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AIR TRAFFIC CONTROL

Observations on FAA's Modernization Program

Statement of Gerald L. Dillingham,
Associate Director, Transportation Issues,
Resources, Community, and Economic
Development Division

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Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to testify on the Federal Aviation Administration's (FAA) program to modernize its National Airspace System (NAS), a multibillion dollar investment comprising over 200 separate projects. In late 1981, FAA began this program to replace and upgrade the system's equipment and facilities to meet the expected increase in traffic volume, enhance the margin of air safety, and increase the efficiency of the air traffic control (ATC) system—the principal component of the NAS. However, the modernization program has experienced many problems in meeting cost, schedule, and performance goals. As a result, many of the promised benefits from using the new equipment have been delayed and the aviation community's confidence in FAA's ability to manage the modernization program has been weakened. Because of the complexity, the cost, and the problem-plagued past of FAA's modernization program, GAO designated it a high-risk information technology initiative in 1995 and again in 1997.[1] FAA is currently developing a new modernization approach.

Our testimony today, which is based on completed and ongoing work, discusses (1) the status of key modernization projects, (2) FAA's actions to implement recommendations to correct modernization problems, and (3) the opportunities and challenges facing FAA as it embarks upon its new modernization approach. In summary, we found the following:

- Since 1982, the Congress has appropriated over $25 billion to the modernization program. While FAA has fielded some equipment, historically, the agency has experienced considerable difficulty in delivering systems within promised cost and schedule parameters. As a result, FAA has been forced to implement costly interim projects. Meanwhile, two key systems—the Wide Area Augmentation System and the Standard Terminal Automation Replacement System—have encountered cost increases and schedule delays.
- Our work has pinpointed the root causes of FAA's modernization problems and has recommended actions to overcome them. Most recently, we found shortcomings in the areas of systems architecture or the overall modernization blueprint, cost estimating and accounting, software acquisition, and organizational culture. Although FAA has begun to implement many of our recommendations, sustained management attention is required to improve the management of the modernization program.

[1]FAA's modernization program is one of four information management and technology high-risk areas. See High-Risk Series: An Overview (GAO/HR-95-1, Feb. 1995) and High-Risk Series: Information Management and Technology (GAO/HR-97-9, Feb. 1997).

- FAA is collaborating with and seeking commitment from users in developing a new approach to make the modernization less costly and to provide earlier user benefits. The challenge for FAA is to have disciplined processes in place in order to deliver projects as promised. The agency will also need to quickly address the looming year 2000 computer crisis to ensure that critical ATC systems do not malfunction or produce inaccurate information simply because the century has changed.

Background

As the principal component of the NAS, FAA's ATC system must operate continuously—24 hours a day, 365 days a year. Under federal law, FAA has primary responsibility for operating a common ATC system—a vast network of radars; automated data processing, navigation, and communications equipment; and traffic control facilities. FAA meets this responsibility by providing such services as controlling takeoffs and landings and managing the flow of air traffic between airports.[2] Users of FAA's services include the military, other government users, private pilots, and commercial aircraft operators.[3]

Projects in FAA's modernization program are primarily organized around seven functional areas—automation, communications, facilities, navigation and landing, surveillance, weather, and mission support.

Over the past 16 years, FAA's modernization projects have experienced substantial cost overruns, lengthy schedule delays, and significant performance shortfalls. To illustrate, the centerpiece of that modernization program—the Advanced Automation System (AAS)—was restructured in 1994 after estimated costs to develop the system tripled from $2.5 billion to $7.6 billion and delays in putting significantly less-than-promised system

[2]FAA uses three types of facilities to control traffic. Airport towers direct traffic on the ground, before landing, and after takeoff within about 5 nautical miles from the airport and about 3,000 feet above the airport. Terminal radar approach control (TRACON) facilities sequence and separate aircraft as they approach and leave airports, beginning about 5 nautical miles and ending about 50 nautical miles from the airport and generally up to 10,000 feet above the ground. Air route traffic control centers called en route centers, control planes in transit and during approaches to some airports. The airspace that most en route centers control extends above 18,000 feet for commercial aircraft. En route centers also handle aircraft at lower altitudes when dealing directly with a control tower, or when agreed upon with a terminal facility.

[3]The Department of Defense (DOD), with FAA's authority and oversight, also provides air traffic services, primarily in support of its military mission, but also to civil users. The DOD operates tower and terminal facilities; therefore, FAA and DOD have formally agreed to cooperate in modernizing air traffic control facilities.

capabilities into operation were expected to run 8 years or more over original estimates.[4]

FAA Has Fielded Some Equipment but Key Projects Continue to Experience Cost and Schedule Problems

The Congress has appropriated over $25 billion for ATC modernization between fiscal years 1982 and 1998.[5] FAA estimates that it plans to spend an additional $11 billion through fiscal year 2003 on projects in the modernization program.

Of the over $25 billion appropriated to date, FAA has reported spending about $5.3 billion on 81 completed projects and $15.7 billion on about 130 ongoing projects. Of the remaining funds, FAA has reported spending about $2.8 billion on projects that have been cancelled or restructured and $1.6 billion for personnel-related expenses associated with systems acquisition. (See app. I for a list of completed projects.) FAA has fielded some equipment, most recently a new voice communications system. However, delays in other projects have caused the agency to implement costly interim projects. Furthermore, the agency is still having difficulties in acquiring new systems within agreed-to schedule and cost parameters.

New Equipment Is Being Fielded

FAA has been fielding new ATC systems. For example, in February 1997, FAA commissioned the last of 21 Voice Switching and Control System (VSCS) units.[6,7] As one of the original projects in the 1983 modernization plan, the VSCS project encountered many difficulties during its early years. Since the project was restructured in 1992, FAA has been successful in completing the first phase of the project—installing the equipment into existing en route controller workstations. The second phase is now underway—making VSCS interface with the new display replacement equipment that is being installed in the en route centers.

During the past year, FAA has commissioned 183 additional systems or units of systems. For example, FAA commissioned an additional 97 units for its Automated Surface Observing System, which brings the total of

[4]AAS was designed to replace computer hardware and software, including workstations, used by controllers in ATC facilities.

[5]These funds were appropriated to FAA's facilities and equipment account, which finances systems acquisition.

[6] The term "commissioned" is defined as the formal approval of the equipment for operational use.

[7] The Voice Switching and Control System replaces and improves ground-to-ground and air-to-ground communications equipment at FAA's Air Route Traffic Control Centers.

commissioned units to 230 out of 597 that are planned.[8] (See app. II for details on the implementation status of 17 major ongoing modernization projects and app. III for data on changes in their cost and schedules.)

Delays Have Led to Costly Interim Projects

Problems with modernization projects have caused delays in replacing FAA's aging equipment, especially the automation equipment in the en route and terminal facilities. We found that FAA has added four interim projects—three for the TRACONs and one for the en route centers—reported to cost about $655 million—to sustain and enhance current automated air traffic control equipment. FAA began its first program for the TRACONs in 1987 and expects to complete its third program in 2000. In general, these programs provide new displays and software and upgrade hardware and data-processing equipment to allow TRACONs to handle increased traffic. One program for the en route centers—the Display Complex Channel Rehost—was completed in 1997. Under this program, FAA transferred existing software from obsolete display channel computers to new more reliable and maintainable computers at five en route centers.

The cost for interim projects could go even higher if FAA decides to implement an interim solution to overcome hardware problems and resolve year 2000 date requirements with the Host computer system.[9] FAA is assessing the Host computer's microcode—low-level machine instructions used to service the main computer—with a plan to resolve any identified year 2000 date issues, while at the same time preparing to purchase and implement new hardware—Interim Host—for each of its 20 en route centers before January 1, 2000. FAA expects to incur costs of about $160 million during fiscal years 1998 and 1999 for the Interim Host.

Major Acquisitions Continue to Face Delays and Cost Increases

Two key components of the modernization effort—the Wide Area Augmentation System (WAAS) and the Standard Terminal Automation Replacement System (STARS)—have encountered delays and cost increases.

[8]The Automated Surface Observing System, a joint program with the National Weather Service, FAA, and DOD, automates and enhances methods for collecting, processing, and displaying surface weather conditions, such as temperature and precipitation.

[9]The Host computer is the centerpiece information-processing system in FAA's en route centers. It processes flight, radar, and display data for use by the controllers. When FAA restructured the AAS program in 1994, it cancelled the segment that included the Host replacement. It now plans to replace the Host by 2005.

In September 1997, FAA estimated total life cycle costs for WAAS at $2.4 billion ($900 million for facilities and equipment and $1.5 billion for operations). In January 1998, the estimate had increased by $600 million to $3 billion ($1 billion for facilities and equipment and $2 billion for operations).[10] The increased costs for facilities and equipment are attributable to FAA's including previously overlooked costs for periodically updating WAAS' equipment. The revised cost estimate for operations and maintenance is largely attributable to higher than expected costs to lease geostationary satellites.

In developing WAAS, FAA has also encountered delays. When signing the original development contract with Wilcox Electric in August 1995, FAA planned for the initial system to be operational by December 1997. Because of concerns about the contractor's performance, however, FAA terminated the original contract and signed a development contract with Raytheon (formerly Hughes Aircraft) in October 1996 that called for the initial system to be operational by April 1999. The 16-month schedule slippage was caused by problems with the original contractor's performance, design changes, and increased software development.

Last year, we reported that the implementation of STARS—particularly at the three facilities targeted for operating the system before fiscal year 2000—will likely be delayed if FAA and its contractor experience any difficulties in developing the software.[11] These difficulties have materialized.[12] In January 1998, FAA reported that more delays are likely because software requirements could increase to resolve air traffic controllers' dissatisfaction with the system's computer-human interface.

FAA also reported an unexpected cost increase of $35 million for STARS during fiscal year 1998. It attributed the increase to such factors as adding resources to maintain the program's schedule and the effects of any design

[10]FAA is acquiring WAAS—a network of equipment on the ground and in space—to enhance DOD's Global Positioning System (GPS) so that it can meet civil air navigation needs. WAAS was originally intended to be a sole means navigation system—users would not need another navigation system aboard the aircraft. By providing sole means of navigation, FAA could replace the current ground-based civil air navigation system. Over the past year, FAA has focused on a technical issue—WAAS/GPS signal vulnerability to radio frequency interference—that, if not resolved, could require FAA to cancel its plans to phase out all of its ground-based navigation aids, thereby reducing the cost savings expected from implementing WAAS.

[11]Through STARS, FAA will replace, from December 1998 through February 2005, old computers, controller workstations, and related equipment at about 170 FAA terminal air traffic control facilities. See Air Traffic Control: Status of FAA's Standard Terminal Automation Replacement System Project (GAO/RCED-97-51, Mar. 5, 1997).

[12]See Air Traffic Control: Timely Completion of FAA's Standard Terminal Automation Replacement System Is At Risk (GAO/AIMD-98-41R, Jan. 23, 1998).

changes to address new computer-human interface concerns. Also, the estimated size of software development—measured in source lines of code—is now 50 percent larger than the original November 1996 estimate. FAA has requested a reprogramming of fiscal year 1998 funds to address this cost increase.

FAA Has Begun to Implement Recommendations to Correct Root Causes of Modernization Problems

Our reviews have identified some of the root causes of long-standing problems with FAA's modernization and have recommended solutions to them. Among the causes of these problems were the lack of a complete and enforced systems architecture,[13] unreliable cost information, lack of mature software acquisition processes, and an organizational culture that did not always act in the agency's long-term best interest. While FAA has begun to implement many of our recommendations, it will need to stay focused on continued improvement.

A Complete Systems Architecture Is Key to Guiding and Constraining ATC Modernization Investments

FAA has proceeded to modernize its many ATC systems without the benefits of a complete systems architecture, or overall blueprint, to guide their development and evolution.[14] In February 1997, we reported that FAA has been doing a good job of defining one piece of its architecture—the logical architecture. That architecture describes FAA's concept of operations, business functions, high-level descriptions of information systems and their interrelationships, and information flows among systems. This high-level architecture will guide the modernization of FAA's ATC systems over the next 20 years. We identified shortcomings in two main areas. FAA's system modernization lacked a technical architecture and an effective enforcement mechanism.[15]

FAA generally agreed with the recommendation in our February 1997 report to develop a technical architecture and has begun the task. We will continue to monitor FAA's efforts. Also, to be effective, the architecture must be enforced consistently. FAA has no organizational entity responsible for enforcing architectural consistency. Until FAA defines and

[13]An enforcement mechanism is necessary to ensure that projects being developed comply with the architecture and that any architectural deviations are justified.

[14]Air Traffic Control: Complete and Enforced Architecture Needed for FAA Systems Modernization (GAO/AIMD-97-30, Feb. 3, 1997).

[15]A complete systems architecture consists of two principal components—a "logical" architecture and a "technical" architecture. The technical architecture details the specific information technology and communications standards and approaches that will be used to build the systems, including those that address critical hardware, software, communications, data management, security, and performance characteristics. It ensures that the systems interoperate effectively and efficiently.

enforces a complete ATC systems architecture, the agency cannot ensure compatibility among its existing and future programs.

We also recommended in the February 1997 report that FAA develop a management structure for enforcing the architecture that is similar to the provisions of the Clinger-Cohen Act of 1996 for department-level Chief Information Officers (CIO). FAA disagrees with this recommendation because it believes that the current location of its CIO, within the research and acquisition line of business, is effective. We continue to believe that such a structure is necessary. FAA's CIO does not report directly to the Administrator and does not have organizational or budgetary authority over those who develop ATC systems or the units that operate and maintain them. Furthermore, the agency's long history of problems in managing information technology projects reflects weaknesses in its current structure.

Reliable Cost Information Is Needed to Effectively Manage Modernization Projects

In January 1997, we reported that FAA lacks reliable cost-estimating processes and cost-accounting practices needed to effectively manage investments in information technology, which leaves it at risk of making ill-informed decisions on critical multimillion, even billion, dollar air traffic control systems.[16] Without reliable cost information, the likelihood of poor investment decisions is increased, not only when a project is initiated, but also throughout its life cycle. We recommended that FAA improve its cost-estimating processes and fully implement a cost-accounting system.

Our recent review of the reliability of FAA's reported financial information and the possible program and budgetary effects of reported financial statement deficiencies again highlights the need for reliable cost information. The audit of FAA's 1996 financial statement disclosed many problems in reporting of operating materials and supplies and property and equipment.[17] Many of these problems resulted from the lack of a reliable system for accumulating project cost accounting information. Although FAA has begun to institutionalize defined cost-estimating processes and to acquire a cost-accounting system, it will be awhile before FAA and other decisionmakers have accurate information to determine and control costs.

[16]Air Traffic Control: Improved Cost Information Needed to Make Billion Dollar Modernization Investment Decisions (GAO/AIMD-97-20, Jan. 22, 1997).

[17]The Department of Transportation Inspector General audited FAA's fiscal year 1996 Statement of Financial Position. For our analysis of that audit see Financial Management: Federal Aviation Administration Lacked Accountability for Major Assets (GAO/AIMD-98-62, Feb. 18, 1998).

A Mature Software Acquisition Capability Is Important to the Success of FAA's ATC Modernization Program

In March 1997, we reported that FAA's processes for acquiring software—the most costly and complex component of ATC systems—are ad hoc, sometimes chaotic, and not repeatable across projects.[18] As a result, FAA is at great risk of acquiring software that does not perform as intended and is not delivered on time and within budget. Furthermore, FAA lacks an effective approach for improving its processes for acquiring software.

In the March 1997 report, we recommended that FAA improve its software acquisition capabilities by institutionalizing mature acquisition processes and reiterated our prior recommendation that FAA establish a management structure similar to the department-level CIOs to instill process discipline. FAA concurred with part of our recommendation and has initiated efforts to improve its software acquisition processes. These efforts, however, are not comprehensive, are not complete, and have not yet been implemented agencywide. Furthermore, FAA disagrees with our recommendation related to its management structure. Without establishing strong software acquisition processes and an effective management structure, FAA risks making the same mistakes it did on failed systems acquisition projects.

Continued Management Attention Is Critical to Comprehensive Cultural Change

In August 1996, we reported that an underlying cause of FAA's ATC acquisition problems is its organizational culture—the beliefs, the values, and the attitudes and expectations shared by an organization's members that affect their behavior and the behavior of the organization as a whole.[19] We found that FAA's acquisitions were impaired when employees acted in ways that did not reflect a strong commitment to mission focus, accountability, coordination, and adaptability. We recommended that FAA develop a comprehensive strategy for cultural change that (1) addresses specific responsibilities and performance measures for all stakeholders throughout FAA and (2) provides the incentives needed to promote the desired behaviors and achieve agencywide cultural change.

In response to our recommendations, FAA issued a report outlining its overall strategy for changing its acquisition culture and describing its ongoing actions to influence organizational culture and improve its life cycle acquisition management processes.[20] For example, the Acquisition

[18]Air Traffic Control: Immature Software Acquisition Processes Increase FAA System Acquisition Risks (GAO/AIMD-97-47, Mar. 21, 1997).

[19]Aviation Acquisition: A Comprehensive Strategy Is Needed for Cultural Change at FAA (GAO/RCED-96-159, Aug. 22, 1996).

[20]Strategy for Acquisition Culture Change, Federal Aviation Administration, June 1997.

and Research (ARA) organization has proposed restructuring its personnel system to tie pay to performance based on 15 measurable goals, each with its own performance plan. ARA's proposed personnel system is under consideration by the Administrator.

In our August 1996 report, we also noted that the Integrated Product Development System, based on integrated teams, was a major FAA initiative to address the shortcomings with its organizational culture. According to an ARA program official, FAA has 15 integrated product teams, the majority of which have approved plans. The official indicated that all team members have received training to prepare them for their roles and that ARA is developing a set of standards to measure the performance of the integrated teams. However, the official also acknowledged that FAA has had difficulty in gaining commitment to the integrated team concept throughout the agency because offices outside of ARA have been resistant to integrated teams.

To help overcome institutional cultural barriers, FAA and external stakeholders have been discussing the establishment of a special program office responsible for the acquisition of free flight systems.[21] Although, the details of how such an office would operate have not been put forward, one option would be for this office to have its own budget and the authority to make certifications and regulations and to determine system requirements. Such an office could be viewed as the evolutionary successor to the integrated product team system. Another approach being considered by FAA is the establishment of a single NAS manager at the level of associate administrator to eliminate traditional "stovepipes" between the acquisition and air traffic organizations.

As FAA considers recommendations to create a new structure, we believe that it would be advantageous for FAA to implement our recommendation to create a management structure similar to the department-level CIO as called for in the Clinger-Cohen Act. Having an effective CIO, with the organizational and budgetary authority to implement and enforce a complete, agencywide systems architecture would go a long way towards eliminating traditional "stovepipes" between integrated product teams, as well as between the acquisition and air traffic organizations. Furthermore, the agency could gain valuable insight from the experiences of other organizations that have implemented similar structures. Regardless of future direction, FAA recognizes that considerable work is needed to

[21]Free flight is a new operational concept that would provide airspace users with more flexibility in choosing preferred routes with less air traffic restrictions.

modify behaviors and create comprehensive cultural change. A continued focus on cultural change initiatives will be critical in the years ahead.

FAA Is Revising the Modernization Program and Implementing Acquisition Reform but Faces New Challenges

While FAA is involving external and internal stakeholders in revising its approach to the modernization program, it will need to stay focused on implementing solutions to the root causes of past problems, ensure that all aspects of its acquisition management system are effectively implemented, and quickly address the looming crisis with the year 2000 date requirements.

FAA Is Seeking Consensus From Stakeholders on an Achievable Modernization Program

The FAA Administrator has begun an outreach effort with the aviation community to build consensus on and seek commitment to the future direction of the agency's modernization program. Similar to our findings on the logical architecture, a review of this program by the NAS Modernization Task Force concluded that the architecture under development builds on the concept of operations for the NAS and identifies the programs needed to meet the needs of the user community.[22] However, the task force found that the architecture is not realistic because of (1) an insufficient budget; (2) the preponderance of risks associated primarily with certifying and deploying new equipment and with users' cost to acquire equipment; and (3) unresolved institutional issues and a lack of user commitment.

The task force recommended a revised approach that would be less costly and would be focused more on providing near-term user benefits.[23] Under this revised approach, FAA would (1) implement a set of core technologies to provide immediate user benefits;[24] (2) modify the Flight 2000 initiative to address critical risk areas associated with key communications,

[22]The NAS Modernization Task Force includes FAA and DOD officials and representatives of external stakeholders.

[23]These recommendations are now being considered by the RTCA Free Flight Select Committee, which expects to make formal recommendations to the Administrator by the end of February 1998. RTCA functions as a federal advisory committee and develops consensus-based recommendations on contemporary aviation issues.

[24]These technologies include initial conflict probe, center-TRACON automation system tools, collaborative decisionmaking tools, and controller-pilot data link.

navigation, and surveillance programs;[25] and (3) proceed with implementing critical time-driven activities related to the Host computer and the year 2000 problems and with implementing such systems as STARS, surveillance radars, and en route displays to replace aging infrastructure.

The details on how FAA intends to implement the task force's recommendations are not yet known. However, from our discussions with task force officials, their practical effect would be that the development and the deployment of some current programs would be accelerated while others would be slowed down. Meanwhile, FAA would continue developing programs like STARS and the Display System Replacement and work to ensure that its computers recognize the year 2000. For example, under the revised approach, the WAAS program would be slowed down after Phase I, which is scheduled to provide initial satellite navigation capabilities by 1999, to enable FAA to resolve technical issues and explore how costs could be reduced. Further development would be subject to review and risk mitigation under the expanded Flight 2000 initiative.

FAA faces both opportunities and challenges as it revises the modernization program. On the one hand, FAA has an opportunity to regain user confidence by delivering systems that benefit them. On the other hand, FAA is challenged to follow through with its investment management process improvements. We urge FAA to proceed cautiously as it attempts to expedite the deployment of key technologies to avoid repeating past practices, such as undue concern for schedules at the expense of disciplined systems development and careful, thorough testing. FAA will need to resist this temptation, as the results are typically systems that cost more than expected, are of low quality, and are late as well.

FAA Will Need to Continue Improving Its Acquisition Management Process

Concerned that burdensome procurement rules were a primary contributor to FAA's acquisition problems, the Congress exempted FAA from many procurement rules. In response, the agency implemented its Acquisition Management System (AMS) on April 1, 1996, to improve its acquisition of new technology.

AMS is intended to provide high-level acquisition policy and guidance and to establish rigorous investment management practices. We are currently reviewing FAA's investment management approach, including its practices and processes for selecting, controlling, and evaluating projects, and

[25]Through the Flight 2000 initiative, FAA plans to demonstrate and test key technologies needed to implement free flight.

expect to report later this year. As FAA continues to implement AMS and embarks on a revised modernization approach, it will need to establish baselines for individual projects and performance measurements to track key goals.

Under AMS, an acquisition project should have a baseline, which establishes the performance, life-cycle cost, schedule, and benefit boundaries within which the program is authorized to operate. Having an effective investment analysis capability is important in developing these baselines. In its May 1997 report on AMS, FAA noted that it has focused more attention on investment management analyses.[26] The agency reported that it has established several investment analysis teams of individuals with expertise in such areas as cost estimating, market analysis, and risk assessment to help prepare program baselines to use in determining the best way to satisfy mission needs.

Although FAA has begun efforts to establish new baselines for projects that were underway prior to AMS, program evaluation officials question the availability and the quality of operations and maintenance data that are being used to estimate life-cycle project costs. FAA's history of unplanned cost increases, most recently seen with its STARS and WAAS programs, coupled with past deficiencies in cost estimating processes and practices point to the need to use reliable and complete data to establish realistic baselines.

As for performance measurements, FAA does not have a unified effort underway to effectively measure progress toward achieving acquisition goals. FAA has established a goal to reduce the time to field systems by 50 percent and to reduce the cost of acquisitions by 20 percent during the first 3 years under AMS. FAA also plans to measure performance in such other critical areas as customer satisfaction and the quality of products and services. According to FAA's evaluation, while individual organizations are attempting to measure progress in meeting the two goals, a coordinated agencywide measurement effort is lacking.

FAA's failure to field systems on time and within cost indicates the need for a comprehensive system of performance measurements that can help provide systematic feedback about accomplishments and progress in meeting mission objectives. The need for such measurements will become even more critical as FAA expedites the deployment of some projects.

[26]Evaluation of FAA Acquisition Reform—The First Year: April 1996-March 1997, FAA Program Evaluation Staff, Office of Systems Architecture and Investment Analysis, May 1997.

Clearly identified performance measurements will help FAA, the Congress, and system users assess how well the agency achieves its goals.

Urgent Action Needed to Ensure Computers Recognize the Year 2000

On January 1, 2000, computer systems worldwide could malfunction or produce inaccurate information simply because the century has changed. Unless corrected, such failures could have a costly, widespread impact. The problem is rooted in how dates are recorded and computed. For the past several decades, systems have typically used two digits to represent the year, such as "97" for 1997, to save electronic storage space and reduce operating costs. This practice, however, makes 2000 indistinguishable from 1900, and the ambiguity could cause systems to malfunction in unforeseen ways or to fail completely.

FAA's challenge is great. Correcting this problem will be difficult and expensive, and must be done while such systems continue to operate. In less than 2 years, hundreds of computer systems that are critical to FAA's operations, such as monitoring and controlling air traffic, could fail to perform as needed unless proper date-related calculations can be made.

FAA's progress in making its systems ready for the year 2000 has been too slow. We have reported that, at its current pace, it will not make it in time.[27] The agency has been severely behind schedule in completing basic awareness and assessment activities—critical first and second phases in an effective year 2000 program. For example, just this month FAA appointed a program manager who reports to the Administrator.

Delays in completing the first two phases have left FAA little time for critical renovation, validation, and implementation activities—the final three phases in an effective year 2000 program. With less than 2 years left, FAA is quickly running out of time, making contingency planning for continuity of operations even more critical.

If critical FAA systems are not year 2000 compliant and ready for reliable operation on January 1 of that year, the agency's capability in several areas—including the monitoring and controlling of air traffic—could be severely compromised. The potential serious consequences could include degraded safety, grounded or delayed flights, increased airline costs, and customer inconvenience. We have made a number of recommendations

[27]FAA Computer Systems: Limited Progress on Year 2000 Issue Increases Risk Dramatically (GAO/AIMD-98-45, Jan. 30, 1998).

aimed at expediting the completion of overdue awareness and assessment activities.

Mr. Chairman, this concludes my statement. We will be happy to answer any questions from you or any Member of the Subcommittee.

Modernization Projects Completed Through August 1998

Dollars in millions

Project (project number)	Completion date	Total reported facilities and equipment cost
Automated Radar Terminal System (ARTS) IIIA Assembler (22-02)	1983	0[a]
ARTS II Displays (22-07)	1984	$ 3.6
Radar Remote Weather Display System (23-10)	1984	0[a]
Interim Voice Response System (23-06)	1985	0[a]
Geostationary Operational Environmental Satellite Recorders (23-11)	1985	1.9
En Route Automation (21-01)	1986	2.3
ARTS IIIA Memory (22-04)	1986	8.6
Additional ARTS IIIA at FAA Technical Center (22-05)	1986	4.7
ARTS II Interfacility Interface (22-08)	1986	0[a]
Consolidated Notice to Airmen System (23-03)	1986	0[a]
Radar Microwave Link Trunking (25-01)	1986	8.2
Teletypewriter Replacement (25-09)	1986	5.1
Nonradar Approach (21-14)	1987	1.6
Visual Flight Rules Air Traffic Control Tower Closures (22-14)	1987	1.5
Air/Ground Communications Equipment Modernization (24-01)	1987	60.6
Airport Telecommunications (25-05)	1987	4.2
Data System Specialist Support (51-20)	1987	32.0
Host Computer (21-07)[b]	1988	290.7
Altitude Reporting Mode of Secondary Radar (Mode-C) (21-10)	1988	0[a]
Enhanced Target Generator Displays (ARTS III) (22-03)	1988	0[a]
Nondirectional Beacon (24-04)	1988	23.8
National Airspace Data Interchange Network IA (25-06)	1988	17.0
Aircraft Fleet Conversion (26-11)	1988	68.6
Enhanced Terminal Conflict Alert (22-01)	1989	0.4
Automatic Terminal Information Service Recorders (22-10)	1989	11.2
High-Altitude En Route Flight Advisory Service (23-07)	1989	6.3
Hazardous In Flight Weather Advisory Service (23-08)	1989	7.3

(continued)

Dollars in millions

Project (project number)	Completion date	Total reported facilities and equipment cost
Instrument Landing System (24-06)	1989	69.6
Power Conditioning Systems for ARTS III (26-06)	1989	21.5
TPX-42 Replacement (22-17)	1990	40.0
Flight Data Entry and Print-Out Devices (21-02)	1991	18.8
En Route Automated Radar Tracking System Enhancements (21-04)	1991	2.8
Offshore Flight Data Processing System (21-16)	1991	1.0
Sustain New York Terminal Radar Approach Control (TRACON) (22-18)	1991	95.4
Computer-Based Instruction (26-02)	1991	10.4
National Radio Communication System (26-14)	1991	82.7
Direct Access Radar Channel System (21-03)	1992	45.0
Air Traffic Control Tower/TRACON Modernization (22-13)[c]	1992	391.4
Communications Facilities Consolidation/Network (24-02)	1992	16.8
National Airspace Data Interchange Network II (25-07)	1992	42.4
Power System (26-07)	1992	71.5
Modernization of Unmanned FAA Buildings and Equipment (26-08)	1992	85.7
Aircraft and Related Equipment (26-12)	1992	68.9
National Airspace System Spectrum Engineering (26-15)	1992	9.4
System Support Lab (26-17)	1992	31.5
General Support Lab (26-18)	1992	25.6
ARTS IIA Enhancements (22-06)	1993	12.9
Area Control Facilities (21-15)	1993	9.6
Data Multiplexing Network (25-02)	1993	34.0
Radar Microwave Link Replacement and Expansion (25-03)[d]	1993	268.4
Large Airport Cable Loop Systems (26-05)	1993	20.3
Interfacility Data Transfer System for Edwards Air Force Base Radar Approach Control (35-20)	1994	1.8
Visual Navaids (24-09)	1994	137.7
Acquisition of Flight Service Facilities (26-10)	1994	79.7
Interim Support Plan[e] (46-30)	1994	362.9

(continued)

Dollars in millions

Project (project number)	Completion date	Total reported facilities and equipment cost
Tower Integration Program (42-20)	1994	11.2
Radar Pedestal Vibration Analysis (44-43)	1994	5.0
Low-Level Wind Shear Alert System (23-12)	1994	47.2
Human Resource Management (56-22)	1994	7.3
Brite Radar Indicator Tower Equipment (22-16)	1994	64.5
Approach Lighting System Improvement Program (24-10)	1994	121.9
Central Weather Processor (23-02)	1994	81.1
General Support (26-16)[f]	1994	824.0
National Implementation of the “Imaging” Aid for Dependent Converging Runway Approaches (62-24)	1994	4.6
Integrated Communications Switching System (23-13)	1995	98.3
System Engineering and Integration Contract (26-13)	1995	759.3
National Airspace Data Interchange Network II Continuation (35-07)	1995	23.7
ARTS IIIA Peripheral Adapter Module Modernization (52-21)	1995	5.9
Instrument Landing System and Visual Navaids Engineering and Sparing (44-24)	1995	13.1
Air Traffic Control Tower/TRACON Establishment (32-13)	1995	13.1
Flight Service Automation System (23-01)	1995	313.7
Multichannel Voice Recorders (22-11)	1996	40.2
Weather Message Switching Center Replacement (23-04)	1996	32.5
Computer Aided Engineering Graphics Enhancements (56-25)	1996	3.7
Oceanic Display and Planning System (21-05)	1996	36.8
Integrated Communications Switching System Logistics Support (43-14)	1996	10.6
Maintenance Control Center (26-04)	1996	47.9
Long-Range Navigation-C (LORAN-C) Systems (24-17)	1996	51.9
ARTS IIA Interface with Mode-S/Airport Surveillance Radar-9 (22-09)	1996	0[a]
Replacement of Controllers Chairs (42-24)	1996	5.1
ARTS IIIA-Expand 1 Capacity and Provide Mode C Intruder Capability (32-20)	997 1	09.8

(continued)

Dollars in millions

Project (project number)	Completion date	Total reported facilities and equipment cost
Display Channel Complex Rehost (A-01)	1997	61.3
Digital Bright Radar Indicator Tower Equipment (32-16)	1998	24.2
Civil Aviation Registry Modernization (56-24)	1998	34.4
FAA Telecommunications (45-21)	1998	16.1
Precision Automated Tracking System (56-16)	1998	3.3
National Airspace Integrated Logistic Support (56-58)	1998	27.6
Long Range Radar Radome Replacement (44-42)	1998	39.5
Computer Resources Nucleus (56-28)	1998	158.1
Total		**$5,714.2**

[a]The cost of this project was covered under another facilities and equipment project.

[b]Installed at en route centers to allow processing of existing air traffic control software on new equipment.

[c]Project comprised a variety of tower and terminal replacement and modernization projects. Project was continued in the Capital Investment Plan under projects 42-13 and 42-14.

[d]Also known as the Radio Communications Link project, it was designed to convert aging "special purpose" Radar Microwave Link System into a "general purpose" system for data, voice, and radar communications among en route centers and other major FAA facilities.

[e]Project was activated to sustain and upgrade air traffic control operations and acquire eight terminal radars awaiting the full implementation of the Advanced Automation System.

[f]Project comprised a variety of diverse support projects and has been continued in the Capital Investment Plan under Continued General Support (46-16).

Source: FAA. We did not independently verify the schedule and cost information.

Status of FAA's Major Modernization Projects

Over the past decade, we have reported on FAA's progress in meeting schedule commitments for last-site implementation, which signals completion of the project. Prior to this year, we have used the dates from the 1983 NAS modernization plan. This year, after discussions with FAA officials, we are measuring FAA's progress against an interim date—which in most cases represents the date of contract award or investment decision. We will continue to show the original date, but will only measure progress against the interim date.

Major projects	Last-site implementation: Year: 1983 NAS Plan	Last-site implementation: Year: Interim estimate	Last-site implementation: Year: 1998 estimate	Last-site implementation: Years delayed	Number of operational systems: Planned	Number of operational systems: Commissioned: Since Feb-97	Number of operational systems: Commissioned: Current total
Aeronautical Data Link (ADL)	N/A	TBD[a]	TBD	N/A	57 TDLS I[a] 57 TDLS II[a]	0 20	57 48
Air Route Surveillance Radar (ARSR-4)	1991	1996[b]	1999	3	41 radars	19	32
Airport Surface Detection Equipment (ASDE-3)	1990	1996[c]	1999	3	38 radars	3	29
Airport Surveillance Radar (ASR-9)	1992	1996[d]	1998	2	120 radars	2	113
Air Traffic Control Beacon Interrogator (ATCBI) Replacement	N/A	2004[e]	2004	0	125 systems	0	0
Automated Surface Observing System (ASOS)	1997	2002[f]	2002	0	597 units	97	230
En Route Automation—Display System Replacement (DSR)	N/A	2000[g]	2000	0	21 systems	0	0
Integrated Terminal Weather System (ITWS)	N/A	2003[h]	2003	0	34 systems	0	0
Mode S	1993	1996[i]	1999	3	144 systems	9	80
Oceanic Automation Program (OAP) Build 1.0	N/A	2000[j]	2001	1	2 systems	0	0
Operational and Supportability Implementation System (OASIS)	N/A	2001[k]	2001	0	61 stations	0	0
Terminal Automation—Standard Terminal Automation Replacement System (STARS)	N/A	2005[l]	2005	0	173 systems	0	0
Terminal Doppler Weather Radar (TDWR)	N/A	1998[m]	2001	3	45 radars	11	33
Terminal Radar Digitize, Replace, and Establish (TRDRE)	N/A	2005[n]	2005	0	108 radars	0	0
Voice Switching and Control System (VSCS)	1992	1997[o]	1997	0	21 units	1	21
Weather and Radar Processor (WARP)	N/A	2000[p]	2000	0	Stage 0: 21 Stage 1 and 2: 21	21 0	21 0
Wide Area Augmentation System (WAAS)	N/A	1999[q]	1999	0	1 system	0	0

[a]The JRC investment decision on Aeronautical Data Link is scheduled for later this year.

TDLS is the Tower Data Link Services. TDLS I (Predeparture Clearance/Flight Data Input/Output CRT/Rank Emulation) has been commissioned at all 57 sites; TDLS II (Digital-Automatic Terminal Information Service) has been installed at all 57 sites and commissioned at 48 sites.

[b]Date reflects last-site implementation (source 1989 NAS Plan) when the contract was awarded in 1988.

[c]Date reflects last-site implementation (source 1993 CIP) when the program was rescoped in 1993 to acquire seven additional systems per congressional direction. When the original contract was awarded in 1985, last-site implementation was scheduled for 1990 (source 1986 NAS Plan).

[d]Date reflects last-site implementation (source 1993 CIP) when the program was rescoped to acquire six additional systems (two were mandated by Congress). The original contract was awarded in 1983.

[e]Reflects APB from July 1997JRC-approved investment decision.

[f]The Congress added $10 million in both the fiscal year 1997 and fiscal year 1998 appropriations to acquire additional ASOS systems. The date reflects these additional systems. When the original contract was awarded in 1991, last-site implementation was scheduled for 1997 (Source 1991 CIP).

[g]Date reflects the Display System Replacement (DSR) project, initiated as part of the June 1994 restructuring of the Advanced Automation System into three distinct areas: en route, terminal, and tower automation.

[h]Date reflects January 1997 program rebaselining associated with contract award.

[i]Date reflects last-site implementation (source 1993 CIP) when the program was rescoped to acquire 11 additional systems. The systems commissioned are those that have been upgraded to full Mode-S capability.

[j]In 1996, the program was rescoped. The date reflects the projected last-site implementation for Build 1.0.

[k]Date reflects APB from December 1996 JRC investment decision.

[l]Date reflects APB approved January 1996. The production contract was awarded in September 1996.

[m]Date is from the 1987 NAS Plan, when TDWR project was added. The 1998 estimate includes the last five systems (Fort Lauderdale, San Juan, Las Vegas, Midway, and New York), which have been delayed due to land acquisition problems and environmental issues. Excluding these last five systems, last-site implementation is scheduled for 8/98.

[n]Date reflects APB approved at November 1997 JRC investment decision. The program was expanded in scope to replace ASR-8s (in addition to ASR-7s) as well as provide for new establishments.

[o]Date reflects last-site implementation when the production contract was awarded in 1991 (source 1991 CIP). The date reflects the first phase of the project, when systems were installed in existing en route controller workstations. Last-site implementation date for the second phase of the project, when the system will interface with the DSR, is estimated for 2000.

[p]Date reflects last-site implementation when the contract was awarded in June 1996. The date is for Stages 1-2.

[q]Reflects January 1998 JRC approval of rebaselined program. Date reflects Initial Operational Capability when WAAS will provide supplemental CAT I precision approach capability.

Note: Two projects that GAO reviewed in February 1997 are not included. The Terminal ATC Automation (TATCA) project has been integrated into the Air Traffic Management (ATM) program, which contains multi-segmented projects. TATCA functionality is contained within the Traffic Manager Advisor (TMA), Final Approach Spacing Tool (FAST), and Descent Advisor (DA). The Tower Automation Program has been terminated.

Source: FAA. We did not independently verify the schedule information.

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