STATUS REPORT ON THE ADVANCED TECHNOLOGIES AND OCEANIC PROCEDURES

Federal Aviation Administration

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U.S. Department of Transportation

Office of the Secretary of Transportation

The Inspector General

Office of Inspector General
Washington, DC 20590

March 31, 2004

The Honorable John L. Mica
Chairman
The Honorable Peter A. DeFazio
Ranking Democratic Member
Subcommittee on Aviation
Committee on Transportation
and Infrastructure
House of Representatives
Washington, DC 20515

Dear Mr. Chairman and Representative DeFazio:

As requested, we are providing you with a status report on the Federal Aviation Administration's (FAA) Advanced Technologies and Oceanic Procedures (ATOP) Program. ATOP is an important, long overdue effort to modernize FAA facilities that manage air traffic over the Atlantic, Pacific, and Arctic Oceans. This report summarizes a briefing we provided to Subcommittee staff earlier this year on FAA's progress and problems in deploying ATOP. We updated our analysis to reflect recent developments in the ATOP program. A copy of the updated briefing materials is enclosed.

Despite advances in computer and communications technology, FAA air traffic controllers must manually track oceanic air traffic and estimate aircraft locations. This labor-intensive process requires larger-than-necessary separation between aircraft because of the lack of real-time information on their location. For example, using manual procedures, controllers must maintain 100-mile separation[1] between aircraft. By using automation to refine the known position of aircraft, ATOP will enable FAA to safely reduce separation between aircraft to about 30 miles and provide for more fuel-efficient routing.

[1] Separation is a safety standard that refers to the distance between aircraft wingtip to wingtip or nose to tail.

After little success with efforts to modernize oceanic facilities in the 1990s, FAA competitively awarded a $217 million fixed-price contract to Lockheed Martin in June 2001 to develop and implement ATOP. FAA plans call for oceanic automation systems to be fielded at Oakland Center in June 2004, New York Center in March 2005, and Anchorage Center in March 2006.

Results

We found that ATOP has experienced some serious and unexpected software development and testing problems. For example, the ATOP program completed the initial phase of testing, known as factory acceptance testing, 12 months later than internal schedules called for because of the need for additional software development. The number of lines of software code that needed to be developed for ATOP rose from 83,000 to the current estimate of 160,000, which represents an increase of 93 percent over estimates made in 2001. These problems were traceable to Lockheed Martin's decision to rely on a previously developed system that could not meet FAA's requirements. As a result of the problems, Lockheed Martin did not meet its contractual milestone to provide an operational system in Oakland by April 2003.

In October 2003, FAA began systems testing to determine whether the new automation system would perform as intended. However, testing uncovered software problems that prompted FAA to halt testing of ATOP's air traffic management functions. For example, the system did not meet test criteria for sending messages between controllers and pilots via data link as quickly as it should. Also, the system did not meet test criteria for coordinating flight data with adjacent control facilities when an aircraft passes from one facility to the next. Testing resumed in February 2004. The time it took to fix these problems places the June date for deploying ATOP to Oakland in jeopardy because FAA now has less time to conduct site acceptance testing to ensure the system is installed and functioning properly.

To FAA's credit, the Agency took an unusual approach and relied on what is largely a fixed price contract and kept requirements stable. Consequently, the costs associated with additional software development and fixing software problems discovered during testing have, until recently, been absorbed by the contractor, not the Government.

Due to the software problems and pending delays, FAA on March 9, 2004, modified the contract in an effort to maintain FAA's schedule for deploying ATOP to Oakland by the end of June 2004. The modification expanded the use of cost-reimbursable elements (time and materials) in the contract and increased the net value of the contract by $11 million, from $217.9 million to $228.9 million. The

$11 million adjustment is modest compared to cost growth we have seen with other FAA modernization programs[2] and can be accommodated in the current ATOP cost baseline.

In essence, FAA is now shifting some of the risk for deploying ATOP from the contractor to the Government. In particular, the modification allows the contractor to focus additional resources to fix software development problems at the Government's expense. The contractor had staff working on a later and more advanced software version of ATOP even though the first software version was experiencing problems. Now, FAA has shifted resources to help get the basic ATOP system to Oakland in June.

Although the increase of $11 million is modest, we are concerned FAA has shifted the risk of additional cost growth from the contractor to the Government. The critical issue is what happens with ATOP between now and February 2005. This timeframe is important because the recent contract modification limits the contractor's responsibility for paying to fix software problems FAA finds in ATOP after February 28, 2005. According to FAA, after work on the initial version of ATOP software (required for Oakland) is completed, the Agency will test the more advanced version at its Atlantic City Technical Center by the end of this year. After February 2005, FAA must pay to fix software problems that are found. Given the change in the contract and the tight timeframe, it will be critical for FAA to identify all software problems before that date.

A key schedule driver is how quickly ATOP can successfully pass site acceptance tests at Oakland. We note that FAA built additional time into the ATOP schedule to handle unanticipated problems, but most of this schedule reserve was consumed resolving problems discovered during factory acceptance testing (completed in July 2003), which took much longer than anticipated.

As work on ATOP continues, it is important that FAA keep requirements stable to control costs and manage a number of challenges that continue to need attention. They include:

- Fixing any additional software problems found during testing. The time it takes to fix these problems will directly impact the scheduled deployment of ATOP.

- Adapting ATOP to unique oceanic environments. For ATOP to function effectively in the Atlantic, Pacific, and Arctic environments, the standard

[2] For additional information on FAA's major acquisitions, see our Testimony CC-2004-004, "Observations on Bringing Fiscal Discipline and Accountability to FAA's Air Traffic Control Modernization Program," October 30, 2003.

program software must be adapted, i.e. "customized" to the specific requirements of each site's airspace in terms of routes, fixes, and sector boundaries. FAA sought to mitigate this challenge by tasking Lockheed Martin to begin work on the New York facility (which controls traffic over the Atlantic) in December 2001.

- Responding to new concerns with human factors as controllers transition to the new technology. Controllers have been involved in the development of ATOP since the program's inception. However, FAA believes acceptance by all controllers is a concern because ATOP represents a significant change in the way controllers will manage air traffic. Specifically, ATOP will require controllers to use electronic flight data (instead of paper strips) and rely on a new automated tool to help detect potential conflicts between aircraft.

- Providing training and related materials to controllers and maintenance technicians in a timely manner. The challenge lies in getting sufficient numbers of controllers and maintenance technicians trained by June 2004. With every change made to the software during testing, procedures and technical manuals must be revised.

Additionally, FAA is in the process of updating the life-cycle cost for ATOP. The current total life-cycle cost estimate associated with ATOP is $1.6 billion ($548 million planned for Facilities and Equipment and $1.065 billion planned for Operations) through fiscal year 2013. Of particular concern are the costs associated with operating ATOP once it is fielded and the corresponding effect on the Agency's Operations account. The following table illustrates the current life-cycle cost estimate for ATOP.

Current Estimated ATOP Life-Cycle Costs
($ in Millions)

Funding Plan (Fiscal Years)	2000-2002	2003	2004	2005	2006	2007	2008 – 2013	TOTAL
Facilities and Equipment*	$162.9	$93.8	$68.7	$50.4	$35.1	$31.7	$105.6	**$548.2**
Operations**	$140.6	$74.1	$70.3	$69.3	$81.9	$84.0	$545.3	**$1065.5**

Source: FAA's Approved Baseline as of May 2001.

* Facilities and Equipment costs include development, engineering and program support, site preparation, test and evaluation efforts, as well as planned upgrades, commonly referred to as "tech refresh."

** Operations costs include telecommunications, air traffic labor, airway facilities labor, second-level engineering, and sustainment. The telecommunications costs associated with ATOP represents over 40 percent of the cost to operate the new oceanic system.

These life-cycle costs were developed almost 3 years ago (May 2001), and FAA recognizes the estimates for operating ATOP once it is fielded are no longer reliable and need to be updated. FAA plans to have better information on the cost to operate and sustain ATOP later this year. As we have reported before, the impact on FAA's Operations account is important given the increasing demands on this account, as well as declining budget resources.

We are not making recommendations at this time because FAA management is aware of the issues and focusing on the risks facing ATOP. We will continue to monitor progress with ATOP. Also, in the conference report accompanying the Omnibus Appropriations Bill for Fiscal Year 2004, the Congress directed our office to compare FAA's pursuit of oceanic automation capabilities to the experiences of NavCanada and other oceanic air traffic service providers. We intend to begin work on that audit later this year.

Objectives, Scope, and Methodology

We performed our review in accordance with Government Auditing Standards prescribed by the Controller General of the United States. The enclosed briefing materials provide additional details on objectives, scope, and methodology. The briefing materials also contain updated information we collected to supplement the briefing we provided to Subcommittee staff in January 2004.

We provided FAA's Vice President for En Route and Oceanic Services and ATOP program officials with a draft of our report and incorporated their comments into the report where appropriate. The Vice President for En Route and Oceanic Services generally agreed with our analysis and results.

If I can answer any questions or be of further assistance, please contact me at (202) 366-1959 or my Deputy, Todd J. Zinser, at (202) 366-6767.

Sincerely,

Kenneth M. Mead
Inspector General

Enclosure

cc: FAA Administrator

Status Report on the Advanced Technologies and Oceanic Procedures

Office of Inspector General

Briefing for the Subcommittee on Aviation

Committee on Transportation and Infrastructure

U.S. House of Representatives

Overview

The House Aviation Subcommittee asked our office to provide a status report on the Advanced Technologies and Oceanic Procedures (ATOP) program. In doing so, we evaluated FAA's progress in meeting cost, schedule and performance parameters. We also examined risks to meeting ATOP's first deployment, which is planned for June 2004. Our work was performed in accordance with generally accepted government auditing standards.

This report addresses:

- Defining ATOP
- Managing Oceanic Airspace
- Modernizing Oceanic Airspace
- Reviewing ATOP Cost and Schedule
- Assessing Progress and Problems
- Managing Challenges to Cost and Schedule

Defining ATOP

- ATOP is a long-overdue new automation system specifically designed for FAA facilities that manage oceanic air traffic. ATOP is important because controllers currently rely on a labor-intensive process (i.e., using paper strips) to monitor air traffic for surveillance and separation purposes.
- ATOP will collect, manage, and display air traffic data as well as provide electronic flight-strip data on the computer displays. The new system will integrate a variety of capabilities such as automatic dependent surveillance, data link communications (for controllers and pilots), and conflict probe.
- ATOP has important benefits such as enabling FAA to safely reduce aircraft separation from 100 nautical miles to 30 nautical miles, commonly referred to as "30/30 separation" (meaning 30 miles separation wingtip to wingtip and nose to tail), a desirable benefit for airlines who operate international routes.
- ATOP will also allow airlines to take advantage of technologies currently onboard aircraft, including the Future Air Navigation System (FANS-1) avionics package.

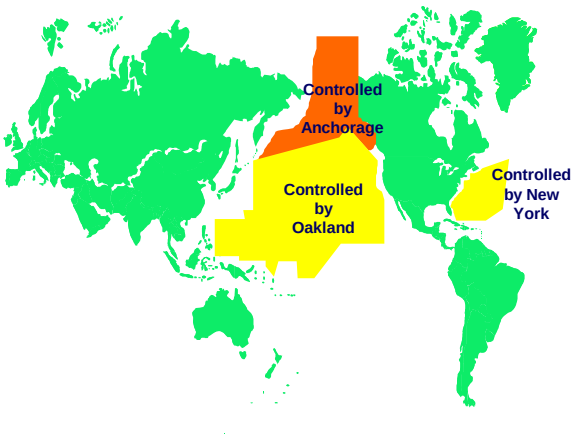
Managing Oceanic Airspace

ATOP will help promote U.S. leadership in air traffic management around the world.

FAA is currently responsible for providing air traffic services to 80 percent of the world's controlled oceanic airspace. This airspace is assigned by the International Civil Aviation Organization, and it can be reassigned to another country.

FAA's oceanic facilities handled more than 600,000 flights in 2002. (Oakland handled more than 220,000 flights, New York more than 350,000, and Anchorage more than 66,000.)

U.S. Oceanic Airspace

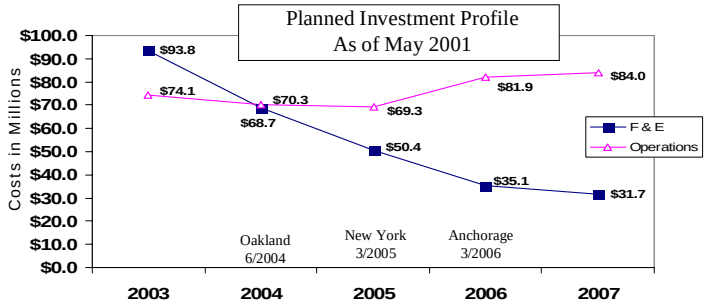


Modernizing Oceanic Airspace

- FAA has struggled for years to modernize its oceanic facilities. In 1995, FAA awarded a contract for oceanic modernization to the Hughes Corporation. However, in 1998, due to poor contractor performance and other problems, the contract was downsized to deliver only the data link portion of the system.
- In 2001, FAA embarked on a new effort to modernize its oceanic air traffic control facilities and awarded a largely firm-fixed-price contract to Lockheed Martin for $217 million to procure four new oceanic systems (for Oakland, New York, Anchorage, and the FAA Technical Center).

ATOP Cost and Schedule

The planned total *life-cycle cost* associated with ATOP is $1.6 billion ($548 million planned for Facilities and Equipment and $1.065 billion planned for Operations) through 2013. Thus far, Congress has appropriated $321.3 million toward the ATOP acquisition.

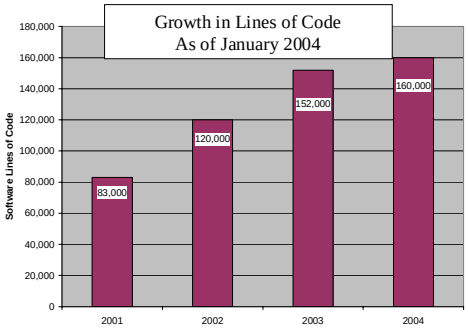


- In addition to development costs, FAA will use Facilities and Equipment (F&E) funds for engineering and program support, site preparation, and test and evaluation efforts, as well as planned upgrades (including "tech refresh") for the system.
- The estimates for operations cost, the bulk of which are telecommunications and labor costs, are under review by FAA and need to be updated.

Assessing Progress and Problems

At an early stage, the ATOP program experienced software development problems because Lockheed Martin underestimated the amount of software code needed to meet FAA's requirements. This resulted in unexpected additional software development and schedule delays.

- The software lines of code that needed to be developed for ATOP increased by 93 percent (from 83,000 to 160,000 lines of code) since 2001. As a result, the first phase of testing —known as factory acceptance testing conducted by Lockheed Martin to determine if the system meets FAA requirements—was completed 12 months behind schedule.
- Software development problems are traceable to Lockheed Martin's decision to rely on non-developmental software from an existing system that they did not fully evaluate and that did not fully meet FAA requirements.
- As a result of the problems, Lockheed Martin did not meet its contractual milestone to provide an operational system in Oakland by April 2003.



Assessing Progress and Problems

- System testing[1] began in October 2003. During testing, FAA uncovered a number of test-critical issues that forced FAA to halt testing of ATOP's air traffic management functions. For example, when a controller typed a message to a pilot via data link, the system did not send the message as quickly as it should. Also, the system did not properly coordinate flight data to adjacent control facilities when an aircraft passed from the one facility to the next. According to FAA officials, issues had to be fixed before testing could resume.
- It is uncertain whether ATOP can be operational in Oakland by June 2004 as currently planned. The agency built in additional time (beyond the contractual initial operating date) for unexpected problems, but most of this schedule reserve has been consumed addressing problems discovered during Factory Acceptance Testing conducted by Lockheed Martin.
- Until recently, the costs associated with additional software development and fixing software problems have been absorbed by the contractor—not the Government. This is because FAA has relied on what is largely a fixed-price contract and kept requirements stable.
- Facing delays to deploying ATOP to Oakland, on March 9, 2004 FAA modified the contract in an effort to maintain the schedule. The modification will expand the time-and-materials portion of the contract, and increase the net value of the contract by $11 million.

[1] System testing is a review conducted at the FAA William J. Hughes Technical Center to ensure the system works as intended. Testing involves both Air Traffic and Maintenance Technician Functions.

Assessing Progress and Problems

The key schedule driver to deploying ATOP to Oakland is successful completion of System Test and Site Acceptance Testing. Until these two significant tests are completed, we cannot determine if the schedule for deploying ATOP to Oakland in June 2004 can be met.

Event	Planned	Actual	Extent of Delays
Factory Acceptance Testing: Conducted by Lockheed Martin to determine if system meets FAA requirements.	Start: May 2002 End: July 2002	Start: November 2002 End: July 2003	12 months
System Testing: Review conducted at the FAA William J. Hughes Technical Center to ensure the system works as intended.	Start: August 2002 End: October 2002	Start: October 2003 Delayed due to issues with Air Traffic Functions	At least 17 months
Site Acceptance Testing: Lockheed Martin test to ensure system is installed and functioning properly on site.	Start: November 2002 End: November 2002	TBD	At least 16 months
Oakland Initial Operating Capability: Airway Facilities declares system capable for conditional use in the National Airspace System.	June 2004	TBD	N/A

Managing Challenges to Cost and Schedule

FAA needs to keep requirements stable and manage a number of challenges to prevent further cost growth and schedule delays.

- **Software Development and Discovery of Unexpected Problems During Testing.** According to program officials, this is one of the most important watch items. Our prior audit work on other FAA major acquisitions shows that when any software-intensive effort experiences difficulty in the early stages of development, problems tend to persist and take longer to resolve. Testing has uncovered problems that need to be fixed. Most recently, software problems were identified that caused FAA to prematurely halt testing of ATOP's Air Traffic functions. Lockheed Martin resolved these problems and testing resumed in February 2004. The time and effort it takes to resolve problems that are discovered during testing is important because the current schedule calls for ATOP to be deployed at Oakland in June 2004.

Managing Challenges

- **Adapting ATOP Software to Atlantic, Pacific, and Arctic Oceanic Environments.** For ATOP to function effectively and to provide promised benefits safely, standard program software must be adapted for each specific airspace in Oakland, New York, and Anchorage. The new system must precisely mirror routes, boundaries, and fixes. For example, at the New York facility, ATOP must provide a seamless transition to airspace on the Atlantic seaboard, which is more congested and complex than the Pacific airspace. In December 2001, FAA sought to mitigate this challenge by tasking Lockheed Martin to begin work on the New York facility (which controls traffic over the Atlantic).

Managing Challenges

- **Human Factors and Transitioning to New Technology.** Controllers have been involved in the development of ATOP since the program's inception. However, FAA believes acceptance by all controllers is a concern because ATOP represents a significant change in the way controllers will manage air traffic. Specifically, ATOP will require controllers to use electronic flight data (instead of paper strips) and rely on a new automated tool to help detect potential conflicts between aircraft. After software development and testing, ATOP program officials believe this is the most pressing management challenge facing the implementation of this new system. However, this transition should be manageable, given that other FAA facilities (enroute facilities that manage high altitude traffic over the continental United States) are using automated controller tools and electronic flight data.

Managing Challenges

- **Training for Controllers and Maintenance Technicians.** The challenge lies in getting sufficient numbers of controllers and maintenance technicians trained by June 2004, when the first system is expected to be operational at Oakland. FAA points out that some revisions to training may result from changes that occur as a result of testing. Airway Facilities training materials (i.e., procedure and technical manuals) have yet to be fully developed and approved. This is a deliverable under the contract with Lockheed Martin. Technician training takes about 12 weeks. FAA recognizes this is a problem and is looking at alternatives to speed up the training process, including hiring additional instructors.

Objective, Scope and Methodology

Our objective was to evaluate FAA's management of the ATOP program with respect to cost, schedule, and performance. We focused our efforts on FAA's progress to provide the first operational system to Oakland, California.

To meet this objective, we:

- Reviewed key documents for the ATOP program such as the acquisition strategy plans.
- Interviewed ATOP program officials, test officials at William J. Hughes Technical Center, and Lockheed Martin officials to discuss the test program and test issues associated with the air traffic/airways facilities training programs.
- Reviewed ATOP test reports, gathered data on critical program trouble reports, and assessed FAA's and Lockheed Martin's progress on these program trouble reports.
- Reviewed cost and schedule analysis reports, as well as obtained and reviewed Lockheed Martin's earned value management reports and monthly program management reviews, to assess FAA's progress in meeting the cost, schedule, and performance goals for this program.
- Visited the Oakland oceanic facility in California to actually witness the system.