements focus on changes to system architecture, remote maintenance monitoring, and security. For example, FAA has a new requirement for dual transmitters. Revised requirements will drive changes in design, production, verification, and installation, which will cost more and take longer to deploy. FAA revised requirements for LAAS are expected to translate into the performance parameters shown in Figure 2.

[5] RTCA provides a forum for the Government and industry to define technical standards for aviation systems. For additional details on the DO-178B process, see Software Considerations in Airborne Systems and Equipment Certification, Document No. RTCA/DO-178B, December 1, 1992.

Figure 2: LAAS CAT I Performance Requirements

LAAS Performance Requirement	Description
Integrity	Expected to alert a pilot within 3 seconds of transmitting *hazardously misleading information*. The probability of such an event occurring shall be less than 1 in 6.6 million chances during any 150 second approach interval.
Continuity	Per 15 second interval of time, expected to have less than 1 in 1 million unscheduled interruptions of its transmission, where LAAS messages are not transmitted for 3 seconds or more.
Coverage	Expected to cover a radius of 23 nautical miles up to 10,000 feet above ground level.
Availability	Expected to be available 8,759.39 hours out of a possible 8,760 hours per year.
Accuracy	Expected to have a *vertical position* within 4.4 meters of the true position 95 percent of the time, and a *horizontal position* within 9 meters of the true position 95 percent of the time.

Source: OIG analysis of FAA data.

Regarding the CAT II/III LAAS acquisition, FAA officials recognize this is a research and development effort, and they are in the early stages of defining requirements. At this stage, the ground station specification and design have yet to be defined, and related avionics performance standards still need to be determined. It is questionable how much progress can be made without the experiences and lessons learned with meeting CAT I requirements. Moreover, FAA officials need to develop a strategy for how they plan to acquire CAT II/III LAAS (e.g., continue with Government/Industry cost sharing approach or standard FAA acquisition) to help define LAAS requirements. In 1999, FAA planned to contract for a CAT II/III full-scale development effort in 2003, but now agency officials do not expect to make a decision until early fiscal year 2005. Given the uncertainty about CAT II/III development, FAA should delay contracting for CAT II/III LAAS until requirements are better defined.

The Key Cost and Schedule Driver Focuses on Integrity and How FAA Will Certify the System as Safe

While satellite-navigation systems offer important safety and capacity benefits, they also present extraordinarily complex systems to assess in terms of safety. Figure 3 outlines the key technical risks for achieving CAT I LAAS and FAA's assessment of the levels of risks.

Figure 3: Key Technical Risks to Achieving CAT I

Technical Risk	Description of Risk	FAA Assessment of Risks
Integrity	Integrity is the ability to provide timely warnings (e.g., to pilots) when part or all of the system is providing erroneous information and thus should not be used. LAAS developers may have difficulty proving the integrity requirements can be met. The validation of integrity requirements is difficult.	Medium to High
Multipath	Siting of the LAAS GPS reference receiver antenna will be a major challenge due to the effects of multipath (false errors).	Medium to High
High Frequency LAAS Transmitter	Broadcasting the LAAS signal at low altitudes may be difficult to deliver; antenna design and siting criteria need to be defined.	Medium

Source: FAA's Acquisition Strategy Paper for CAT I LAAS, dated April 2002

The key question focuses on meeting LAAS *integrity* requirements: the ability of the system to alert the pilot when it should not be used. The goal is to prevent *hazardously misleading information* from reaching the pilot while the aircraft is in the final phases of flight. This proved to be a major stumbling block for the Wide Area Augmentation System (WAAS).

LAAS program officials believe that it should be easier to solve LAAS integrity problems than those of WAAS because of the limited LAAS coverage, i.e., 20 to 30 miles around an airport. However, other FAA officials are uncertain about how easily LAAS can be certified as safe. They note that WAAS did not achieve CAT I performance. They also believe that LAAS will be challenging because there are some unknowns (such as the impact of solar activity on the GPS signal), and siting constraints due to an airport-unique environment.

FAA has yet to fully determine how to verify that a LAAS design (both ground station and avionics) is in compliance with the integrity requirements. An important issue focuses on how various safety requirements can be distributed among air and ground LAAS components. Once this is decided, FAA must agree on the best approach (i.e., analyses, operational test, simulation modeling or some combination) to certify the system is safe. The fact that none of the GIP teams has completed a safety assurance plan to validate system safety for a CAT I system adds to this risk. A safety assurance plan outlines the approach to certifying system safety and verifying system integrity. FAA and industry have little experience in certifying and testing two different platforms (LAAS ground station and avionics) that satisfy one combined precision approach capability.

LAAS Is at a Critical Juncture, and There Are Significant Opportunities for FAA to Avoid Past Problems That Plagued WAAS

It is important not to repeat mistakes that were made with WAAS, which resulted in a 3-year slip and cost overruns totaling millions of dollars.[6] Problems with WAAS were traceable to vexing technical problems, unrealistic cost and schedule estimates, and concurrent development and production activities, as well as the fact that FAA made decisions about the overall design of the system without determining how the system would be certified as safe for pilots to use. FAA needs to take a number of steps to avoid these mistakes with LAAS.

FAA Needs to Develop an Effective Acquisition Strategy for LAAS

LAAS is at a critical juncture—the shift from prototype development to production systems. FAA needs to develop and implement an acquisition strategy that is commensurate with LAAS' current level of maturity and the unknowns about how the system will be certified as safe for pilots to use.

FAA is working to develop an approach for LAAS and intends to procure a limited number of CAT I systems, including 6 systems for airports, as a precursor to a much larger deployment (between 15 and 40 production systems per year). Given the complex nature of the acquisition, FAA should withhold funds for additional locations beyond the six planned until a clearly defined process has been established for certifying LAAS as safe and at least one system has been certified. Such an incremental approach was central to the success of the Free Flight Phase 1 initiative.

FAA should also develop *"check points"* to assess overall progress with LAAS to help make investment decisions. For example, LAAS check points could be established to measure completion of activities associated with certifying the system as safe (e.g., successfully passing system stability tests). FAA should clearly distinguish between development and production activities in program plans and budgets.

A key element in the LAAS acquisition strategy is bringing the correct skill mix (from inside and outside FAA) to bear on the all-important integrity issues in a timely fashion. FAA waited until the 11th hour to obtain the necessary expertise for WAAS by forming a technical panel and seeking independent, scientific advice. This expertise will be needed to deliver LAAS CAT I services and becomes even more critical as work proceeds on CAT II/III services.

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[6] Observations on FAA's Satellite Navigation Efforts, June 29, 2000, OIG Report Number CC-2000-277.

To assist FAA and industry, the agency plans to use the LAAS Integrity Panel (LIP) for the CAT I acquisition. FAA followed a similar approach to identify solutions to WAAS problems. However, FAA has not formally tasked the LIP to work on the CAT I acquisition to examine integrity issues. We note that this panel can help ensure consensus exists between the academic and technical community on a definitive methodology for verifying compliance with LAAS integrity requirements. FAA needs to formally task the LIP to begin work on the best approach for certifying LAAS as safe.

LAAS Cost and Schedule Are Not Reliable and Need to Be Revised

FAA has made a number of adjustments to LAAS cost and schedule estimates as shown in Figure 4.

Figure 4: Historical Perspective on LAAS Cost and Schedule

Cost and Schedule Changes	January 1998	September 1999	Proposed (as of March 2002)	Acquisition Strategy Paper (as of April 2002)
Development and Implementation Costs	$530.1 million	$696.1 million	$813.2 million	$456.5 million
CAT I	31	46	50	50
CAT II/III	112	114	130	0
Total Systems	143	160	180	50
Initial Operations (CAT I Service)	2002	2003	2004	2004

Note: The $456.5 million consists of CAT I production, implementation, and general program costs. FAA could not differentiate general program costs between CAT I/II/III at this time.
Source: OIG Analysis of FAA Documents

These cost changes reflect a degree of program volatility. FAA's informal March 2002 status of the program encompassed CAT I and CAT II/III, just as it did during the previous two approved program baselines. This estimate of $813.2 million reflected a 17 percent increase over previous costs approved for the program. But in the April 2002 estimate, reflected in FAA's Acquisition Strategy, all requirements and costs for the CAT II/III portion of the program were omitted (except those FAA deemed shared program costs between the two program segments).

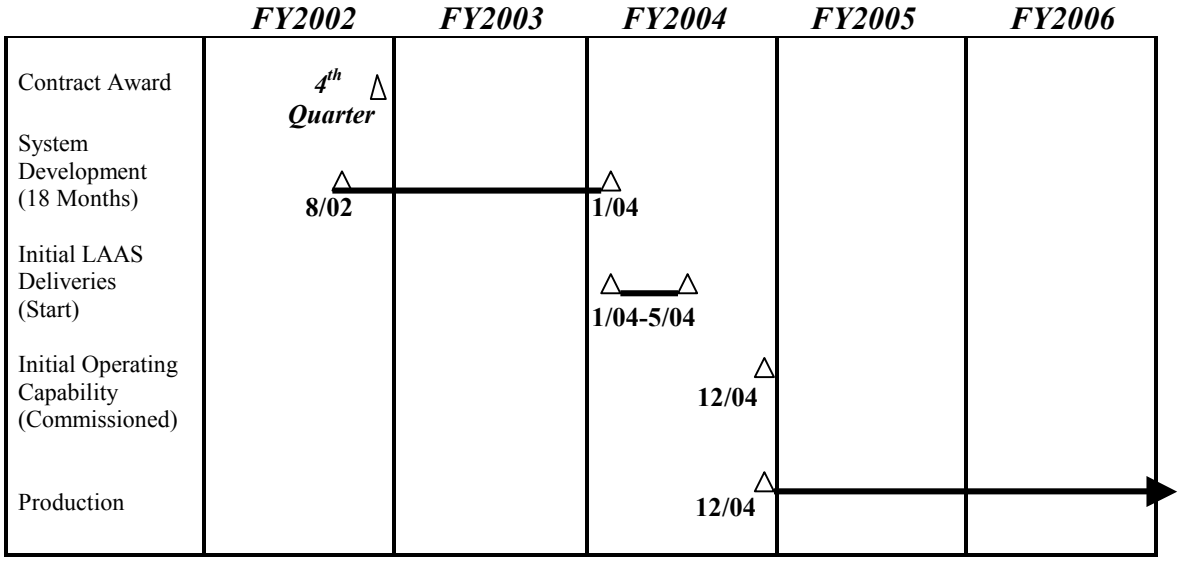
Moreover, the April 2002 FAA acquisition document estimates that $456.5 million will be required for 50 CAT I systems. This is in contrast to the latest LAAS

program cost estimate of $813.2 million for 180 CAT I/II/III systems. In essence, the $456.5 million figure suggests that FAA will procure less than one-third of the total number of systems for approximately three-fifths of the total estimated program costs. FAA should rebaseline LAAS costs by splitting CAT I *completely* from the CAT II/III acquisition. Also, FAA should rebaseline CAT II/III LAAS costs once requirements are better defined.

LAAS Scheduled Milestones Cannot Be Fully Supported and Require Updating

FAA's inability to identify the complete scope of work at this time will affect the agency's ability to meet schedule. Moreover, a recent FAA document we reviewed (an amendment to the request for proposals for the LAAS contract for CAT I service) suggests that it will take 6 months longer than anticipated to develop LAAS. This means that LAAS CAT I would not be commissioned until mid- 2005. Figure 5 provides information on key LAAS milestones that are expected to occur over the next several fiscal years.

Figure 5: LAAS CAT I Program Schedule



Note: These milestones are under review and will be revised.
Source: LAAS Program Status Brief: Satellite Operational Implementation Team, June 4, 2002

In reviewing FAA's master schedule, we found that the complete scope of work for the new full-scale development effort has not been adequately defined. For instance, a CAT I initial operational capability is scheduled for December 2004, but there is no milestone for full operational capability for CAT I LAAS, leaving it open-ended with regard to when all sites will be achieving the CAT I capability.

FAA has yet to develop a schedule showing when all LAAS CAT I capabilities (straight-in, curved, and segmented approaches) will be provided when the system is deployed. In fact, the only capability currently planned for the CAT I LAAS acquisition when the system is initially deployed is the straight-in precision approaches, similar to what is now provided by the Instrument Landing System (ILS).

The LAAS schedule addresses the development effort at a high level, but the work required to perform critical operational verification and site acceptance is not sufficiently defined, given the complex nature of this acquisition. Therefore, FAA should rebaseline the LAAS CAT I schedule to reflect more realistic implementation dates. FAA's LAAS CAT II/III schedule is currently under revision because FAA recognizes that more work is needed to adequately reflect contract award and implementation dates.

LAAS Benefits Have Changed Over Time and Need to Be Updated

A much clearer picture of the benefits of LAAS is needed. As outlined in the agency Operational Evolution Plan, LAAS is expected to play an important part in enhancing capacity by increasing the number of aircraft that can land (the arrival rate) under all weather conditions. LAAS is also expected to support reduced separation between aircraft and enable approaches to closely spaced runways. The principal beneficiaries of LAAS will be large commercial airlines.

FAA's 2001 capacity benchmark report suggests that LAAS—in conjunction with other new technologies and procedures—could boost airport operations in good weather between 10 and 17 percent.[7] Some airports will benefit more than others. For example, FAA estimated the increase in operations could be about 17 percent for the Los Angeles International Airport because of the unique characteristics of its airspace and runways.

Additionally, one LAAS will allow precision approaches at multiple runway ends at an airport (airport terrain and lighting permitting), whereas an ILS is required at each runway end to deliver precision approach services. Moreover, FAA will assess in the future if LAAS can provide precision approach capability to adjacent airports.

We found that the role of LAAS in FAA's overall plans for transitioning to satellite navigation and its anticipated benefits have changed considerably over the past few years.

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[7] See FAA's Airport Capacity Benchmark Report 2001. The technology and procedures used include the Simultaneous Offset Instrument Approach (SOIA), Automatic Dependent Surveillance-Broadcast (ADS-B), Precision Runway Monitor (PRM), and Cockpit Display of Traffic Information (CDTI). FAA did not specifically allocate capacity gains to each technology.

- First, LAAS' role in the transition to satellite-based navigation has changed due to performance shortfalls with WAAS. WAAS was intended to provide CAT I performance to the majority of the Nation's airports, but it is now clear that it will provide something less. LAAS was expected to provide CAT I performance only where WAAS could not, but FAA must now determine whether LAAS will fill the void left by WAAS. Further, LAAS was expected to be particularly beneficial by providing the more demanding CAT II and III services. Now, LAAS is the primary vehicle for providing CAT I services in the 2005 timeframe, and the effort to pursue CAT II and III is now a research and development effort with an uncertain delivery date.

- Second, LAAS was originally expected to allow for shorter and more flexible curved and segmented approaches to airports than approaches provided by an ILS. This is highly valued by large commercial airlines and a direct link to boosting airport arrival rates under all weather conditions. However, the new system will only provide straight-in, ILS look-alike service when initially deployed. It is uncertain when more flexible approaches can be developed and implemented, but FAA expects to have cost and schedule estimates for the new procedures by April 2003. FAA officials told us that it can take up to 5 to 7 years to define, develop, and publish new approach and landing procedures.

- Finally, an important benefit of LAAS rested in the operations and maintenance savings that would result from decommissioning ILS ground-based navigation and landing systems, numbering approximately 1,275 in total. In effect, FAA believed that GPS/WAAS/LAAS could serve as a *"sole means"* system of navigation, meaning that FAA and airspace users could rely exclusively on satellite-based navigation without a back-up system of some type. This is no longer the case.

  The results of a 2001 Volpe Transportation Systems study on GPS vulnerability underscore the need to maintain *back-up systems* to mitigate the risk of intentional and unintentional interference.[8] Based on the results of the study, FAA and the Department of Transportation are reviewing FAA's long-term navigation architecture and working to finalize planned back-up systems for all modes of transportation. Early indications are that large numbers of CAT I, II, and III ILSs will be maintained well into the foreseeable future and that much of the savings associated with replacing ILS with LAAS may no longer be realized. In fact, FAA continues to

[8] Vulnerability Assessment of the Transportation Infrastructure Relying on the GPS, Final Report, August 20, 2001, prepared by John A. Volpe National Transportation Systems Center for DOT.

purchase ILS equipment for airports and will continue to do so as a matter of policy.

The Volpe report also shows the need for FAA to work closely with the Department of Defense in developing systems that can detect and mitigate the effects of jamming on GPS signals. FAA needs to be positioned to take advantage of lessons learned by the Department of Defense (i.e., the human factors implications for pilots) and transfer technology for protecting satellite signals that have potential for civil aviation.

These shifts in benefits raise questions about how quickly FAA can and should move forward with LAAS. The last cost/benefit analysis for LAAS was done in September 1999, but it was done in the context of a combined WAAS/LAAS implementation and, as we discussed, key assumptions (performance of systems and timing of services) are no longer valid.

Although LAAS has significant potential safety benefits that may prove difficult to quantify with a high degree of fidelity, they cannot be ignored and need to be factored into FAA's analysis. The safety benefits of LAAS focus on providing highly accurate and reliable *vertical guidance* in the terminal environment under all weather conditions, which is the most complex of all air traffic domains and where the majority of accidents occur.

The benefits of LAAS cannot accrue without airspace users purchasing and installing new avionics. However, airspace users may find little incentive to equip if they obtain the same service from LAAS as they do from ILS. Based on our discussion with aviation officials, it appears that the decision to invest in LAAS avionics will depend on when curved and segmented approaches can be available.

FAA cannot expect airspace users to invest in LAAS until a much clearer picture of benefits emerges. FAA recognizes this and expects to complete a new investment analysis, or business case, for investing in LAAS by September 2003. FAA needs to seek ways to accelerate this effort in order to make informed decisions about how to move forward with LAAS. The investment analysis needs to address when benefits will accrue as well as the nature of potential safety benefits. The Department's work on determining appropriate back-up systems needs to be factored into the investment analysis.

Additionally, uncertainties surrounding when LAAS full services will be provided may also impact FAA's timeline for implementing other technologies outlined in FAA's Operational Evolution Plan, particularly the pace of *Automatic Dependent Surveillance-Broadcast* and *in-cockpit moving map displays*. Both of these systems can be implemented independently of LAAS, but they may not meet their full potential without LAAS. FAA was planning to conduct an analysis at

Memphis airport in 2003 to determine how LAAS (in conjunction with moving map displays and other systems) can help track aircraft and other vehicles on airport runways and taxiways. However, with LAAS implementation not planned until the 2005 timeframe, such an analysis will be postponed.

Reporting to the Congress on LAAS

In the 2002 Conference Report, the conferees directed FAA to report quarterly to the House and Senate Committees on Appropriations beginning in fiscal year 2002 regarding the progress towards completing several activities in fiscal year 2002, including awarding a contract for CAT I LAAS and initiating flight evaluations for the development of complex LAAS curved and segmented approaches. FAA has not yet submitted a report. While the agency has indicated a contract for LAAS CAT I will be awarded in the next several months, FAA officials have indicated that most of the work to define advanced procedures, conduct flight evaluations, and collect data to develop curved and segmented approaches will take considerable time. FAA has yet to establish firm dates for these actions.

In addition to the activities spelled out in the Conference agreement, FAA should include in its report information on LAAS pertaining to (1) updated cost and schedule baselines, (2) status of CAT II/III research and development efforts, (3) progress on developing advanced procedures (curved and segmented approaches), (4) progress toward resolving LAAS integrity concerns, and (5) changes to LAAS requirements.

Recommendations

LAAS is an important acquisition that has potential to enhance capacity and improve the safety of airport operations. It is also an acquisition in a state of transition. While important progress has been made, much work remains to develop and implement LAAS. FAA needs to take a number of steps to reduce the risk of repeating problems it experienced with WAAS. We recommend that FAA:

1. Develop an acquisition strategy of how FAA will pursue LAAS CAT II and III services (through a standard research program or Government/Industry approach) and delay contracting for CAT II and III LAAS until requirements are better defined.

2. Determine the skill mix required to manage LAAS, and address and resolve questions about integrity. This should include establishing and funding the formation of the LAAS Integrity Panel to ensure consensus exists between the academic and technical community on what constitutes a definitive

methodology for demonstrating compliance with LAAS integrity requirements, and to assist with determining the best approach for certifying LAAS as safe.

3. Establish check points for measuring progress and making LAAS investment decisions. In program plans and budgets, FAA should clearly distinguish between development and production activities.

4. Withhold funds for additional locations beyond the six systems planned until a clearly defined process has been established for certifying LAAS as safe and at least one system has been certified.

5. Report (in quarterly reports required by Congress) information on LAAS pertaining to (1) updated cost and schedule baselines, (2) status of CAT II and III research and development efforts, (3) progress on developing advanced procedures (curved and segmented approaches), (4) progress toward resolving LAAS integrity concerns, and (5) changes to LAAS requirements.

6. Rebaseline the CAT I LAAS acquisition to accurately reflect more realistic costs, schedule, and benefits, once the LAAS business case is complete. Also, FAA should rebaseline CAT II and III LAAS costs once requirements are more defined.

7. Accelerate the completion of the LAAS investment analysis (or business case) to determine the LAAS cost/benefit ratio, how many and what type of systems will be needed, when benefits will accrue, and the potential safety benefits of LAAS. Additionally, FAA should factor in the results of the Department's efforts to review FAA long-term navigation architecture and determine appropriate back-up systems.

8. Leverage work at the Department of Defense on new systems that can detect and mitigate the effects of intentional and unintentional interference on the GPS signal.

FAA Comments and Office of Inspector General Response

On November 19, 2002, FAA provided written comments (see Appendix) to our October 3, 2002 discussion draft report. We incorporated these comments into our final report where appropriate and made a number of technical adjustments to the report. FAA concurred with seven of our recommendations and partially concurred with one recommendation.

The Associate Administrator for Research and Acquisitions stated that our draft report was useful and timely because it raised critical questions that will directly

affect the overall cost and schedule of LAAS and how the system will be certified as safe for pilots to use. FAA delayed awarding a contract for LAAS and has promised to take actions to address our concerns.

For recommendations 1, 3, 4, 6, 7, and 8, FAA's proposed actions are responsive and address the intent of our recommendations. FAA plans to obtain a Joint Resources Council (JRC) approval—a key agency decision making body for acquisitions—before awarding a full-scale development contract for the CAT II/III LAAS, with a decision date in early fiscal year 2005. FAA agreed with the need for check points to measure progress with the LAAS acquisition and added the "critical design phase" as a key decision point.

Also, FAA agreed to limit CAT I LAAS production to the six systems planned until integrity issues are successfully resolved and one system has been certified. FAA is also restructuring the development portion of the contract to help ensure all design work, particularly the system integrity design, is successfully completed before any software coding or hardware procurements commence. In addition, FAA agreed to rebaseline the cost and schedules of the LAAS acquisition, including CAT I and CAT II/III efforts. FAA agreed to accelerate the LAAS investment analysis and factor in the Department's work on FAA's long-term navigation architecture. Finally, FAA plans to continue working closely with the Department of Defense on ways to safeguard satellite-based navigation programs from intentional and unintentional interference.

FAA's response to recommendation 2 regarding the right skill mix to manage LAAS and resolve questions about integrity did not address the intent of our recommendation. FAA stated that it has had a LAAS integrity panel in place since 1996. We agree but note that the panel has not been formally tasked to examine integrity issues with the LAAS CAT I acquisition. FAA needs to invigorate this panel to help prevent problems it has experienced with other modernization efforts, principally WAAS. We request that FAA provide a target date for formally tasking the panel to begin work on the CAT I acquisition.

FAA partially concurred with recommendation 5 to initiate quarterly reports to Congress and report additional information on LAAS pertaining to, among other things, updated cost and schedule baselines, the status of CAT II/III research and development efforts, progress in resolving integrity concerns, and changes to LAAS requirements. FAA stated it will provide an end-of-the-year LAAS status report to Congress that addresses the LAAS efforts in the fiscal year 2002 LAAS appropriation language by the end of 2002. LAAS program officials also indicated they will provide the FAA Administrator with a quarterly status report that addresses the areas identified in our recommendation. We believe providing

LAAS quarterly reports to the FAA Administrator is an important step in keeping decision makers informed and meets the intent of our recommendation.

EXHIBIT A. AUDIT SCOPE AND METHODOLOGY

We analyzed program cost, schedule, and risk impacting the implementation of the LAAS Program and verified results with the program office. We evaluated key FAA-generated program status documents that included monthly program status reports, Investment Analysis Reports, Government/Industry Partnership Agreements, and Acquisition Strategy Papers. We also reviewed briefing packages provided by each industry partner. These documents were used to identify, track and evaluate program costs, schedule and risks. In addition we identified key issues affecting the successful development and deployment of LAAS. We analyzed relevant program management documentation such as the work breakdown structure, procurement documentation (i.e., Requests for Proposals), specifications, plans and processes.

We interviewed personnel from FAA's LAAS Program Office, Flight Standards Service, Aircraft Certification Service, Research & Requirements Development Directorate, Aircraft Certification Service, airports, and aviation associations. We also interviewed Government/Industry partners and other parties integral to the development of LAAS (e.g., Honeywell, Inc.; Raytheon Co.; Thales Air Traffic Management (ATM), Inc.; and Federal Express) to obtain their views on the development and implementation of LAAS and FAA management and control of the acquisition program. We also interviewed DOT officials and attended task force meetings to assess which back-up systems are needed for departmental GPS-based systems.

We conducted the audit at FAA Headquarters in Washington, D. C.; FAA regional offices; airport facilities; Government/Industry partner facilities; and aviation association facilities (see Exhibit C). Audit work was performed from September 2001 through May 2002. The review was conducted in accordance with the Government Auditing Standards prescribed by the Comptroller General of the United States.

EXHIBIT B. HOW LAAS WORKS AND UPGRADES REQUIRED

LAAS Ground Station		
Component	**Function**	**Upgrades Required**
GPS Receiver	Monitors and tracks GPS signals, WAAS signals, and orbital parameters.	A new monitoring function to accurately measure distortions and detect errors transmitted by GPS signals. An added function to produce optimal accuracy for LAAS signal-in-space. This new feature will help meet siting and coverage requirements. Upgraded antenna to minimize multipath (false errors) effects in the broadcast reference corrections. Ability to track up to 18 GPS signals. The associated receiver software modification has to be developed and certified to stringent standards, which is a significant effort.
LAAS Ground Facility (LGF)	Generates differential corrections, integrity parameters, and precision approach data that are broadcast via the VDB.	Software upgrades with monitors, receiver interface, and signal quality functions. After the upgrades are made, development and test activities occur as well as certification that the software meets stringent software development standards.
VHF Data Broadcast (VDB)	Broadcasts LGF corrections to the airborne subsystem for processing.	Determining how the VDB will be sited at airports to achieve the desired service will be a major challenge. Additionally, software upgrades are needed to ensure the transmitter and monitors comply with software standards. Requiring dual VDB transmitters could significantly affect cost and risk.
LAAS Airborne Subsystem		
LAAS Avionics	Applies the LGF corrections to the GPS and WAAS signals to obtain position with the required accuracy, integrity, continuity, and availability.	LAAS avionics manufacturer does not anticipate any major upgrades to its prototype system. The manufacturer is waiting for FAA to complete the technical standard order that prescribes the minimum performance standards. Production of CAT I LAAS avionics is expected to begin in mid-2003.

EXHIBIT C. ACTIVITIES VISITED OR CONTACTED

Federal Aviation Administration

FAA Headquarters, Washington, D.C.

Southern Region, Oklahoma City, OK

Southern Region Air Traffic Control Tower, Memphis, TN

William J. Hughes Technical Center, Atlantic City, NJ

Mike Monroney Aeronautical Center, Oklahoma City, OK

Airports

Chicago O'Hare International Airport

Memphis International Airport

Contractors and Industry Associations

Raytheon Company

Honeywell Incorporated

Thales Air Traffic Management (ATM), Incorporated

Federal Express

Air Line Pilots Association

Air Transport Association

Aircraft Owners and Pilots Association

Regional Airline Association

Air Cargo Association

Rockwell Collins

Innovative Solutions International-Satellite Navigation Division

EXHIBIT D. MAJOR CONTRIBUTORS TO THIS REPORT

THE FOLLOWING INDIVIDUALS CONTRIBUTED TO THIS REPORT.

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Matthew Hampton	Program Director
Kevin Dorsey	Project Manager
Heidi Leinneweber	Senior Analyst
Melissa Pyron	Senior Auditor

APPENDIX. MANAGEMENT COMMENTS

U.S. Department
of Transportation
Federal Aviation Administration

Memorandum

Subject: **INFORMATION:** FAA Needs to Reset Expectations For LAAS Because Considerable Work is Required Before It Can Be Deployed for Operational Use

Date: November 19, 2002

From: Assistant Administrator for Financial Services and Chief Financial Officer

Reply to Attn. of:

To: Deputy Assistant Inspector General for Aviation Programs

On October 3, your office released a copy of the subject discussion draft report followed by an exit conference on October 15. The attachments contain our response to your report.

If you have questions or need further information, please contact Anthony Williams, Budget Policy Division, ABU-100. He can be reached at (202) 267-9000.

Chris Bertram

Attachments

Federal Aviation Administrations (FAA) Response to the Office of Inspector General's (OIG) Discussion Draft Report on FAA Needs to Reset Expectations for Local Area Augmentation System (LAAS) Before It Can Be Deployed for Operational Use

OIG Recommendation 1: Develop an acquisition strategy of how FAA will pursue LAAS Category (CAT) II and III services (through a standard research program or Government/Industry approach) and delay contracting for CAT II and III LAAS until requirements are better defined.

FAA Response: Concur. The FAA decided approximately nine months ago that the CAT II and III full scale development could not be awarded until 2 years of technical studies were accomplished which would define the high level system architecture and performance requirements of the CAT II and III LAAS. The LAAS program will then have to obtain a FAA Joint Resource Council approval to award a full-scale development contract for the CAT II and III LAAS. The earliest date for this decision is early fiscal year (FY) 2005.

OIG Recommendation 2: Determine the skill mix required to manage LAAS, and address and resolve questions about integrity. This should include establishing and funding the formation of the LAAS Integrity Panel to ensure consensus exists between the academic and technical community on what constitutes a definitive methodology for demonstrating compliance with LAAS integrity requirements, and assist with determining the best approach for certifying LAAS as safe.

FAA Response: Concur. The LAAS program has had a LAAS Integrity Panel in place since 1996.

OIG Recommendation 3: Establish check points for measuring progress and making LAAS investment decisions. In program plans and budgets, FAA should clearly distinguish between development and production activities.

FAA Response: Concur. Decision points are in place for the LAAS CAT I production decision and CAT II and III full-scale contract award decision. The FAA is adding another decision point for the critical design phase of the CAT I contract.

OIG Recommendation 4: Withhold funds for additional locations beyond the six systems planned until a clearly defined process has been established for certifying LAAS as safe and at least one system has been certified.

FAA Response: Concur. This acquisition concept has been in place in excess of a year.

OIG Recommendation 5: Report (in quarterly reports required by Congress) information on LAAS pertaining to (1) updated cost and schedule baselines, (2) status of CAT II and III research and development efforts, (3) progress on developing advanced procedures (curved and segmented approaches), (4) progress toward resolving LAAS integrity concerns, and (5) changes to LAAS requirements.

FAA Response: Partially Concur. The FAA will provide an annual LAAS status report to Congress, which addresses the five LAAS efforts in the FY 2002 LAAS appropriation language.

OIG Recommendation 6: Rebaseline the CAT I LAAS acquisition to accurately reflect more realistic costs, schedule, and benefits, once the LAAS business case is complete. Also, FAA should rebaseline CAT II and III LAAS costs once requirements are more defined.

FAA Response: Concur. FAA will update the Acquisition Program Baseline after the LAAS benefits analysis update is completed in late 2003.

OIG Recommendation 7: Accelerate the completion of the LAAS Investment Analysis (or business case), to determine LAAS cost/benefit ratio, how many and what type of systems will be needed, when benefits will accrue, and the potential safety benefits of LAAS. Additionally, FAA should factor in the results of the Departments efforts to review FAA Long-Term Navigation Architecture and determine appropriate back-up systems.

FAA Response: Concur. The FAA will complete the LAAS benefits analysis as quickly as possible. The FAA submitted a Navigation Transition Plan to the Department of Transportation in August 2002 as a part of their Navigation Architecture Plan. The FAA will factor the results of the Department's determinations of the FAA's long-term navigation architecture into the LAAS benefits analysis.

OIG Recommendation 8: Leverage work at the Department of Defense (DoD) on new systems that can detect and mitigate the effects of intentional and unintentional interference.

FAA Response: Concur. The FAA will continue to work closely with the DoD on satellite based navigation programs. LAAS Program activities currently include coordination and representation at the DoD Joint Program Office and liaison with the Joint Precision Approach Landing System at Hanscom Air Force Base.