

**Before the Subcommittee on Aviation,
Committee on Transportation and Infrastructure
U.S. House**

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Federal Aviation Administration

Status Report on the Standard Terminal Automation Replacement System

**Statement of
Alexis M. Stefani
Assistant Inspector General for Auditing
U.S. Department of Transportation**



Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to update you on the Federal Aviation Administration's (FAA) efforts to develop and deploy the Standard Terminal Automation Replacement System (STARS). STARS was designed to provide the software and hardware platform necessary to support future air traffic control tools, such as a data link, and Free Flight. These are important building blocks for future capacity enhancements.

In March of this year, we testified before this Subcommittee that STARS had experienced schedule delays and cost increases; FAA's aggressive deployment schedule would likely lead to further cost and schedule overruns; and problems in the new Airport Surveillance Radar (ASR)-11 program could further delay the STARS program. STARS needs ASR-11 digital radar because FAA has over 100 analog radars in operation that will not work with STARS. At the March hearing, Chairman Mica announced that the Subcommittee would hold a hearing in June to review the status of STARS and progress made by FAA in meeting our recommendations. Today I would like to discuss two points.

- First, deploying STARS within cost and schedule remains at risk due to an aggressive test schedule and dependencies on the ASR-11 digital radar deployment.
- Second, FAA needs to take additional actions to address our March recommendations by quantifying all costs associated with STARS deployment and evaluating if additional Common ARTS will be needed to support FAA's terminal modernization efforts should STARS fall further behind schedule.

Deploying STARS Within Cost and Schedule Remains at Risk. Since we testified in March, STARS software development is nearly complete. However, we are concerned about FAA's ability to deploy STARS within the current cost and schedule because of the compressed software testing schedule, the significant number of trouble reports generated during recent software testing, and delays in the deployment of the ASR-11 radar. The test schedules of the multiple STARS software configurations overlap, and time frames for testing are aggressive. The schedule creates significant risks that delays at any testing phase could further delay STARS deployment.

In May of this year, FAA completed the first phase of system acceptance testing for Full STARS version 1 software (not the nationally deployable system – version 2+) and identified over 500 trouble reports. There were 112 trouble reports that were so serious they affect the essential performance of the system or could jeopardize safety or security. Seventy-seven additional trouble reports are considered critical.

These 189 trouble reports will need to be fixed and retested before moving on to operational testing.

FAA and Raytheon are working to correct the deficiencies before the next important milestone of July 13, 2001, when the software will be retested. Because of the large number of “must fix” problems identified, FAA has acknowledged that not all trouble reports will be corrected before the July 13 test date. To meet that deadline, FAA will allow Raytheon to defer an undetermined amount of fixes until future testing. Given the compressed test schedule, we remain concerned about the number of outstanding trouble reports that need to be fixed.

FAA tasked Mitre Corporation to analyze Raytheon’s ability to complete software development and testing of STARS. According to Mitre, the existing schedule is achievable despite the large number of trouble reports that will need to be fixed. However, resources or schedules will be strained if greater than projected numbers of trouble reports are created, or if resolving trouble reports takes longer than anticipated. The large number of unresolved trouble reports bears close watching.

A significant issue identified by Mitre was that FAA cannot afford to add new requirements to the system during operational test and evaluations. According to Mitre, any additions to the system could impact Raytheon’s ability to correct identified problems and complete testing within the current aggressive schedule.

The ASR-11 program also poses a major risk to STARS deployment. Because STARS is a fully digital system, FAA must replace over 100 analog ASR-7 and ASR-8 radars with the digital ASR-11 radar, which is being developed by Raytheon under a Department of Defense (DOD) contract. However, DOD testing of the ASR-11 identified significant deficiencies in the system including false aircraft targets being displayed and misleading weather detection and display. Based on DOD test results, FAA identified five major areas that need to be addressed before it can proceed with ASR-11 operational testing and evaluation, which was scheduled to start this month. FAA now expects as much as a 6-month delay before it can begin testing ASR-11, which could have significant implications for the deployment of STARS.

With the uncertainties of the ASR-11 program, FAA is moving forward with a contingency plan to purchase digitizers that can convert analog radar signals of ASR-7 and ASR-8 radar systems to digital signals to work with STARS. FAA is evaluating whether digitizers could be an effective “stopgap” measure until the ASR-11 digital radars are deployable. However, digitizers would require extensive operational testing before being used with STARS, and FAA has not developed a test plan using that scenario. In addition, digitizers are expensive, at over \$1 million per system. As of today, it is unclear who will pay for digitizers needed while

Raytheon works to fix problem with the ASR-11. FAA is still searching for alternative solutions to obtain digital radar input in case the ASR-11 is further delayed.

As we testified in March, FAA has already moved forward with an interim measure known as Common ARTS. Common ARTS provides many of the same functions that STARS will provide when completed, including Free Flight tools. Common ARTS standard software package is being used at some of FAA's highest volume terminal facilities including New York, Atlanta, and Chicago. Common ARTS also accepts both digital and analog radar feeds, which would eliminate the ASR-11 risks currently faced by the STARS program.

FAA Must Quantify All Costs Associated with STARS Deployment and Determine If Common ARTS Will Be Needed in Its Terminal Modernization Should STARS Fall Further Behind Schedule. In our March testimony before this Subcommittee, we recommended that FAA analyze its terminal automation strategy. This included: (1) establishing milestone dates and quantifying all costs associated with delivery, installation, training, and testing for STARS deployment; and (2) evaluating whether additional Common ARTS would be needed to support FAA's terminal automation needs.

FAA has not identified all costs associated with deploying STARS through 2008. In our March testimony, we stated that STARS program costs would likely increase, and recommended that FAA identify any and all costs associated with the program. STARS costs have continued to rise, and final cost projections are still incomplete. FAA has identified additional development and deployment costs of \$171 million, increasing the current baseline to \$1.57 billion. FAA also identified costs necessary for STARS implementation through 2004 that were not included in the baseline such as training and facility modernization that will increase the total terminal modernization costs to \$1.678 billion.

As shown in the following chart, the additional deployment costs could increase the total terminal modernization costs by \$104 million. However, those costs are only associated with 67 sites. The costs do not include estimates for the additional 99 sites scheduled for deployment through fiscal year 2008.

Estimated Terminal Modernization Costs Through Fiscal Year 2004

(\$ in millions)

March 2001 Program Baseline	\$ 1,403
Increase to Baseline	<u>\$ 171</u>
Total Baseline Costs as of June 2001	\$1,574
Other Deployment Costs	
Training/Overtime	\$ 17
Facility Modernization	\$ 83
Digitizers	<u>\$ 4</u>
Total Other Costs	\$ 104
Total Estimated Terminal Modernization Costs	\$1,678

FAA's schedule for STARS deployment is only projected through fiscal year 2004 and therefore does not cover the full STARS deployment, which is scheduled for completion in fiscal year 2008. With this limited information, we cannot assess, nor can FAA, if the 2008 date is achievable or what the total projected costs of the program will be. FAA needs to complete the implementation schedule beyond 2004, which will allow the agency to determine the schedule's feasibility and identify additional costs that will be needed to complete other deployment needs such as training and facility modernization.

STARS deployment schedule remains at risk. FAA anticipates it will need up to 180 days from the installation of the STARS equipment to site commissioning for each of the 164 sites. Furthermore, FAA and DOD will need to integrate deployment schedules, because FAA must support the installation, adaptation, and training for DOD sites.

During the peak activity in 2004, equipment will be delivered to 50 sites, or almost 1 new site per week. Once delivered, installation, training, and testing must be done. This is a formidable challenge under the best of circumstances. In addition, many sites will require extensive facility modernization. A key to FAA's ability to maintain the aggressive schedule will be agreement from both the National Air Traffic Controllers Association (NATCA) and the Professional Airway Systems Specialists (PASS) Union on the STARS implementation and training schedule.

FAA did not consider how to integrate Common ARTS into its current terminal modernization efforts should STARS fall further behind schedule. In our March testimony, we recommended that FAA evaluate if additional Common ARTS with displays would be needed to support FAA's terminal automation needs. We also recommended that the evaluation contain a detailed comparison of cost and capabilities of each system, their ability to be upgraded with future enhancements, and their ability to meet realistic deployment schedules.

In response to our recommendation, FAA provided an analysis of an unsolicited proposal by Lockheed Martin (made in March 2001) to replace STARS with Common ARTS. FAA rejected the Lockheed Martin proposal on the premise that the STARS program is “healthy and safe,” and that there was no significant cost advantage to switching systems. FAA concluded that Common ARTS would require extensive computer human interface development work and questioned system security and backup capabilities. In anticipation that those perceived deficiencies would need to be corrected, FAA adjusted the costs of the Lockheed Martin proposal upwards by 24 percent. Before this adjustment, the Lockheed Martin proposal was less than the remaining cost to implement STARS. The analysis, however, did not address why these additional computer human interface, security, and backup needs would be required given that Common ARTS is operational at six of the busiest terminal facilities in the FAA.

In making our recommendations, we envisioned that FAA would evaluate whether Common ARTS, in addition to the six existing and four planned locations, could be expanded to additional locations to support FAA’s terminal automation efforts in the event that STARS falls further behind schedule. However, FAA’s analysis of the Lockheed Martin proposal did not address the intent of our recommendations. Instead FAA’s analysis considered an “all or nothing” scenario between Common ARTS and STARS.

FAA should identify specific sites that could use Common ARTS as an alternate to STARS should FAA experience further schedule slippage in STARS testing and deployment. Many major terminal sites are early in the STARS deployment schedule. For example, Philadelphia’s new terminal radar approach control (TRACON) facility is scheduled to become operational with the nationally deployable version of STARS in November 2002 – only 17 months from now. That timeframe allows no margin for slippage in STARS deployment.

FAA must act now to develop a viable contingency for STARS including specific milestones or trigger dates to decide if Common ARTS systems need to be purchased and installed at specific sites. FAA has determined that it needs an 18-month lead-time from procurement to operational use at a site for Common ARTS, which puts early schedule sites such as Philadelphia at risk now. If STARS deployment is delayed further, FAA will not have sufficient lead-time to purchase and install Common ARTS at this location.

Background

STARS will replace controller workstations with new color displays, processors, and computer software at over 170 FAA and 100 DOD terminal air traffic control facilities.¹ STARS was designed to replace aging equipment and provide the software and hardware platform necessary to support future air traffic control tools in the terminal environment. The terminal environment encompasses 5 to 50 miles around an airport.

In September 1996, FAA awarded a contract to Raytheon Systems Company for the development and implementation of STARS. The original STARS program was estimated to cost approximately \$940 million. The first planned site for full operational capability was September 1998 for DOD and December 1998 for FAA. The last planned operational site was July 2007 for DOD and February 2005 for FAA.

Originally, the STARS development plan was broken down into two phases. The first phase, known as the Initial System Capability, would provide the facilities with new hardware and software capable of providing the same functions as the old automation system being replaced. The second phase, known as Full System Capability, would add additional functions such as the Converging Runway Display

¹ The terminal environment controls aircraft taxiing, or departing from and arriving at airports and consists of both Air Traffic Control Towers and TRACONs at or near airports.

Aid. Due to computer human interface changes, in October 1999, FAA approved a new development strategy calling for incremental development and deployment.

FAA fragmented the STARS development plan into multiple configurations to better manage development. FAA's decision to split the development of STARS using the "*build a little, test a little*" approach resulted in seven configurations, each requiring its own set of milestones for development and testing. FAA now estimates that the last full service STARS will be deployed to FAA facilities by September 2008 – almost 4 years behind schedule. As a result, FAA modified the STARS total program costs from \$940 million to \$1.4 billion.

FAA also moved forward with an interim measure, known as Common ARTS. Common ARTS provides many of the same functions that STARS will provide when completed. The Common ARTS standard software package is being used at FAA's highest volume terminal facilities. In 1998 and 1999, FAA installed the Common ARTS software upgrade to 5 high traffic sites and 131 low-to-mid-traffic sites. On April 10, 2001, FAA commissioned a new Common ARTS at Atlanta and now expects to install Common ARTS at four more high traffic facilities while STARS development is being completed and tested.

Deploying STARS Within Cost and Schedule Remains at Risk

Software development is nearly complete, but testing schedules are aggressive.

Since we last testified before this Subcommittee, software development for STARS has been nearly completed, and FAA has begun testing the developed code. However, given the multi-configuration approach to STARS, the testing schedule is very aggressive.

Because STARS was developed through a process using multiple configurations with each configuration building on the previous one, it must pass extensive and rigorous testing at each phase of development. First, Raytheon, through contractor System Acceptance Testing, demonstrates the technical performance of the new configuration to meet the STARS system requirements. Once the system passes this stage, FAA then performs an operational test and evaluation to determine if the system is operationally suitable and effective. Finally, after the system passes operational testing, FAA conducts yet a third test at an operational facility, known as key site testing.

During each test, “trouble reports” are generated when problems are found in the performance of the software. Trouble reports are then given to the contractor who must resolve each issue before that phase of the system can be retested. The test schedules of the multiple STARS configurations overlap and time frames for testing are aggressive. The schedule creates significant risks that delays at any testing

phase could further delay STARS deployment. As shown in the following table, FAA is in the very early stages of the testing schedule.

FAA Is in the Early Stages of an Aggressive Testing Schedule

STARS TESTING SCHEDULE																							
Task Name	2001												2002										
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug			
Full STARS 1 SAT	████████████████████																						
Full STARS 1 OT&E													████████████████████										
Full STARS 2 SAT													████████████████										
Full STARS 2+ SAT													██										
Full STARS 2/ 2+ OT&E													████████████████████										

Most recent software test

SAT – System Acceptance Testing
OT&E – Operational Test and Evaluation
Full STARS 2+ is the first nationally deployable version of STARS.

Early tests have uncovered problems that could impact STARS deployment. In May of this year, FAA completed the first phase of System Acceptance Testing for Full STARS version 1 software (not to be confused with the nationally deployable system – Full Stars 2+) and identified over 500 trouble reports. There were 112 trouble reports that were so serious they affect the essential performance of the system or jeopardize safety or security. Seventy-seven additional trouble reports are considered critical. These 189 trouble reports will need to be fixed and retested before moving on to operational testing.

FAA and Raytheon are working to correct these deficiencies before the next important milestone of July 13, 2001, when the software will be retested. Because of the large number of “must fix” problems found in the most recent test, FAA has acknowledged that not all trouble reports will be fixed and ready to be retested by the July 13 milestone. Accordingly, FAA has decided to allow Raytheon to defer an undetermined amount of fixes until the scheduled testing date for the next configuration (Full STARS 2). As a result of moving many of the identified trouble reports out, Raytheon has requested that the scheduled testing date for Full STARS 2 be delayed 30 days.

FAA tasked Mitre Corporation to analyze Raytheon’s ability to complete STARS software development and testing. According to Mitre, the existing schedule is achievable despite the large number of trouble reports that will need to be fixed. This was based on an analysis of Raytheon’s historical performance in correcting trouble reports. However, resources or schedules will be strained if greater than expected numbers of trouble reports are created, or resolving trouble reports takes longer than anticipated. The large number of unresolved trouble reports bears close watching.

A significant issue identified by Mitre was that FAA cannot afford to add new requirements to the system during operational test and evaluations. According to

Mitre, additions to the system will impact Raytheon's ability to correct identified problems and complete testing within the current aggressive schedule.

We remain concerned that the number of outstanding trouble reports needing to be fixed in combination with an aggressive test schedule could further delay STARS deployment. FAA has experienced similar problems in the past. In October 2000, FAA started operational testing of the Early Display Configuration. This phase of testing was scheduled to take 4 months, and after problems were identified and corrected, actual testing required more than 7 months.

The ASR-11 digital radar remains a major risk to STARS deployment. In our March testimony, we identified significant concerns regarding development of the ASR-11 digital radar. Because STARS is a fully digital system, FAA planned on replacing over 100 analog ASR-7 and ASR-8 radars with the digital ASR-11 radar, which is being developed by Raytheon under a DOD contract.

DOD testing of the ASR-11 identified significant deficiencies in the system. DOD found critical problems with false aircraft targets being displayed and misleading weather detection and display. Based on DOD test results, FAA identified five major areas that need to be addressed before it can proceed with operational testing and evaluation, which was scheduled to start this month. FAA now expects as much

as a 6-month delay before it can begin testing ASR-11, which could have significant implications for the deployment of STARS.

STARS will require 100 ASR-11 digital radar systems. The most immediate need will be felt at Philadelphia, which is scheduled to become operational in 2002. With the uncertainties of the ASR-11 program, FAA is moving forward with a contingency plan to purchase digitizers that can convert analog radar signals of ASR-7 and ASR-8 radar systems to digital signals to support STARS.

FAA is evaluating whether digitizers could be used as a “stopgap” measure between the analog radar system and the ASR-11 digital radar. However, digitizers would require extensive operational testing before being used with STARS, and FAA has not developed a test plan using that scenario. In addition, digitizers are expensive, at over \$1 million per system. FAA is still searching for alternative solutions to digital radar input in case the ASR-11 is further delayed.

FAA’s Cost Projections and Deployment Schedule for STARS Remain Incomplete

In our March testimony before this Subcommittee, we recommended that FAA analyze its terminal automation strategy. This included:

- Establishing milestone dates and quantifying all costs associated with delivery, installation, training, and testing for STARS deployment; and

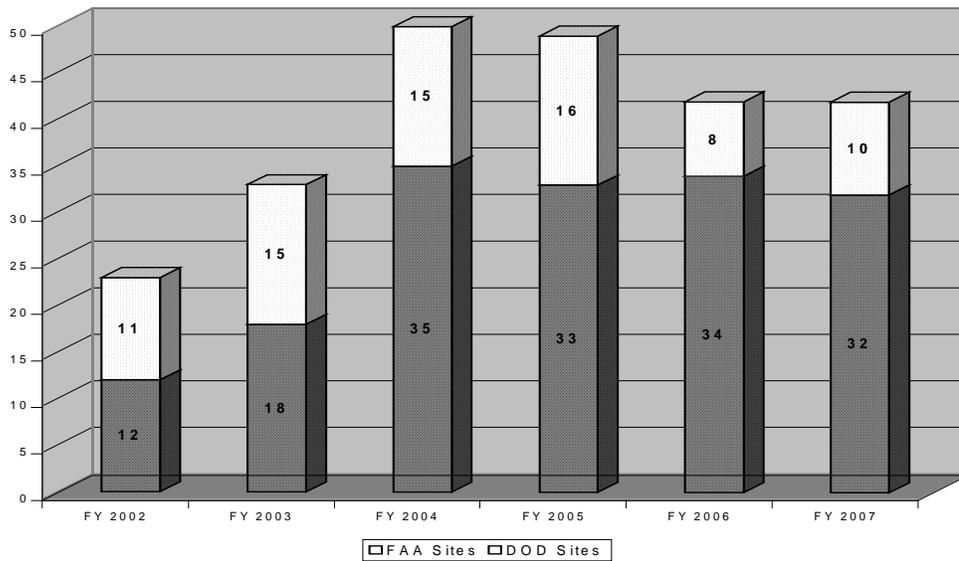
- Evaluating whether additional Common ARTS with color displays, a system comparable to STARS technologies would be needed to support FAA's terminal automation needs. Key to completing this recommendation was for FAA to fully outline its deployment schedule and system costs through the end of STARS deployment, currently scheduled for 2008.

FAA developed site-specific deployment schedules but the schedules do not cover the entire deployment of STARS. FAA's schedule for STARS deployment is only projected through fiscal year 2004 and therefore does not cover the full STARS deployment, which is scheduled for completion in fiscal year 2008. With this limited information, we cannot assess, nor can FAA, if the 2008 date is achievable or what the total projected costs of the program will be. FAA needs to complete the implementation schedule beyond 2004, which will allow the agency to determine the schedule's feasibility and identify additional costs that will be needed to complete other deployment needs such as training and facility modernization.

We believe there are still risks to meeting deployment milestones even if the deployable STARS software is ready for installation starting in October 2001. FAA's deployment schedule, as shown in the following chart, remains very aggressive. FAA anticipates from time of installation to declaring a site operationally capable will require up to 180 days. Furthermore, FAA and DOD will need to integrate deployment schedules, which will have implications to FAA's

schedule because FAA must support the installation, adaptation, and training for DOD sites.

Equipment Delivery to Deployment Sites



During the peak activity in 2004, equipment will be delivered to 50 sites, or almost 1 new site per week. Once the equipment is delivered, installing, training, and testing must be done. This is a formidable challenge under the best of circumstances. In addition, many sites will require extensive facility modernization. A key to FAA's ability to maintain the aggressive schedule will be agreement from both NATCA and PASS on the STARS implementation and training schedule.

FAA has not identified all costs associated with deploying STARS through 2008.

In our March testimony, we stated that we expected STARS program costs to increase, and recommended that FAA identify any and all costs associated with the

program. FAA has now identified additional costs of approximately \$171 million to the baseline costs for STARS - \$165 million of these costs are associated with increased deployment costs and the remaining \$6 million for increased development costs.

In addition, FAA has identified other costs that will be necessary to implement STARS that are not included in the program baseline. Those costs are directly attributable to the deployment of STARS. For example, conversion to STARS will require a significant amount of training. About 9,000 air traffic controllers will need a 1-week training course on STARS, and about 1,500 maintenance technicians will need a 7-week course on maintaining and repairing STARS. In addition, FAA will need to pay personnel overtime costs to fill controller and technician positions while site personnel are in training. FAA will also need to modernize facilities to accommodate STARS. These facilities include TRACONs and Air Traffic Control towers, which will need new STARS displays. These facility costs include upgrading power systems as well as heating, ventilation, and air conditioning systems.

Finally, as we stated earlier, the ASR-11 digital radar is experiencing problems that have required additional contingencies. Based on the current status of the ASR-11 program, FAA now anticipates the need for three radar digitizers through 2004 to

convert analog radar data. However, if the ASR-11 program experiences further delays, the need for additional digitizers, and the associated costs, will increase.

As shown in the following chart, these requirements outside the baseline could add an additional \$104 million to the total terminal modernization costs. However, those costs are only associated with 67 sites through 2004. The costs do not include estimates for the additional 99 sites scheduled for deployment through fiscal year 2008.

**Terminal Modernization Costs Through Fiscal Year 2004
(in millions)**

Current program cost baseline	\$ 1,403
Increase to Baseline for deployment	<u>\$ 171</u>
Total Baseline Costs as of June 2001	\$1,574
Other Deployment Costs	
Training/ Overtime	\$ 17
Facility Modernization	\$ 83
Digitizers	<u>\$ 4</u>
Total Other Costs	<u>\$104</u>
Total Estimated Terminal Modernization Costs	\$1,678

FAA did not identify whether additional Common ARTS could be used to support its terminal automation needs should STARS fall further behind schedule. In our March testimony, we recommended that FAA evaluate if additional Common ARTS with displays would be needed to support FAA’s terminal automation needs. We also recommended that the evaluation include an independent assessment by a group that would not have a vested interest in the outcome. We recommended that the assessment contain a detailed comparison of cost and capabilities of each system,

their ability to be upgraded with future enhancements, and their ability to meet realistic deployment schedules.

In response to our recommendations, FAA provided only a summary analysis of an unsolicited proposal made by Lockheed Martin in March 2001, to replace the STARS program with Common ARTS. FAA rejected the Lockheed Martin proposal on the premise that the STARS program is “healthy and safe,” and that cost comparisons showed no significant advantage to switching systems. FAA concluded that Common ARTS would require extensive computer human interface development work and questioned system security and backup capabilities.

In anticipation that those perceived deficiencies would need to be corrected, FAA increased the Lockheed Martin proposal costs by 24 percent. Before this adjustment, the Lockheed Martin proposal was less than the remaining cost to implement STARS. The analysis did not address why these additional computer human interfaces, security and backup needs would be required given that Common ARTS is operational at 6 of the busiest terminal facilities in FAA.²

In addition to cost considerations, FAA stated that the Lockheed Martin proposal did not address DOD requirements, nor did FAA agree with Lockheed Martin’s

² Common ARTS is currently operational at six of the busiest terminal facilities in the country: New York, Southern California, Atlanta, Denver, Chicago, and Dallas/Fort Worth. Common ARTS is also planned for installation at four other facilities by 2002: Minneapolis, St. Louis, Northern California, and Potomac.

timetable for deployment. FAA stated that Common ARTS deployment would be slightly faster than STARS, but not as fast as the 3-year schedule reduction projected in the Lockheed Martin proposal. According to FAA's analysis, the limit to the proposed timetable was FAA resources, not Lockheed Martin's ability to deliver Common ARTS.

In making our recommendations, we envisioned that FAA would evaluate whether Common Arts, in addition to the six existing and four planned locations, could be expanded to additional locations to support FAA's terminal automation efforts in the event that STARS falls further behind schedule. However, FAA's analysis of the Lockheed Martin proposal did not address the intent of our recommendations. Instead FAA's analysis considered an "all or nothing" scenario of using only Common ARTS or only STARS hardware and software.

FAA should identify specific sites that could use Common ARTS as an alternate to STARS should FAA experience further schedule slippage in STARS development and deployment. Many major terminal sites are early in the STARS deployment schedule. For example, Philadelphia's new TRACON is scheduled to become operational with the nationally deployable version of STARS in November 2002 – only 17 months from now. That timeframe allows no margin for slippage in STARS deployment.

FAA has determined that it needs an 18-month lead-time from procurement to operational use at a site for Common ARTS, which puts early schedule sites such as Philadelphia at risk now. If STARS deployment is delayed further, FAA will not have sufficient lead-time to purchase and install Common ARTS at this location. FAA must act now to develop a viable contingency for STARS including specific milestones or trigger dates to decide if Common ARTS systems need to be purchased and installed at specific sites.

Mr. Chairman, this concludes my statement. I would be pleased to answer any questions.