Office of Inspector General
Audit Report

FAA HAS MADE PROGRESS FIELDING ERAM, BUT CRITICAL WORK ON COMPLEX SITES AND KEY CAPABILITIES REMAINS

Federal Aviation Administration

Report Number: AV-2013-119
Date Issued: August 15, 2013

Memorandum

U.S. Department of Transportation

Office of the Secretary
of Transportation

Office of Inspector General

Subject: <u>ACTION</u>: FAA Has Made Progress Fielding ERAM, but Critical Work on Complex Sites and Key Capabilities Remains
Federal Aviation Administration
Report No. AV-2013-119

Date: August 15, 2013

From: Jeffrey B. Guzzetti
Assistant Inspector General
  for Aviation Audits

Reply to
Attn. of: JA-10

To: Federal Aviation Administrator

The Federal Aviation Administration's (FAA) efforts to modernize the National Airspace System depend on the successful implementation of the foundational En Route Automation Modernization (ERAM) system—a multibillion dollar system for processing flight data at facilities that manage high-altitude traffic. However, we reported in September 2012[1] that extensive software-related problems have significantly delayed ERAM's nationwide implementation, resulting in hundreds of millions of dollars in increased costs. Our report highlighted a number of fundamental weaknesses with program and contract management that had contributed to ERAM's delays, and we made a series of recommendations to reduce risk with further implementation. FAA concurred or partially concurred with all our recommendations and is currently working to address them.

Following our report, and given the importance of ERAM's role in transitioning to the Next Generation Air Transportation System (NextGen), the House Committee on Appropriations, Subcommittee on Transportation, Housing, and Urban Development and Related Agencies, requested that our office continue monitoring ERAM's progress. Accordingly, our objectives were to (1) provide an update on FAA's progress in implementing ERAM, and (2) identify key issues that could delay the program and impact NextGen initiatives. We briefed the Committee on the results of our work on April 18, 2013 (see exhibit D). We conducted our work

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[1] *Weaknesses in Program and Contract Management Contribute to ERAM Delays and Put Other NextGen Initiatives at Risk* (OIG Report Number AV-2012-179), September 13, 2012. OIG reports are available on our Web site at http://www.oig.dot.gov/.

prior to the sequestration resulting from the Budget Control Act of 2011[2] and therefore did not assess its impact on the ERAM program.[3]

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

RESULTS IN BRIEF

FAA made considerable progress deploying ERAM. The Agency is currently using ERAM at 16 sites either on a full- or part-time basis—a significant step given the extensive problems FAA encountered at the first two ERAM sites. FAA plans to have ERAM fully operational at all 20 sites and decommission the legacy system[4] by August 2014. However, as FAA deploys ERAM to the Nation's busiest facilities, such as New York and Washington, DC, the Agency expects to identify new software-related problems that could impact the program's cost and schedule. FAA is currently spending about $12 million a month just on the Facilities and Equipment (F&E) portion of the ERAM contract. As of February 2013, the Agency had spent approximately 65 percent of the available funding for the program with 9 sites still remaining to be completed. If the current contract spending rate does not decline significantly, the Agency will need additional funding to complete the program as planned.

While FAA's progress with ERAM deployment is noteworthy, the Agency faces multiple challenges that could delay the program. For example, air traffic controllers who are working as ERAM subject matter experts raised concerns that FAA has become too schedule driven and is rushing to complete implementation before site-specific issues are adequately addressed. In addition, controllers told us that they have raised concerns with FAA senior management that the amount of software allotted in the program baseline will not be sufficient to fix unresolved issues and successfully complete the program. Our discussions with controllers and subject matter experts also identified other issues with current ERAM capabilities that are required to enable key NextGen initiatives. For example, these officials raised concerns about ERAM's tracker software, which is needed to combine radar- and satellite-based data to more accurately show aircraft location—a key requirement for future NextGen capabilities. Collectively, these concerns point to the need for continued oversight of the program by FAA management.

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[2] P.L.112-25 (Aug.2, 2011).

[3] Due to sequestration, which began on March 1, 2013, FAA incurred a $637 million dollar reduction in funding for the remainder of fiscal year 2013.

[4] HOST, the legacy en route automation system that ERAM intends to replace, has been in place at facilities since the 1970's.

BACKGROUND

ERAM is a key NextGen-enabling program for processing high-altitude air traffic[5] flight information. It replaces HOST, the legacy en route automation system, which consists of a 40-year-old computer hardware and software system, plus a backup, and more than 800 computer display workstations at 20 of FAA's Air Route Traffic Control Centers (ARTCCs).[6] As a foundational component of NextGen, ERAM is critical for meeting FAA's goals of increasing airspace capacity and reducing flight delays. Without ERAM, the key benefits from new NextGen systems—such as satellite-based surveillance systems and data communications for controllers and pilots—cannot be realized.

FAA originally planned to complete ERAM deployment at all 20 sites by December 2010. However, significant software problems identified early on at the program's first two sites impacted the system's ability to safely manage and separate aircraft and raised questions as to what capabilities ERAM would ultimately deliver. In June 2011, FAA rebaselined ERAM, pushing its expected completion to 2014 and increasing costs by an additional $330 million.

Our September 2012 report highlighted a number of fundamental program management weaknesses that contributed to FAA's difficulties in advancing ERAM. These weaknesses included (1) setting an unrealistic schedule; (2) allowing ERAM to successfully pass Government Acceptance even though testing at the Agency's Technical Center was limited and could not replicate actual field conditions; (3) ignoring early warning signs of trouble, such as an unexpectedly high number of problem reports; and (4) not committing enough management attention to identify, communicate, and fix ERAM's problems.

FAA MADE CONSIDERABLE PROGRESS DEPLOYING ERAM, BUT FAA'S ABILITY TO MEET COST AND SCHEDULE GOALS REMAINS UNCERTAIN

FAA is making considerable progress with fielding ERAM and is currently using ERAM at 16 of the 20 sites either on a full- or part-time basis—11 of which are relying on ERAM to control all en route air traffic full time. FAA is currently moving ERAM to the most complex en route sites and plans to bring the remaining four sites that are still running on the legacy system to initial ERAM operations. However, the efforts required to achieve initial and continuous operations at early sites such as Salt Lake City or Seattle are significantly different from upcoming sites like New York, Washington DC, Atlanta, and Miami. Given the complexity of these remaining locations, such as special airspace concerns,

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[5] En route airspace is high-altitude traffic typically above 10,000 feet, where aircraft reach their cruising altitudes and fly as direct a route as possible between their departure and destination points.
[6] ARTCCs, also referred to as en route centers or centers, control high-altitude air traffic nationwide.

FAA may face unique challenges with site-specific software requirements that could delay ERAM's initial operations at these sites. Ultimately, FAA's plans call for all 20 sites to be fully operational with ERAM and for decommissioning[7] and removing the HOST legacy system by August 2014.

While FAA's progress in deploying ERAM is commendable, concerns remain that the Agency will not be able to complete the program within its current cost and schedule goals. As the table below shows, FAA already expended approximately 65 percent of its re-baselined budget and continues to spend nearly $12 million each month on the program, excluding other funding from NextGen programs and other sources.

Table 1. ERAM Budget and Spending

Total average ERAM contract monthly spending rate in CY 2012—F&E only	$12.4 million per month (includes only ERAM contract F&E)
Total average ERAM monthly spending rate in CY 2012—all sources	$21.2 million per month (includes F&E, O&M, and NextGen)[8]
Total F&E funding approved for the program	$374 million (includes $330 million approved in 2011, plus another $44 million shifted from operations funding and other FAA accounts)
Total dollars spent on the program (as of February 2013)	$242 million (about 65 percent of the total approved)
Total dollars remaining in the approved budget (as of February 2013)	$132.1 million

Source: OIG analysis of FAA data.

As of February 2013, ERAM had only $132.1 million remaining in its approved budget—with 18 months of work remaining before its August 2014 schedule goal. However, ERAM's average monthly spending rate is currently about $12 million on the F&E portion of the contract alone. If costs continue and the program spending rate does not drop significantly, FAA will likely need additional funding to complete ERAM.

CONCERNS REMAIN THAT ERAM MAY NOT BE FULLY READY TO PROVIDE KEY NEXTGEN ENABLING CAPABILITIES

Although FAA is making progress in deploying ERAM, the Agency faces several significant challenges that could impact implementation. According to FAA

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[7] Decommissioning involves the disconnection, removal, and disposal of the HOST computer system once ERAM has been declared operationally ready at a site.

[8] This amount includes $12.4 million of Facilities and Equipment (F&E) funding and $3.3 million of Operations and Maintenance (O&M) funding, and $5.5 million from other NextGen program (i.e., ADS-B, DataComm, and SWIM) for CY 2012.

facility staff and National Air Traffic Controllers Association (NATCA) officials, FAA has become overly driven by the program schedule at the expense of developing needed and important requirements and enhancements. We found that the ERAM Program Office is aggressively managing all remaining ERAM software efforts—but focusing only on fixes to "core functionality" to get ERAM operational at the remaining sites. Under the program's new limited focus, the Program Office has reclassified some previously identified requirements, such as flexible and dynamic airspace[9]—which is needed for controllers to manage air traffic at some specific sites—as "enhancements" instead of requirements. Because FAA has prioritized core functionality fixes over all other "enhancements," some important site-specific issues that controllers insist are needed are being deferred to future software releases due to cost concerns.

Moreover, FAA subject matter experts working directly with the ERAM program office and air traffic controllers continue to raise concerns about some ERAM capabilities that are foundational to other NextGen initiatives. While these issues are not expected to delay ERAM's 2014 implementation, they will need to be addressed to advance NextGen and achieve important benefits. These capabilities include:

- **Flight Plan Trajectory Modeler—**This is an ERAM capability that models aircraft flight paths and is used to predict conflicts between converging aircraft and ensure accurate aircraft "handoffs" between facilities. However, the modeler software often required adjustments to change the flight plan trajectory to ensure accurate handoffs. According to controllers, improvements are needed in order to support current operations and NextGen capabilities that use trajectory-based operations.[10]

- **Aircraft Tracking and Sensor Fusion—**This capability allows ERAM to integrate—or 'fuse"—multiple radars and satellite-based information for controllers. However, thus far, controllers have not been able to take advantage of this improved capability because of technical issues with ERAM's current tracking capability. A MITRE[11] analysis found that the ERAM tracker will require adjustments to use the Automatic Dependent Surveillance-Broadcast system (ADS-B)[12] and ground- based radar together to manage air traffic. Until these issues are addressed, it is unlikely FAA will be able to reduce separation between aircraft at high altitudes.

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[9] Flexible and dynamic airspace allows controllers to shift control of airspace segments to other controllers, based on weather and traffic pattern changes.

[10] Trajectory-based operations focus on more precisely managing aircraft from departure to arrival, with the benefits of reduced fuel consumption, lower operating costs, and reduced emissions.

[11] MITRE Corporation managers a Federally Funded Research and Development Center for the FAA—the Center for Advanced Aviation System Development—that assists FAA with scientific research and analysis.

[12] ADS-B, one of NextGen's transformational programs, is a satellite-based surveillance technology that combines the use of aircraft avionics and ground-based systems.

Finally, FAA managers told us that ERAM efforts may likely be impacted further by budget adjustments resulting from sequestration. We did not independently analyze the impact of sequestration on the ERAM program in this review. However, according to FAA officials we interviewed, sequestration funding reductions will significantly impact ERAM implementation. Agency officials told us that FAA will continue to support the facilities that use ERAM on a full-time basis. However, the Program Office intends to halt activities for facilities that were working to transition from part-time use of ERAM to full-time operations. In addition, the Agency will not initiate efforts at the last four sites that are still using the HOST legacy system full-time to control air traffic and have not begun transitioning to ERAM. According to FAA, furloughs, the reduction of overtime and limited travel funding will limit controllers' ability to serve as subject matter experts and participate in workgroups that support ERAM implementation.

CONCLUSION

FAA's long-term goals for NextGen ultimately depend on the success of its ongoing efforts to deploy and fully implement ERAM. Though FAA made significant progress deploying ERAM, it is uncertain whether the program will stay within cost and on schedule. Challenges are expected as ERAM deployment continues at complex sites on the East coast. To better ensure ERAM progress and stakeholder buy-in, FAA will need to address ongoing concerns regarding system capabilities and fully determine the impact sequestration is having on the program. Ultimately, continued management oversight will remain critical to meeting FAA's ERAM and NextGen goals.

RECOMMENDATIONS

We made a series of recommendations in our September 2012 report to reduce risk with ERAM implementation. FAA concurred or partially concurred with all our recommendations and has been working to address them. We acknowledge FAA's work and progress to date in addressing our recommendations and in getting ERAM on track. We encourage the Agency to continue its efforts to address our previous recommendations and to improve ERAM implementation.

AGENCY COMMENTS AND OFFICE OF INSPECTOR GENERAL RESPONSE

On March 22, 2013, we met with FAA's Air Traffic Organization Program Office and ERAM program management to discuss the results of our follow-up work. They agreed with our findings and conclusions, and provided comments to the briefing that we provided to Congressional staff on April 18, 2013 (exhibit D). Subsequently, we provided FAA a copy of our draft report for review on June 13,

2013, and received technical comments on June 25, 2013, which we incorporated into the final report.

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

EXHIBIT A. SCOPE AND METHODOLOGY

We conducted this performance audit between September 2012 and June 2013 in accordance with generally accepted Government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

The scope of our review was FAA's ongoing efforts since September 2012 through June 2013 to deploy ERAM at its 20 Air Route Traffic Control Centers. This included review and analysis of program plans, progress reports, and documentation on implementation costs. As part of our work, we visited and interviewed staff and subject matter experts at 3 of the 20 air traffic facilities fielding ERAM that were experiencing problems or had not yet begun using ERAM (in particular Atlanta, Chicago, and New York) for a first-hand perspective on ERAM progress and any issues going forward. We also met with FAA program officials, NATCA representatives, controllers, and the MITRE Corporation.

EXHIBIT B. ORGANIZATIONS VISITED OR CONTACTED

<u>FAA Facilities</u>

FAA Headquarters

Atlanta Air Route Traffic Control Center

Chicago Air Route Traffic Control Center

Chicago Terminal Radar Approach Control Center

New York Air Route Traffic Control Center

New York Terminal Radar Approach Control Center

<u>Other Organizations</u>

MITRE Corporation

National Air Traffic Controllers Association (NATCA)

EXHIBIT C. MAJOR CONTRIBUTORS TO THIS REPORT

Name	Title
Barry DeWeese	Program Director
Joseph Hance	Project Manager
Sean Woods	Senior Auditor
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Vicki Smith	Senior Analyst
Audre Azuolas	Writer-Editor

Exhibit C. Major Contributors to This Report

Status Update of FAA's ERAM Implementation

April 2013

U.S. Department of Transportation
Office of Inspector General

Introduction

- In September 2012, we reported on FAA's En Route Automation Modernization (ERAM) program—a multibillion dollar program that is intended to replace and significantly enhance the hardware and software at FAA's en route facilities that manage high-altitude air traffic.

- We made a series of recommendations to FAA to improve ERAM's program management, testing, contract structure, and oversight to reduce the associated risks to completing ERAM and to future NextGen-related programs. FAA has been responsive to our recommendations.

- Subsequent to our report, the Majority and Minority staff from the House Committee on Appropriations, Subcommittee on Transportation, Housing, Urban Development, and Related Agencies asked the Inspector General to monitor the status of ERAM's progress.

- We focused on: (1) FAA's progress in implementing ERAM to include current status and costs; and (2) key issues that could delay the program and impact NextGen initiatives going forward.

Exhibit D. ERAM Status Briefing to House Appropriations Committee, April 2013

Background

- FAA's goals for NextGen—increasing airspace capacity and reducing flight delays—depend on the success of its efforts to deploy ERAM—a $2.1 billion system for processing flight data. Without ERAM, the key benefits from new NextGen systems—such as satellite-based surveillance systems and data communications for controllers and pilots—cannot be realized.

- FAA originally planned to complete deploying ERAM to 20 sites by the end of 2010. However, significant software problems identified early on at the key sites impacted the system's ability to safely manage and separate aircraft and raised questions as to what capabilities ERAM will ultimately deliver.

- Our work found that FAA's problems in advancing ERAM were attributable to a number of fundamental program management weaknesses. These weaknesses included: (1) setting an unrealistic schedule; (2) allowing ERAM to successfully pass Government Acceptance even though testing at the Agency's Technical Center was limited and could not replicate actual field conditions; (3) ignoring early warning signs of trouble, such as an unexpectedly high number of problem reports; and (4) a lack of attention to identify, communicate, and fix ERAM's problems.

- In June 2011, FAA rebaselined ERAM, pushing its expected completion to 2014 and increasing costs by an additional $330 million.

Current ERAM Program Status

- **FAA is making significant progress in deploying ERAM at the Agency's 20 en route centers in the continental United States.** Currently, there are eight sites that are fully operational and FAA has begun to remove the legacy system and rely totally on ERAM. Another eight sites are using the system on a full–or part–time basis.

- **ERAM is now being deployed to the most complex sites, such as New York, in the National Airspace System (NAS).** The efforts required to achieve initial operations, and then continuous operations, at sites such as Salt Lake City or Seattle were less complicated when compared with achieving initial operations at more complex sites.

- **FAA is working to begin using ERAM at the last four sites at Atlanta, Jacksonville, Miami, and Fort Worth, that are still using the legacy system.** FAA plans to begin using ERAM at the four remaining sites that are still running on the legacy HOST system by September 2013.

Current ERAM Program Status (continued)

▶ **As FAA deploys ERAM to more complex sites, program officials have stated that they expect to continue to discover problems that could impact the cost and schedule.** For example:

○ New York Center recently fell back to the legacy HOST system due to altitude handoff issues. ERAM use will be restricted to 4-hour runs until a solution is delivered.

○ Atlanta and Miami Centers have identified site-specific issues, such as dynamic airspace that must be addressed prior to beginning initial operations.

▶ **FAA plans for all 20 sites to achieve full operational capability and to decommission and remove the legacy HOST system at all sites by August 2014.**

Current Costs of ERAM

- **As of February 2013, FAA has spent a total of $302 million of the $330 million added since rebaselining of the ERAM program in June 2011.** This includes $242 million in facilities (F&E) funding and $60 million in operations (O&M) funds.

- **FAA's total monthly average spending rate in the ERAM contract is $21 million.** This includes $12 million of F&E funding, $3 million of O&M funding, and $5.5 million from other NextGen programs (i.e., ADS–B, DataComm, and SWIM).

Funding Source	Monthly Average (CY12)
F&E	$12.4 million
O&M	$3.3 million
F&E and O&M – Non–ERAM (NextGen Programs)	$5.5 million
Average Monthly Total	**$21.2 million**

Source: OIG analysis of FAA data on ERAM contract expenditures (numbers rounded)

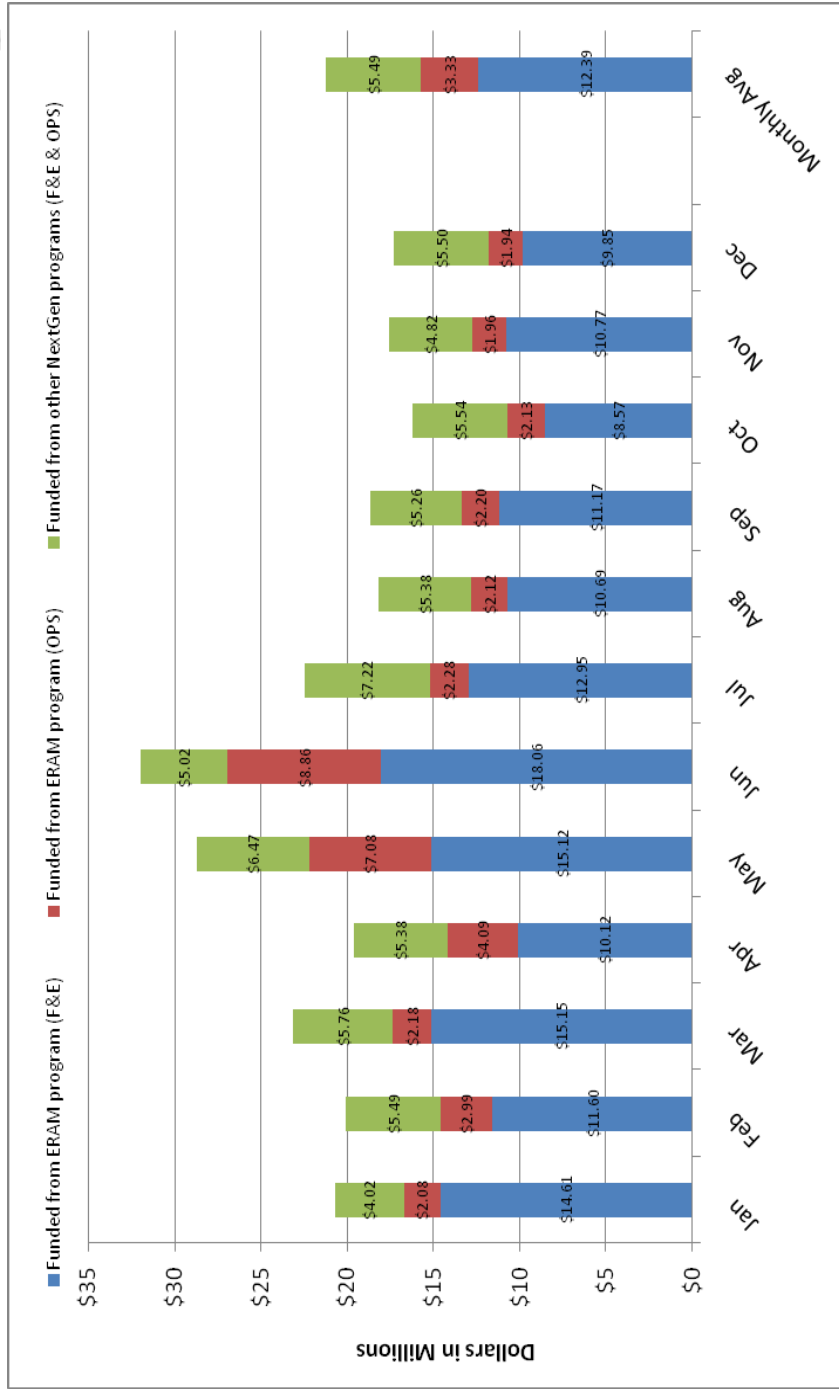# Current Costs of ERAM (continued)

- **FAA has reprogrammed operations funding to support ERAM.** The Office of Management and Budget (OMB) approved the reprogramming of a total of $44 million of existing ERAM O&M funding in FY 2012 and 2013 to F&E funding. While this action did not add additional funding to the program, it did increase F&E funding available to complete ERAM by August 2014 from $330 million to $374 million.

- **Concerns remain that additional funding will be required to complete ERAM.** With 18 months remaining in the schedule, and some of FAA's most complex en route sites remaining ahead, if the current contract burn rate does not decline significantly, the agency will need additional funds to complete this stage of the program.

ERAM Monthly Burn Rate Chart – CY 2012

Source: OIG Analysis

Exhibit D. ERAM Status Briefing to House Appropriations Committee, April 2013

Issues Going Forward

- **FAA is making progress resolving problems and deploying ERAM, but continued senior FAA management oversight is still needed.**

- **Concerns are rising that ERAM implementation is overly milestone driven, to the detriment of system performance.** According to FAA facility and National Air Traffic Controllers Association (NATCA) officials, controllers like ERAM and are supportive of the efforts to field the system. However, there are concerns that FAA has become overly schedule driven, and tensions have increased between NATCA and FAA over the perception that on-time implementation is the primary goal, at the expense of promised or needed capabilities. This has resulted in NATCA leadership raising concerns to senior FAA management.

- **The remaining software baseline is tight, and most is already allocated to planned software builds, leaving little room to fix current or new problems.** The Program Office is aggressively managing the remaining software code—only fixing what is needed for "core functionality" (i.e., functionality that is necessary for controllers to control and manage air traffic). As a result, the Program Office is focusing only on critical and high-priority problems and is deferring lower-priority software fixes to future releases. Some FAA experts estimate that as much as an additional 35,000 lines of software code, in excess of the current baseline, may be needed to complete this stage of the program.

Exhibit D. ERAM Status Briefing to House Appropriations Committee, April 2013

Issues Going Forward (continued)

- **Tension exists between the facilities and the program office over classification of basic requirements versus enhancements.** Previously identified requirements, such as dynamic airspace and holding functions that are necessary for certain facilities to manage air traffic, are being reclassified by the Program Office as "enhancements" and are not being fully addressed at this time.

- **FAA is assessing whether it will retain or remove the ERAM/Legacy backup system.** There are concerns among controllers, technicians and NATCA experts that FAA is planning to remove the Enhanced Back–Up System (EBUS) from ERAM. This system is an independent back–up system that is able to temporarily take over air traffic control should ERAM fail. FAA is still examining this issue.

- **FAA has approved funding for follow–on ERAM NextGen related capabilities.** FAA's Joint Resources Council has approved ERAM software release #4, one of several planned for ERAM, with a cost of $410 million in F&E and $559 million in O&M. This effort will be used to continue to address site specific issues and to add new NextGen related capabilities.

Issues Going Forward (continued)

Based on our discussions with controllers and experts, there are several issues that do not preclude the implementation of ERAM in the 2014 timeframe but will need to be addressed for the system to support NextGen. For example:

▸ **Flight Plan Trajectory Modeler** – This capability models aircraft flight paths and is used to show current and predicted aircraft position to, among other things, predict conflicts and ensure accurate handoffs between controllers and other facilities. However, the modeler unexpectedly displays a target in the wrong location, in direct contradiction to an aircraft's actual position. This has required adjustments to the modeler software to change the flight plan trajectory to ensure accurate handoffs. According to controllers, improvements are needed in order to support current operations and NextGen capabilities that utilize trajectory based operations.

▸ **Aircraft Tracking and Sensor Fusion** – This capability allows ERAM to integrate—or "fuse"—multiple radars and satellite based information for controllers. Thus far, controllers have not been able to take advantage of this improved capability (for using all available radars because) of tracking issues. As a result, fusion has not been fully enabled in ERAM. A MITRE analysis found that the ERAM tracker will require adjustments to use ADS–B and radar together to manage air traffic. Until issues with fusion tracking are addressed, it is unlikely FAA will be able to reduce separation between aircraft at high altitudes.