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AIR TRAFFIC CONTROL

Status of FAA's Modernization Program





United States
General Accounting Office
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Resources, Community, and
Economic Development Division

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April 16, 1993

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Chairman
The Honorable Alfonse M. D'Amato
Ranking Minority Member
Subcommittee on Transportation
and Related Agencies
Committee on Appropriations
United States Senate

The Honorable Bob Carr
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Subcommittee on Transportation
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Committee on Appropriations
House of Representatives

This fact sheet provides information on efforts by the Federal Aviation Administration (FAA) to modernize the air traffic control (ATC) system. It is the fourth annual report requested by your Subcommittees on this subject. This fact sheet discusses the status of ATC modernization, major acquisitions, and new capabilities projects. Since 1981, FAA has been working to modernize the ATC system to permit the safe and expedient movement of traffic. FAA has been acquiring new equipment, such as radars, computers, and communication networks; upgrading older equipment; increasing automation; and consolidating facilities.

Initially, the modernization effort occurred under FAA's National Airspace System (NAS) Plan; however, the scope of the plan was expanded in 1990 and thereafter became known as the Capital Investment Plan (CIP). The CIP includes the projects that were not completed under the NAS Plan as well as 150 newer projects. Under both plans, projects have been funded largely through FAA's Facilities and Equipment (F&E) appropriations. The annual F&E appropriation has increased over ninefold, from \$260 million in fiscal year 1982 to \$2.35 billion in fiscal year 1993. FAA is seeking

\$2.52 billion in fiscal year 1994, a 7-percent increase from the previous year.

In summary, we found that:

- FAA's estimate of the total cost to modernize the ATC system through fiscal year 2000 has grown during this past year. The agency now estimates that this effort will require \$32.8 billion in F&E appropriations--an increase of \$869 million over the \$31.9 billion that we reported in April 1992.¹ A significant portion of this increase is due to the inclusion of 12 new projects in the CIP. In addition, FAA estimates that the costs for some existing CIP projects will extend beyond the year 2000. For example, FAA projects that approximately \$1.3 billion will be needed in fiscal year 2001 for 29 current CIP projects. Current cost estimates are based on FAA's plans to consolidate over 200 terminal and en route control facilities into just 23 facilities. If FAA adopts one of two alternative consolidation plans under consideration--each of which calls for more than 23 facilities--F&E costs could increase between \$1.5 billion and \$2.2 billion over the next 12 years.²
- To date, FAA has completed 46 of 225 projects, including 10 in 1992. All but 1 of the 46 projects are from the original NAS Plan. These 46 projects account for approximately 5 percent of the total estimated cost of modernization through the year 2000. Of the 10 projects completed in 1992, 3 were major acquisitions--that is, their costs exceeded \$50 million.
- FAA has experienced an upward trend in its unobligated F&E account balance. At the end of fiscal year 1992, approximately \$2 billion was unobligated. However, FAA estimates a decline in unobligated balances beginning in fiscal year 1993.
- For the majority of the existing 12 major acquisitions that we reviewed in detail, costs increased and/or schedule delays continued. Specifically, costs for nine projects--including the Advanced Automation System (AAS), the largest project in the CIP--rose by a total of

¹Air Traffic Control: Status of FAA's Modernization Program (GAO/RCED/92-136BR, Apr. 3, 1992).

²Amounts are based on 1993 constant dollars.

\$233.5 million. These increases range from \$1.7 million to \$77.1 million. Schedules were delayed for four projects, including the Airport Surface Detection Equipment (ASDE-3) radar. These delays range from 1 year to 3 years. FAA also recently announced a 14-month delay for a key segment in the \$4.7 billion³ AAS project, which FAA considers the centerpiece of the CIP.

- Although much attention has been focused in the past on these long-standing NAS Plan projects, newer projects will be absorbing an increasing portion of F&E funding over the next few years. These projects' costs are estimated to grow from 3 percent of F&E funding in 1992 to 9 percent by 1997. We have included information on six new capabilities projects. These six projects will account for 54 percent of the funding for new capabilities in 1993 and, according to current estimates, will receive all of the funding by 1999. Because the new projects are in the early stages of development, these cost estimates may change considerably.

SCOPE AND METHODOLOGY

We conducted our review from October 1992 through March 1993, focusing on changes to the modernization program that have occurred not only during the past year but also since the inception of the NAS Plan. Section 1 discusses the cost of the overall modernization effort. Specifically, we have (1) compared changes in total modernization and costs by categories of the ATC system, (2) identified changes in the CIP since April 1992, and (3) calculated unobligated balances and compared them with total appropriations. Section 2 reviews in detail the changes in costs and schedules that have affected 12 major acquisitions since the inception of the NAS Plan and between 1992 and 1993. This section includes (1) a summary of the status of each project, including a comparison of F&E costs and a description of anticipated benefits, progress, and problems; (2) a discussion of major changes in costs, quantities, and schedules for each project; and (3) a separate discussion of each project's progress and problems. Section 3 highlights the status of 6 of the 16 new capabilities projects--those that FAA has identified as significant to the modernization effort. Included in this section are (1) background information about each project and its potential impact on the ATC system, (2) total estimated F&E project costs and

³This figure does not include \$400 million in research, engineering, and development costs.

scheduled implementation dates, and (3) descriptions of the potential impact of these emerging projects on other CIP projects.

We obtained the information for this fact sheet by analyzing data from various sources. Information on the overall costs of ATC modernization, as well as on appropriations and obligations, was obtained from documents provided by FAA budget officials.⁴ Cost information on individual systems was obtained from FAA's program officials for each project and FAA's System Engineering and Integration Contractor (SEIC) reports. Because FAA has not yet published the 1992 CIP, the agency provided us with a draft version dated October 1992. FAA and SEIC officials also provided us with cost and schedule data that support the CIP. Other status information in sections 2 and 3 was obtained during interviews with FAA officials, including program managers, research and development officials, systems engineering officials and, in some cases, contracting officials. We also discussed the 12 major acquisition projects with SEIC officials.

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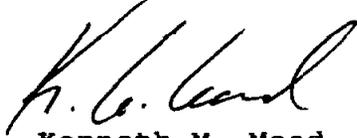
We discussed the facts contained in this fact sheet with representatives of FAA's Associate Administrators for Air Traffic, Contracting and Quality Assistance, NAS Development, and Systems Engineering and Development, as well as with officials from FAA's Office of Acquisition, Policy, and Oversight and Office of Budget. We also discussed the facts with SEIC officials. FAA and SEIC officials generally agreed with the facts as presented. They provided us with some revised funding estimates and implementation dates, as well as with other factual information, which we have incorporated into our fact sheet. As requested, we did not obtain written agency comments on a draft of this fact sheet.

We are providing copies of this fact sheet to the Secretary of Transportation; the Administrator, FAA; and other interested parties. We will make copies available to others on request.

⁴FAA provided the actual or estimated appropriations needed for current or then-year dollars. FAA uses the Office of Management and Budget's forecasts to predict the purchasing power of the dollar in future years. The use of current rather than constant dollars can limit the comparability of project estimates made at different times.

B-247729

If you have any questions about this fact sheet, please contact me at (202) 512-6001. Major contributors to this fact sheet are listed in appendix I.

A handwritten signature in black ink, appearing to read "K. M. Mead". The signature is fluid and cursive, with a large initial "K" and a long, sweeping underline.

Kenneth M. Mead
Director, Transportation Issues

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ABBREVIATIONS

AAS	Advanced Automation System
ACCC	Area Control Computer Complex
AERA	Automated En Route Air Traffic Control
AFSS	Automated Flight Service Station
AGFS	Aviation Gridded Forecast System
ARSR-4	Air Route Surveillance Radar-4
ARTCC	Air Route Traffic Control Centers
ASDE-3	Airport Surface Detection Equipment-3
ASOS	Automated Surface Observing System
ASR-9	Airport Surveillance Radar-9
ASTA	Airport Surface Traffic Automation
ATC	air traffic control
ATCBI	air traffic control beacon interrogator
AWOS	Aviation Weather Observing System
AWPG	Aviation Weather Products Generator
CIP	Capital Investment Plan
CWP	Central Weather Processor
DOD	Department of Defense
F&E	Facilities and Equipment
FAA	Federal Aviation Administration
FSAS	Flight Service Automation System
FSDPS	Flight Service Data Processing System
FSS	Flight Service Station
GAO	General Accounting Office
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
ILS	Instrument Landing System
ISSS	Initial Sector Suite System
LDRCL	Low Density Radio Communication Link
LINCS	Leased Interfacility NAS Communications System
LLWAS	Low Level Windshear Alert System
MLS	Microwave Landing System
MWP	Meteorologist Weather Processor
NAS	National Airspace System
NWS	National Weather Service
ORD	operational readiness date
OT&E	operational test and evaluation
PAMRI	Peripheral Adapter Module Replacement Item
RCL	Radio Communication Link
RML	Radio Microwave Link
RWP	Real-time Weather Processor
SEIC	Systems Engineering and Integration Contractor
TAAS	Terminal Advanced Automation System
TATCA	Terminal Air Traffic Control Automation
TCCC	Tower Control Computer Complex
TDWR	Terminal Doppler Weather Radar
VSCS	Voice Switching and Control System

SECTION 1

INFORMATION ON THE OVERALL STATUS OF MODERNIZATION

The Federal Aviation Administration (FAA) began to modernize the air traffic control (ATC) system in 1981 under a 10-year, \$12 billion program that comprised about 80 projects. In 1991, the modernization effort was redefined as an evolving program incorporating the original projects and about 150 additional ones. Currently, this program is estimated to cost \$32.8 billion through the year 2000 and will require an additional \$1.3 billion for 2001.

TOTAL MODERNIZATION COSTS CONTINUING TO GROW

FAA's total estimated costs for ATC modernization continue to grow. In its October 1992 financial plan, FAA estimates that the modernization program will require \$32.8 billion in Facilities and Equipment (F&E) appropriations through fiscal year 2000. This estimate grew by \$869 million over last year's estimate of \$31.9 billion.¹ Of this cost increase, \$548.7 million is for projects added to the 1992 Capital Investment Plan (CIP).² The remaining increase is owing to a net growth in other NAS Plan and CIP projects and in installation costs.

FAA has also forecasted that the costs for some existing CIP projects may extend past the year 2000. For example, FAA estimates that it will need approximately \$1.3 billion for 29 CIP projects in fiscal year 2001. In addition, some projects, such as the Advanced Automation System (AAS) and the Microwave Landing System (MLS), will not be completely implemented by 2001. AAS is scheduled to achieve last-site implementation by 2002, and MLS is expected to be completed by 2008.

Between 1991 and 1992, the largest proportional increase in a project's costs--from \$3.5 million to \$53.3 million--was for the Logistics Support System and Facilities. This project identifies equipment, facilities, and systems required to support CIP projects throughout their life cycle. The change in funding occurred because the program office submitted a financial baseline change notice to restore approximately \$50 million cut by FAA in 1991. According to FAA budget officials, this money will be used, among other things, to procure initial spare parts for other CIP projects, expand the automated storage and retrieval system, and continue development of an information management system. The second largest proportional increase in project costs--from

¹Air Traffic Control: Status of FAA's Modernization Program
(GAO/RCED-92-136BR, Apr. 3, 1992).

²Prior to 1992, \$1 million was spent on two of these projects.

\$18.7 million to \$97.7 million--was for the Global Navigation Satellite System (GNSS). Originally, this project was designed to procure monitors so that the Global Positioning System (GPS), a satellite-based system, could be used for supplemental en route navigation and nonprecision approaches. This project has since been enlarged to include all of the augmentations needed to enable civil aviation to use GPS exclusively for en route navigation, terminal nonprecision approaches, and precision approaches. For more information on GNSS, see section 3.

The largest proportional decrease between 1991 and 1992 is associated with the Airport Cable Loop Systems Sustained Support, whose costs declined from \$39.1 million to \$1.0 million. This project provides for the continuance of existing cable loop projects³ at airports throughout the United States and for the updating of existing projects as needed. According to FAA budget officials, the decline in costs has occurred because FAA decided to replace and repair cable loops at various airport sites on a case-by-case basis. After the program office develops a mission need statement, this program may become national in focus. At that time, more funding may be required.

LARGEST COST GROWTH IN TERMINAL PROJECTS IN THE PAST YEAR

The CIP categorizes each project by the area of the ATC system that the project is designed to improve. Currently, there are six ATC categories--en route airspace, terminal airspace, flight service and weather information, ground-to-air facilities and equipment, interfacility communications, and maintenance and operations support.

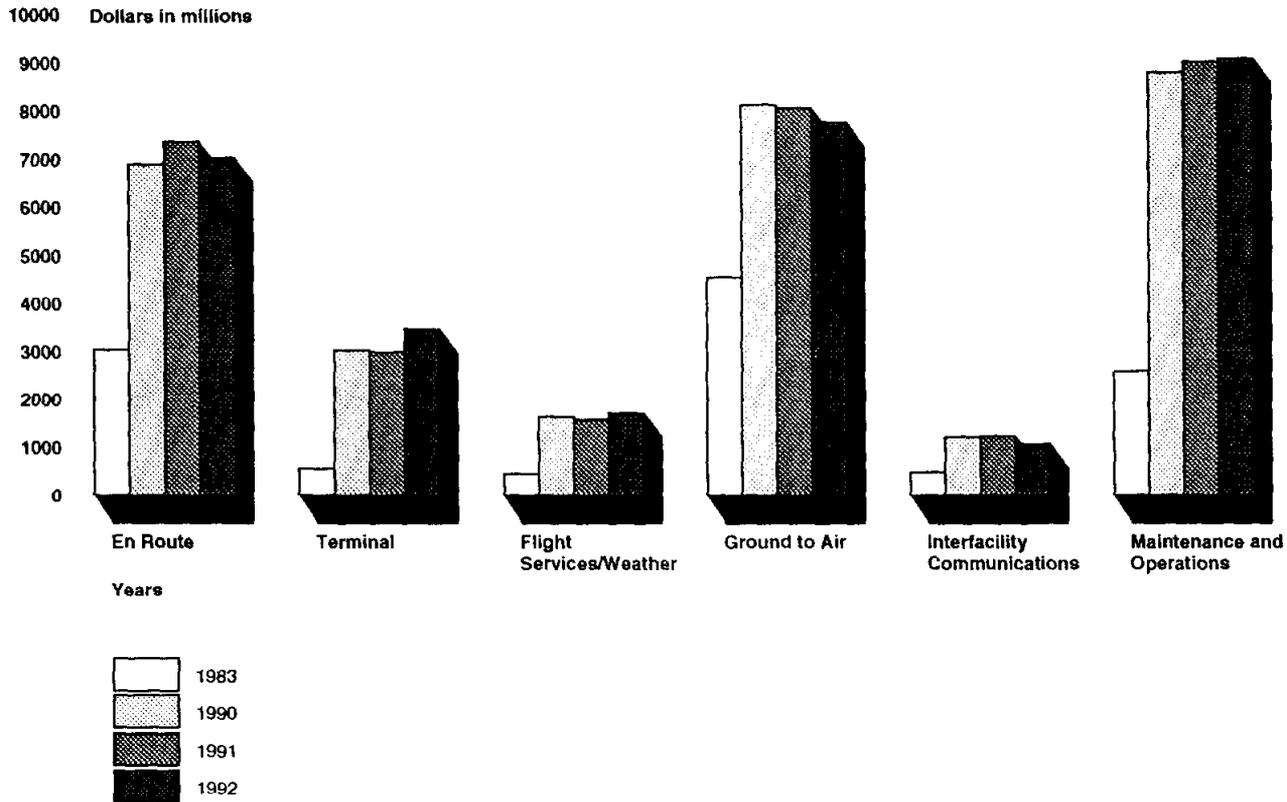
- En route projects affect the control of the aircraft in flight, that is, between takeoff and landing.
- Terminal projects affect aircraft approaches, landings, takeoffs, and departures from airports.
- Flight service and weather projects provide vital information to pilots about conditions and requirements along the route that the pilots will follow.
- Ground-to-air projects provide the facilities and equipment on the ground that support communication, navigation, landing, and the surveillance of aircraft in flight.

³This is a power cable system that allows for reliable power distribution and flexible signal transmissions at an airport. These cables have been configured into a loop.

- Interfacility communication projects allow FAA facilities on the ground to communicate with one another.
- Maintenance and operations support projects provide the facilities and equipment needed to keep the system functioning effectively.

We compared the 1991 and 1992 financial plans for the CIP to identify the categories in which the largest funding increases were anticipated. Total estimated F&E costs increased over last year's projections for three of the six categories. Costs for terminal projects grew by \$480.3 million, while costs for flight service and weather projects grew by \$143.3 million. In comparison, costs for maintenance and operations grew by \$68.8 million. For the remaining three project categories (en route, ground-to-air, and interfacility), estimated F&E costs declined by between \$159.8 million and \$328.8 million. However, between 1983 and 1991, funding for en route and ground-to-air projects grew substantially. For example, the cost for en route projects grew by \$4.3 billion from 1983 to 1991. Costs for ground-to-air projects grew by \$3.5 billion during the same time. Figure 1.1 shows the differences in F&E funding for the six ATC categories.

Figure 1.1: F&E Funding Estimates for Each ATC Category



Source: GAO analysis of FAA data.

TEN PROJECTS COMPLETED
IN 1992

One way to measure FAA's progress in modernizing the ATC system is to identify the number of projects that have been completed. FAA has fully implemented 46 projects in the field--10 in the past year. All but one of these completed projects are from the original NAS Plan. Of the 10 projects completed in 1992, 3 were major acquisitions--that is, a project whose total cost exceeds \$50 million.⁴ For nine of these completed projects, last-

⁴The three major acquisition projects completed in 1992 are the (1) Air Traffic Control Tower (ATCT)/Terminal Radar Approach Control (TRACON) establishment, replacement, and modernization; (2) modernization and improvement of FAA buildings and equipment; and (3) purchase of aircraft and related equipment.

site implementation was attained either on time or earlier than planned in the 1991 CIP. Only one project was delayed, by 5 months. FAA has 179 active or planned projects remaining in the CIP.

The 46 completed projects cost \$1.7 billion, or approximately 5 percent of the total estimated cost of FAA's ATC modernization effort through fiscal year 2000. This expenditure represents a 2-percent increase over last year's outlay. The remaining 95 percent of the modernization effort comprises funding for the most costly projects, including the 12 major acquisitions that we review in detail. For example, in 1992, the total cost estimate for AAS is \$4.7 billion and for MLS is \$2.6 billion. Last-site implementation dates for these two projects are 2002 and 2008, respectively.

TWELVE NEW PROJECTS ADDED
TO THE 1992 CIP

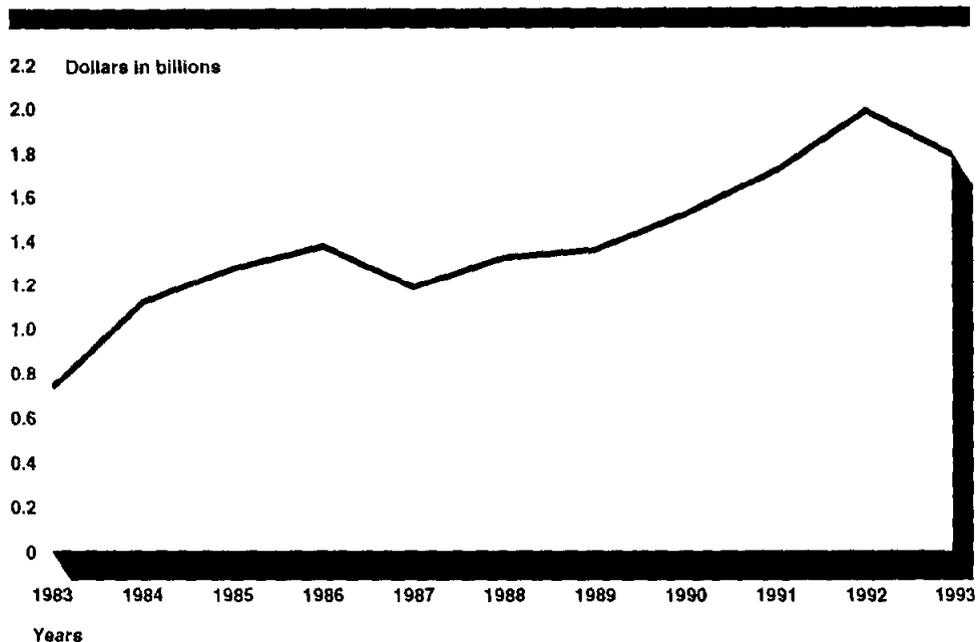
FAA has added 12 projects to the 1992 CIP--7 more than were added last year but substantially fewer than the 94 projects that were added in 1990. According to FAA, the 12 projects will cost \$548.7 million. The funding estimates for these 12 projects range from \$2 million to \$169.1 million; the average cost per project is approximately \$46 million through fiscal year 2000. More information on one of these new projects--the Oceanic Automation System--appears in section 3.

The number of new projects may increase if FAA decides to revise its current ATC consolidation plan in the 1992 CIP. To date, FAA has identified seven other projects that may be added.

RISING UNOBLIGATED F&E BALANCES
EXPECTED TO DECLINE SLIGHTLY IN 1993

Progress in modernizing the ATC system can also be measured by the amount of F&E funding that FAA has obligated. Obligations involve awarding contracts, placing orders, and receiving services during a given period and requiring payments during the same or a future period. Figure 1.2 shows changes in the amount of FAA's unobligated F&E appropriations since 1983. As compared with fiscal year 1991, the total unobligated balance of \$1.98 billion was \$267.4 million higher in fiscal year 1992. FAA predicts a slight decline by the end of fiscal year 1993, to a total balance of \$1.78 billion.

Figure 1.2: FAA's Unobligated F&E Appropriations for Fiscal Years 1983-93



Note: Data for 1993 data are estimated.

Source: GAO analysis of FAA data.

These unobligated balances have occurred for many reasons. For example, they have resulted from multiple-year budget authority in which appropriations have been available for more than 1 fiscal year. According to FAA's Office of Budget, prior to fiscal year 1992, F&E funds were available for 5 years, and many projects were fully funded because FAA initially asked for all of the money it needed to purchase and install a given number of units per project. This F&E funding was also used to prepare sites, test equipment, and purchase spare parts. However, beginning in fiscal year 1992, the period of availability for F&E funds was decreased from 5 years to 3 years to reduce the unobligated balances carried over from one year to another. With this reduction in the length of the appropriation, FAA may not be able to continue fully funding projects from the outset. In fact, for fiscal year 1993, FAA began incremental F&E funding for all projects because the agency thought that it would be difficult to obligate all the money needed for a project within 3 years. This change in funding policy accounts for the estimated decline in unobligated funds in 1993, as shown in

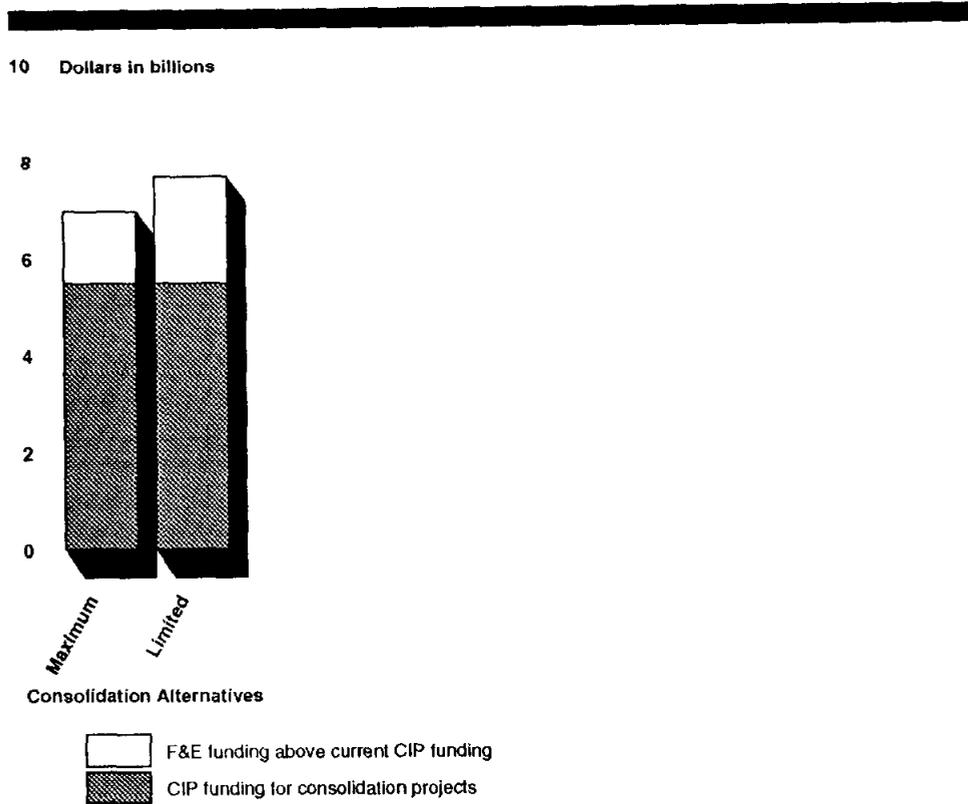
figure 1.2. Unobligated balances have also occurred when funds have been obligated later than planned because of delays in CIP projects.

LIMITED CONSOLIDATION PLANS
EXPECTED TO INCREASE COSTS AND
DELAY SCHEDULES

FAA initially planned to consolidate over 200 terminal radar approach control facilities and air route traffic control centers into 23 facilities. However, this consolidation plan has operational vulnerabilities. For example, if any one of these 23 consolidated facilities should fail, FAA believes, the adjacent facilities could not adequately handle the airspace, and the risk of traffic accidents would increase. To avoid this problem, FAA is considering two alternatives to the plan. These alternatives include maximum consolidation (27 facilities) and limited consolidation (202 facilities). FAA officials have told us that the agency's revised consolidation plan will be included in the final 1992 CIP and reflected in FAA's 1994 budget submission.

If FAA determines that more than 23 consolidated facilities are needed, costs may grow and schedules change for numerous projects within the CIP, including, for example, AAS, the Voice Switching and Control System, the Low Density Radio Communication Link, and the TRACON replacement and modernization. More units or channels may be needed for each project, and last-site implementation may be delayed for many projects. The amount of the increase in F&E funding and the length of the delays in schedules depends on the extent of consolidation. Currently, FAA estimates that F&E costs may rise over the next 12 years by \$1.5 billion to \$2.2 billion over current CIP funding estimates, depending on which alternative for consolidation is chosen. FAA has not yet projected the number of projects that may be delayed or the length of the delays. Figure 1.3 shows total CIP funding and estimated increases by alternative.

Figure 1.3: Impact of Consolidation Alternatives on the F&E Funding Estimates in the CIP (1993-2005)



Note: Amounts are based on 1993 constant dollars.

Source: GAO analysis of FAA data.

SECTION 2

INFORMATION ON THE STATUS OF 12 MAJOR PROJECTS

This section provides information on changes in costs and schedules for 12 of FAA's major acquisitions. Figure 2.1 briefly describes each project, compares total estimated F&E costs for 2 years (1992 and 1993), and summarizes key progress and problems for 1992. A more detailed discussion of each project's progress and problems follows table 2.2.

Costs for the 12 major projects that we reviewed in detail represent about 37 percent of the total F&E costs that FAA has estimated in 1992 for its modernization effort through fiscal year 2000. Costs for some of these projects, such as the Advanced Automation System (AAS) and the Microwave Landing System (MLS), will extend beyond the year 2000. As compared with the projection in FAA's 1983 financial plan, the total estimated cost in 1992 for these projects has risen by 57 percent. Since last year's report, costs for 9 of the 12 projects have risen. These cost increases total \$233.5 million.

Delays for first- and last-site implementation, from 1983 to 1992, have averaged about 5 years. Schedule slips for specific projects range from 1 to 12 years for first-site implementation and 1 to 9 years for last-site implementation. Since we issued our last report, some changes in schedules have occurred for four projects. First-site implementation has been delayed for the Air Route Surveillance Radar (ARSR-4) by 1 year and for the Airport Surface Detection Equipment (ASDE-3) by 2 years. Last-site implementation has been delayed for three projects--for AAS and ASDE-3 by 1 year and for ASR-9 by 3 years.

Figure 2.1 Major System Summary

Project by function	Description and anticipated benefits	2-year comparison of total F&E cost estimates (In millions of current dollars)		
		1992	1993	Difference
En Route				
Advanced Automation System (AAS) (2002) ^a	<ul style="list-style-type: none"> - Replaces hardware, software, and work stations at air traffic control facilities. - To be implemented in five phases. - Increases controllers' productivity, reduces operating costs, and increases airway safety and efficiency. 	\$4,672.9	\$4,703.4	\$ 30.5
Voice Switching and Control System (VSCS) (1997)	<ul style="list-style-type: none"> - Replaces and improves voice ground-to-ground and air-to-ground communications at air traffic control facilities. - Increases controllers' efficiency and allows safer handling of anticipated increases in air traffic. 	\$1,399.8	\$1,407.0	\$ 7.2
Flight Service and Weather				
Automated Weather Observing System (AWOS) (1997)	<ul style="list-style-type: none"> - Obtains aviation-critical data, such as wind velocity, temperature, dew point, altimeter setting, cloud height, and visibility. - Processes and transmits weather data to pilots via a synthesized computer voice. - Improves air safety at small, nontowered airports and eliminates or reduces observation errors at larger airports. 	\$ 216.2	\$ 229.9	\$ 13.7
Central Weather Processor (CWP) (Under review)	<ul style="list-style-type: none"> - Collects, synthesizes, and disseminates weather data, tailoring it to users' needs. - Includes Meteorologist Weather Processor and Real-time Weather Processor. - Reduces weather-related accidents and air traffic delays. 	\$ 136.5	\$ 152.0	\$ 15.5
Flight Service Automation System (FSAS) (1995)	<ul style="list-style-type: none"> - Provides pilots with automated weather data and access to the FAA system and identifies any national airspace system changes. Also simplifies flight plan filing. - Increases flight service efficiency and mitigates cost of additional staff and facilities to meet potential increase in demand for flight services. 	\$ 504.3	532.5	\$ 28.2

Key progress and problem issues - calendar year 1992

- Costs grew by \$30.5 million, primarily because of (1) a \$13.3 million increase to modify software in two phases of AAS and (2) a \$15.7 million increase to develop and install the Initial Sector Suite System (ISSS) test equipment.

- The projected date for government acceptance of the Initial Sector Suite System (ISSS) was delayed by 14 months. FAA has required IBM to deliver a plan to address ISSS' development problems, and the agency is looking at ways to make the current contract more flexible to mitigate risk and contain costs.

- Costs grew by \$7.2 million because of a change in the project's automatic reconfiguration capability.

- Implementation was delayed because of problems developing and integrating software while upgrading a prototype system to a full production system.

- The first prototype upgrade system was delivered to FAA's Technical Center for testing 6 months late in January 1993.

- Cost were increased by \$13.7 million to make the Automated Surface Observing System (ASOS) voice message format compatible with international standards, acquire more AWOS units, and cover costs from prior years that had been deferred in the ASOS program.

- First-site implementation was delayed by 10 months because FAA did not have the modems and telecommunication lines to link ASOS with FAA's ATC network

- AWOS has incurred maintenance and availability problems, which FAA is working to correct. For example, FAA has procured approximately \$1 million in spare parts and is negotiating a new maintenance contract.

- Total cost increase of \$15.5 million is attributable to the introduction of the Meteorologist Weather Processor (MWP) Phase II. MWP II is in the early stages of development.

- Work on RWP has been suspended; however, FAA is considering resuming work following its review of system requirements, which was completed in March 1993.

- FSAS costs increased by a net total of \$28.2 million. This includes an increase of \$46.3 million for a computerized system to support Automated Flight Service Stations (AFSS), a graphic weather display project, and costs for expanding the AFSSs. FSAS costs also declined by \$18.1 million because of changes in the power conditioning and computer replacement systems.

- Forty of the 61 AFSSs have been commissioned with Model 1 Full Capacity equipment.

- Neither the first- nor the last-site implementation date has been changed for FSAS.

Figure 2.1. Major System Summary (continued)

Project by function	Description and anticipated benefits	2-year comparison of total F&E cost estimates (In millions of current dollars)		
		1992	1993	Difference
Ground-to-Air				
Air Route Surveillance Radar (ARSR-4) (1996)	<ul style="list-style-type: none"> - Provides for long-range surveillance radar, en route navigation, air defense, and drug interdiction. - Decreases costs by substituting unmanned radar for old, hard-to-maintain systems and reducing number of site operators required. 	\$ 383.1	\$ 383.1	None
Airport Surface Detection Equipment-3 (ASDE-3) (1996)	<ul style="list-style-type: none"> - Enables busy airports to monitor ground activity of aircraft and other vehicles under all weather conditions. - Is capable of scanning entire airport facility and focusing on specific areas. - Increases surface safety and collision avoidance by replacing aging and less reliable ASDE-1 and -2 radar equipment. 	\$ 141.5	\$ 191.0	\$ 49.5
Airport Surveillance Radar (ASR-9) (1996)	<ul style="list-style-type: none"> - Provides highly accurate monitoring of aircraft movement/position within a 60-mile radius of the airport terminal. - Displays weather and aircraft information simultaneously. - Increases busy airports' safety by providing more accurate data to separate and control movement of aircraft in and out of airports. 	\$ 761.8	\$ 838.9	\$ 77.1
Microwave Landing System (MLS) (2008)	<ul style="list-style-type: none"> - Gives electronic guidance to aircraft for precision approaches and landings in any weather conditions. - Promotes safety in bad weather and reduces costs by expanding airspace capacity. 	\$2,623.7	\$2,623.7	None
Mode Select (Mode S) (1996)	<ul style="list-style-type: none"> - Reduces signal interference between aircraft and establishes a clear message channel between the aircraft and ground facilities. - Allows pilots to obtain weather information directly rather than through controllers. - Improves safety by identifying the location of aircraft more accurately. 	\$ 424.0	\$ 425.7	\$ 1.7

Key progress and problem issues - calendar year 1992

- Site preparation for the first ARSR-4 was completed in August 1992. The first operational readiness date is January 1994, a delay of 3 months since last year.
 - Last-site implementation is scheduled for February 1996.
-
- Costs have increased by \$49.5 million for 11 additional ASDE-3s.
 - Delays in installing the original ASDE-3 systems may occur over the next 2 years because of problems in developing the remote towers for the radars and ongoing airport construction that may not be completed in time to permit installation on schedule. FAA is exploring changes to the ASDE-3 deployment schedule to prevent serious schedule slippages. Consequently, both first- and last-site implementation dates have been delayed.
 - FAA is implementing the ASDE-3 radar with a split-target problem because, even with this problem, ASDE-3 improves controllers' tracking of aircraft during periods of low visibility. FAA expects to fix this problem by fiscal year 1994.
-
- Costs have increased by \$77.1 million to procure ancillary equipment and spare parts for six additional ASR-9s and to install these systems.
 - Last-site implementation has been delayed by 3 years to permit the installation of the six additional radars. Only 45 of the 98 delivered systems have been commissioned because a fault in the design of a transmitter component was detected after operational testing. FAA believes that it has addressed this problem by modifying the operation and components of the transmitter. FAA expects to authorize full production of the new transmitter components in March 1993.
-
- Costs have not grown since last year.
 - In June 1992, FAA awarded two contracts for six Category II/III MLSs, which are scheduled for delivery in 1996. These contracts were awarded 10 months late. First-site implementation is scheduled for 1997. The agency is delaying a decision to go to full production until the feasibility of satellite technology for precision landings has been determined and the development systems pass operational testing and evaluation.
-
- Reprogramming late in fiscal year 1992 increased costs by \$1.7 million.
 - A full-production contract was signed over 8 years ago; however, no operational system has been received.
 - Software development difficulties that have delayed the project for years have not yet been fully resolved. In response to these continuing difficulties, FAA plans to implement an Interim Beacon Initiative that provides less-capable radar services to 37 sites awaiting Mode S. The first implementation date for this interim system is May 1993. Once operational testing of the Mode S software has been completed, each interim system will be upgraded to a full Mode S.

Figure 2.1. Major System Summary (continued)

Project by function	Description and anticipated benefits	2-year comparison of total F&E cost estimates (In millions of current dollars)		
		1992	1993	Difference
Ground-to-Air (con't)				
Terminal Doppler Weather Radar (TDWR) (1996)	<ul style="list-style-type: none"> - Detects windshear and microbursts around airports, as well as gust fronts, wind shifts, and precipitation. - Promotes safety by providing alerts of hazardous weather conditions in terminal areas and of changing wind conditions that influence runway usage. 	\$ 340.6	\$ 350.7	\$ 10.1
Interfacility Communications				
Radar Microwave Link (RML) - Replacement and Expansion (Under review)	<ul style="list-style-type: none"> - Replaces and expands aging RML. Consists of the Radio Communications Link (RCL) Backbone, a Low Density RCL (LDRCL), and a Routing and Circuit Restoral (RCR) system. - Reduces costs and promotes safety by providing an effective, reliable voice and data service connecting Air Route Traffic Control Centers, long-range radars, and other air traffic facilities. 	\$ 313.3	\$ 313.3	\$ None

*Year in parentheses is FAA's 1992 CIP estimate for last-site implementation.

Source: GAO analysis of FAA data.

Key progress and problem issues - calendar year 1992

- Cost growth of \$10.1 million is attributable to changes in technical services support, increases in costs for back-up engine generators, and required improvements in data-archiving capabilities.
- First-site implementation date has slipped by 2 months because of delays in integrating TDWR with the Low-Level Windshear Alert System (LLWAS). Last-site implementation remains scheduled for 1996.

- Cost for the RML project have not grown.
- FAA completed the RCL portion of the program in November 1992.
- FAA has begun installation at 10 LDRCL sites; however the first and last operational readiness dates have each slipped by 1 year. These delays have occurred because the prime contractor was changed and operational testing and evaluation has not proceeded as quickly as anticipated.
- Work on RCR has stopped because the agency is considering leasing this service instead of procuring RCR.

CHANGES IN THE COSTS OF MAJOR
ACQUISITIONS SINCE 1983

We developed unit cost indexes for 11 of the 12 major acquisition projects that we reviewed.¹ Since the 1983 NAS Plan, FAA changed quantity requirements for 8 of these 11 projects. For 4 out of the 11 projects, the number of planned units has increased; for another 4, the number of units has decreased; and for 3, the number has not changed since 1983. To compare current cost estimates with initial cost estimates for these projects, we calculated unit costs for both periods. Specifically, we divided both initial and current costs by the number of units scheduled to be produced or served. As table 2.1 shows, the estimated unit costs grew for 10 of the 11 projects. The Airport Surveillance Radar (ASR-9) is the only project whose unit costs decreased, although its total cost grew by \$77.1 million, as noted in figure 2.1.

¹Because the scope of the Central Weather Processor was extensively revised in 1987, we could not compare unit cost estimates for this project.

Table 2.1: Changes in the Unit Cost for 11 Major CIP Projects

In millions of current dollars

Project	1983 F&E costs	1983 planned units	1983 F&E cost index	Current F&E costs ^a	Current planned units	Current F&E cost index	Percent change in unit cost
AAS	\$2,069.9	23 facilities	\$90.00	\$4,703.4	23 facilities	\$204.5	127
ARSR-4	425.8	48 radars	8.87	383.1	39 radars	9.82	11
ASDE-3	83.2	21 radars	3.96	191.0	44 radars	4.34	10
ASR-9	930.9	96 radars	9.70	839.9	124 radars	6.77	-30
AWOS	160.7	700 units	.23	229.9	737 units	.31	35
FSAS	305.1	61 stations	5.00	370.7 ^b	61 stations	6.08	22
MLS	1,245.6	1,250 systems	1.00	2,623.7	1,280 systems	2.05	105
Mode S	487.2	197 systems	2.47	473.2 ^c	137 systems	3.45	40
RML Repl/Exp	264.3 ^d	1,000 sites	.26	313.3	871 sites	.36	38
TDWR	550.0 ^d	102 radars	5.39	350.7	47 radars	7.46	38
VSCS	258.6	25 units	10.34	1,407.0	25 units	56.28	444

^aBased on program official's most recent estimate of F&E cost.

^bExcludes \$161.8 million currently identified for replacing computers, accommodating space needs, and installing power conditioning systems. These items were not included in the 1983 plans for the FSAS project.

^cIncludes \$47.5 million for the Aeronautical Data Link project. In 1983, the data link was part of the Mode S program.

^dCost data from 1985 and 1987 are used for the RML Replacement and Expansion project and the Terminal Doppler Weather Radar project, respectively, because earlier data are not sufficient to create a cost index.

Source: GAO analysis of FAA data.

CHANGES IN SCHEDULES FOR MAJOR ACQUISITIONS

As table 2.2 shows, CIP schedules have slipped for 11 of the 12 major acquisition projects since 1983. Table 2.2 focuses on the milestones that estimate when the first and last system will be implemented. The average delay from the 1983 NAS Plan to the 1992 CIP for both first-site and last-site implementation is 5 years.

Comparisons of milestones in the 1983 NAS Plan with those in the 1992 CIP show more variation for individual projects. For example, slips in first-site implementation range from 1 year to 12 years; slips in last-site implementation range from 1 year to 9 years.

Since we issued our report last year, FAA has rescheduled either the first- or last-site implementation for four projects. FAA has delayed the first-site implementation for ARSR-4 by 1 year and for ASDE-3 by 2 years. FAA has also delayed the last-site implementation of three projects--of AAS and ASDE-3 by 1 year and of ASR-9 by 3 years.

Table 2.2: Changes in Implementation Milestones for 12 Major FAA Projects

	First-site implementation				Last-site implementation			
	Year of first-site implementation			Years delayed	Year of last-site implementation			Years delayed
	83 NAS	91 CIP	92 CIP	83 NAS - 92 CIP	83 NAS	91 CIP	92 CIP	83 NAS - 92 CIP
Advanced Automation System	1990	1991	1991	1	1994	2001	2002	8
Air Route Surveillance Radar	1985	1993	1994	9	1995	1996	1996	1
Airport Surface Detection Equipment Radar	1987	1992	1993	6	1990	1994	1996	6
Airport Surveillance Radar	1985	1989	1989	4	1992	1993	1996	4
Automated Weather Observing System	1986	1989	1989	3	1990	1997	1997	7
Central Weather Processor	1990	1991	1991	1	1991	1998	*	*
Flight Service Automation System	1984	1991	1991	7	1989	1995	1995	6
Microwave Landing System	1985	1997	1997	12	1999	2008	2008 ^b	9
Mode S	1986	1993	1993	7	1993	1996	1996	3
Radar Microwave Link Replacement and Expansion	1985	1986	1986	1	1989	1994	*	*
Terminal Doppler Weather Radar	^c	1993	1993	^c	^c	1996	1996	^c
Voice Switching and Control System	1989	1995	1995	6	1992	1997	1997	5
Average years of delay				5				5

*Because portions of the Central Weather Processor (CWP) and the Radar Microwave Link (RML) Replacement and Expansion are being reevaluated, we cannot determine the last-site implementation dates.

^bThe last-site implementation date is for all Microwave Landing Systems (MLS) and is according to the program office.

^cThe Terminal Doppler Weather Radar project was not included in the 1983 NAS Plan.

Source: Implementation dates from FAA's 1983 NAS Plan, 1991 CIP, and unpublished 1992 CIP.

PROGRESS AND PROBLEMS ASSOCIATED
WITH THE 12 MAJOR PROJECTS

The following summaries of the 12 major projects we reviewed include (1) information on project changes and funding histories, (2) reasons for changes in project implementation dates and in total cost estimates, and (3) a description of key accomplishments and problems encountered on each project since we issued our last report in 1992. In some cases, project milestones may differ from the dates identified by FAA in its 1992 CIP, as noted in table 2.2.

FAA program offices for these 12 projects provided us with (1) total F&E cost estimates for fiscal years 1992 and 1993, (2) cumulative F&E funds appropriated through fiscal years 1992 and 1993, and (3) cumulative F&E funds obligated through fiscal year 1992. Fiscal year 1993 F&E figures are based on estimates current at the time of our review. In one instance, the estimate for a project changed since last year's report because FAA reevaluated funding for it after we completed our review in April 1992. Specifically, reprogramming in the Mode S program late in fiscal year 1992 led to a \$1.7 million increase in costs that we did not include in our previous report.

ADVANCED AUTOMATION SYSTEM (AAS)

Vendor: International Business Machines (IBM), Rockville, Maryland

Background

AAS is intended to be the centerpiece of FAA's modernized air traffic control system. It is designed to replace aging equipment, increase controllers' productivity, and accommodate projected traffic growth through the use of modern equipment and advanced software functions.

FAA awarded a contract to IBM in 1988 to complete the design and production of AAS. The contract calls for AAS to be implemented in five distinct segments: (1) the Peripheral Adapter Module Replacement Item (PAMRI), (2) the Initial Sector Suite System (ISSS), (3) the Terminal Advanced Automation System (TAAS), (4) the Area Control Computer Complex (ACCC), and (5) the Tower Control Computer Complex (TCCC). To date, FAA and IBM have worked primarily on the second segment of the project--ISSS. This segment is important because subsequent segments depend greatly on its successful completion.

AAS Progress and Problems

Since awarding a contract to IBM, FAA has seen costs increase and schedules slip for AAS. FAA currently estimates total F&E costs for AAS to be \$4,703.4 million. This total includes an increase of \$11.9 million incurred during the past year for three approved requirement changes to modify TAAS and ACCC software. In addition, costs for AAS have increased because of two financial baseline change notices, totaling \$15.7 million, to develop and install ISSS test equipment. Finally, an interface change to TCCC added \$1.5 million to the total F&E estimate. In total, FAA's estimate of F&E costs for AAS increased by \$30.5 million this past year. Furthermore, as we recently reported, the agency has identified about \$235 million in additional costs that may have to be added to the project.²

Since AAS' inception, the project's schedule has slipped by 6 years, from 1996 to 2002. This year, additional delays occurred. In late 1992, IBM announced that government acceptance of the ISSS system would now be delayed by an additional 14 months until September 1994, 33 months later than originally planned in the contract. FAA required that IBM deliver a plan to address problems in developing ISSS. In March 1993, FAA and IBM agreed on a new schedule for ISSS, which incorporates this 14-month slip. Moreover, FAA managers from the AAS program office, Airway

²Air Traffic Control: Advanced Automation System Problems Need to Be Addressed, (GAO/T-RCED-93-15, Mar. 10, 1993).

Facilities Office, and Air Traffic Office are meeting to establish priorities for proposed requirement changes and make the current contract more flexible to mitigate risk and contain costs.

Additional schedule delays may occur because of recent congressional budget cuts and continued uncertainty about consolidating air traffic control facilities. For example, in fiscal year 1993, the Congress appropriated \$80 million less than FAA had requested because of continuing development problems. This reduction in funding has prevented completion of the design for the full TCCC and caused IBM to stop work on the ACCC segments of AAS.

A discussion of progress and problems within the individual AAS segments follows.

PAMRI

PAMRI will provide new communications computers to connect en route centers with external systems, such as radars. PAMRI is ahead of schedule. All 20 systems have been delivered to the field, and 19 have reached operational readiness. FAA expects that all PAMRI systems will reach operational readiness by April 1993, 3 months ahead of schedule. However, because FAA needs additional radar display equipment to increase system redundancy, the agency began to introduce system redundancy in PAMRI beginning with the 16th system. Retrofits for the first 15 sites began in September 1992 and are scheduled to be completed by May 1993. As of March 1993, 14 PAMRI systems have been retrofitted.

ISSS

ISSS work stations will replace controllers' existing work stations at en route centers with new hardware and software, including radar displays. These work stations will provide higher-resolution screens and color capabilities. The critical design review for ISSS was completed in 1988. Nevertheless, technical problems remain. For example, the electronic flight strip data that ISSS produces are not viewed as "operationally suitable" by FAA's controllers. In addition, IBM cannot meet the requirement that a supervisor's work station instantaneously display data from any controller's work station. In November 1992, the contractor announced a 14-month delay in the government's acceptance of the system, from July 1993 to September 1994. The operational readiness date for the first ISSS has slipped from August 1995 to October 1996. In response to this delay, FAA is requiring that the contractor identify how and when it intends to deliver an ISSS that (1) meets contract requirements and (2) successfully completes formal tests at both the factory and the FAA Technical Center.

TAAS

TAAS will provide terminal controllers with new work stations identical to those used in ISSS, as well as with new hardware and software to perform terminal control functions. The critical design review for the TAAS segment of AAS was completed in January 1992. Formal milestones for the TAAS segment have not changed-- first-site implementation remains scheduled for January 1997. However, the program office has recently indicated that the TAAS segment will be delayed by 7 additional months, at a minimum. If FAA adopts the limited facility consolidation alternative that it is currently considering, TAAS will be installed in only 10 terminal control facilities, and FAA will establish a new program to develop a system for 170 terminal facilities.

ACCC

ACCC is a major software enhancement program that ties ISSS and TAAS together into a single facility so that the existing en route Host computer can be replaced. FAA plans to implement ACCC in four phases. The first phase replaces the computer, the second phase provides initial Automated En Route Air Traffic Control (AERA) services, the third phase provides full AERA capability, and the final phase completes ACCC requirements. FAA completed a critical design review for the first phase of ACCC in September 1992 and planned to hold critical design reviews for the other phases in September 1993, 1994, and 1995, respectively. However, program officials said that fiscal year 1993 appropriation cuts have caused a 6-month to 12-month delay in phase 1 of ACCC's development as well as a suspension of work on the latter three phases of ACCC. FAA expects that the suspension of work will cause another 12-month to 18-month delay in developing full ACCC/AERA; however, the agency has not yet announced the impact of these delays on ACCC's schedule.

TCCC

TCCC will replace hardware and software at selected airport towers. According to FAA officials, fiscal year 1993 budget cuts have delayed the critical design review for TCCC by 1 year, from June 1992 to June 1993. To date, FAA has announced no formal changes to the TCCC development schedule other than the delay in the critical design review. However, FAA officials told us that they now plan to limit the original scope of TCCC. FAA has divided the project into two phases: during the first, equipment that provides automated information on the airport environment will be replaced; during the second, tower controllers will receive new consoles, including automated flight strips and new radar screens. Originally, FAA had planned to equip 258 towers with a complete TCCC system, including new controller consoles. Now, the agency may provide automated airport environmental data at only 108 of these towers.

Two-Year AAS Funding History

Dollars in millions

	<u>FY 1992</u>	<u>FY 1993</u>
Total estimated F&E costs as of	\$4,672.9	\$4,703.4
Cumulative F&E funds appropriated through	\$1,890.5	\$2,290.3
Cumulative F&E obligations	\$1,855.0	--

AIR ROUTE SURVEILLANCE RADAR (ARSR-4)

Vendor: Westinghouse Electric Company, Baltimore, Maryland

Background

ARSR-4 is a long-range primary surveillance radar. A primary surveillance radar system tracks aircraft and weather by emitting radio signals that are reflected by all of the aircraft and weather conditions present in the area covered by the system. FAA is planning to procure 39 ARSR-4 units in a program jointly funded by the Department of Defense. Thirty-eight of these radars will be placed along the perimeter of the United States and will assist in en route navigation, air defense, and drug interdiction. One radar will be used for field support and training.

Ten of the 39 ARSR-4s will be used to replace ARSR-3s, which will then be moved to the interior of the United States as part of the "ARSR-3 Leapfrog" program. Five of these transplanted ARSR-3s will replace older radar systems, such as the ARSR-2, while the other five will be placed at new locations.

ARSR-4 Progress and Problems

The estimated total cost of the ARSR-4 project has not increased over the past year; however, the schedule for first-site implementation has slipped to January 1994, a delay of 3 months since last year. Last-site implementation is scheduled for March 1996.

According to the ARSR-4 program manager, FAA completed the first-site preparation of the ARSR-4 at Mt. Laguna, California, in August 1992. On October 2, 1992, high winds damaged radome panels and the radar antenna during construction at the Mt. Laguna site. The radome is the protective exterior that encases the radar antenna. The program office believes that the incident has not affected the ARSR-4 schedule.

FAA requested funding for the last six radars in its fiscal year 1993 budget submission. The House Committee on Appropriations' report on the Department of Transportation's fiscal year 1993 budget recommended an \$18 million cut from FAA's funding request for this project and stated that ". . . the Committee believes the request for six additional radars is clearly premature." The \$18 million cut was sustained in the conference report. Consequently, the program office has not executed the option for the last six radars, which was set to expire on April 1, 1993. FAA recently received an extension of this option to June 1, 1994, following negotiations with Westinghouse. In addition, FAA received (1) goods and services from Westinghouse and (2) a release from most existing claims by Westinghouse concerning past events. In return, FAA waived the Economic Price Adjustment clause of the

ARSR-4 contract. Under the terms of this clause, Westinghouse estimated that it would have to pay \$17 million to FAA. If FAA procures the last six radars after June 1, 1994, the ARSR-4 program office estimates that it will have to pay Westinghouse approximately \$16.7 million (\$2.8 million per site) over the option price.

Two-year ARSR-4 Funding History

Dollars in millions

	<u>FY 1992</u>	<u>FY 1993</u>
Total estimated F&E costs as of	\$383.1 ³	\$383.1
Cumulative F&E funds appropriated through	\$256.6	\$329.0
Cumulative F&E funds obligated through	\$226.5	--

³Reported as \$383.7 million in last year's report. According to the program manager, this represents a revision in FAA's calculations, but there has been no real change in the estimated cost of the program over the past year.

AIRPORT SURFACE DETECTION EQUIPMENT-3 (ASDE-3)

Vendor: Norden Systems, Inc., Norwalk, Connecticut

Background

ASDE-3 is a ground radar designed to provide surveillance of aircraft and vehicles operating on the surface of airports under all weather conditions, including rain and fog. FAA developed this system to replace the aging and less reliable ASDE-2 system with technology that better meets controllers' needs. Last year, the Congress provided funding to purchase 11 additional ASDE-3s. Now FAA plans to procure 44 ASDE-3s for 40 sites.

ASDE-3 Progress and Problems

During the past year, the cost of the ASDE-3 project increased from \$141.5 million to \$191.0 million. This increase is largely due to the Congress' decision to have FAA purchase 11 additional ASDE-3s at a cost of a \$49.5 million. In addition, the costs of ASDE-3 may increase because of two pending financial baseline change notices. For example, FAA is seeking approval for an increase of \$16 million for site configuration changes and solutions to a split-target problem. This problem causes some types of aircraft on the ground to appear as two or more targets on a controller's display screen when the radar is used to focus on specific parts of a runway. Also, FAA is seeking \$14 million for, among other things, software and hardware changes performed by Norden on ASDE-3 from 1986 to 1992. Taken together, these two potential changes could raise the project's total estimated costs to over \$220 million.

FAA plans to install ASDE-3 even though it has a target-splitting problem because the agency believes that even with this problem, ASDE-3 will significantly increase controllers' current capabilities to track aircraft and vehicles on airport surfaces during periods of low visibility. FAA has begun exploring solutions to the target-splitting problem and plans to correct it sometime in fiscal year 1994 at a cost of about \$7.7 million.

The ASDE-3 program office expects delays in installing ASDE-3s at the nation's airports over the next 2 years for two reasons. First, a Norden subcontractor responsible for developing remote towers for the radar is in financial difficulty and may not be able to provide the necessary equipment to install the radar at some airports. Second, some airports--such as Newark, LaGuardia, and O'Hare--may not be ready to accept ASDE-3 because of ongoing or planned airport construction projects. Therefore, FAA is exploring changes to ASDE-3's deployment schedule to provide the new radar to airports that are ready to receive it. Because of these delays, both the first- and last-site implementation dates have slipped. First-site implementation is now expected in March 1993, a delay of

1 year. Last-site implementation has also been delayed because of the decision to procure 11 additional ASDE-3s. It is now scheduled for July 1996, a delay of 25 months.

Two-Year ASDE-3 Funding History

Dollars in millions

	<u>FY 1992⁴</u>	<u>FY 1993</u>
Total estimated F&E costs as of	\$141.5	\$191.0
Cumulative F&E funds appropriated through	\$138.5	\$191.0
Cumulative F&E obligations	\$128.5	--

⁴FAA's ASDE-3 program office revised the estimate that it gave us for last year's report because a financial baseline change notice that was included in last year's estimate has not yet been approved. This change is to solve the target-splitting problem and site configuration changes. Total estimated costs for this period were reduced from \$158.2 to \$141.5 million.

AIRPORT SURVEILLANCE RADAR (ASR-9)

Vendor: Westinghouse Electric Corporation, Linthicum, Maryland

Background

ASR-9 is a primary surveillance radar system that enables air traffic controllers to monitor aircraft and weather within a 60-mile radius of the system's site. A primary surveillance radar system tracks aircraft and weather by emitting radio signals that are reflected by all of the aircraft and weather conditions present in the area covered by the system.

FAA is procuring 124 ASR-9 systems, including 6 systems that were added to the project last year. In addition to the radars, this procurement includes installation, spare parts, and ancillary equipment, such as automation, communications, and display systems. FAA will install 28 new radars and replace 96 aging radars, including 40 ASR-4/5/6s and 56 ASR-7/8s. Also, as part of the ASR-9 project, FAA will use the 56 displaced ASR-7/8s to replace all of the ASR-4/5/6s, the oldest ASRs.

ASR-9 Progress and Problems

During the last year, the ASR-9 project's costs increased and the schedule was delayed. According to FAA, the total estimated costs of the project will be \$838.9 million, an increase of \$77.1 million. This increase will be used primarily to finance the installation of, and purchase spare parts and expensive ancillary equipment for, the six additional ASR-9s procured in fiscal year 1992. Two of these systems were added by congressional mandate; the other four systems were added as a result of an FAA reprogramming action.

Because of commissioning delays, the last-site implementation date, or operational readiness date, of ASR-9 was postponed from 1993 to 1996. As of February 18, 1993, 134 ASR-9s had been accepted in the factory,⁵ 8 systems more than scheduled. However, only 98 systems had been delivered--32 systems fewer than expected--and 36 systems remained in storage. Also, only 45 systems had been commissioned--37 systems fewer than scheduled. FAA is working to resolve commissioning delays. These delays resulted from problems that affected the ASR-9 transmitter, including radiation problems and the unexpected failure of some of the transmitter's components. FAA believes that it has addressed these problems by modifying the operation and components of the

⁵FAA said that it accepts an ASR-9 in the factory when the radar successfully passes final tests designed by the agency to ensure that the system meets manufacturing standards and operates according to contract specifications.

transmitter as well as by increasing the availability of some of ASR-9's spare parts. For instance, in September 1992, FAA authorized the limited production of modified transmitter components; in late March 1993, it expects to authorize full production. FAA expects to commission four ASR-9s per month during 1993 and has scheduled the last-site implementation for April 1996.

According to FAA, during the last year, the ASR-9's operational availability rate met the 99.9-percent rate specified in the contract. The radar's rate rose to 99.92 percent, up from 99.8 percent the year before.

Delays in commissioning ASR-9 have slowed the relocation of ASR-7/8s because a radar cannot be relocated until its replacement has been commissioned. As of February 18, 1993, FAA had relocated 31 ASR-7/8s, 6 systems fewer than scheduled.

Two-Year ASR-9 Funding History

Dollars in millions

	<u>FY 1992</u>	<u>FY 1993</u>
Total estimated F&E costs as of	\$761.8	\$838.9
Cumulative F&E funds appropriated through ⁶	\$749.2	\$769.1
Cumulative F&E obligations	\$696.2	--

⁶FAA's ASR-9 program office revised the fiscal year 1992 cumulative appropriation from \$735.2 million to \$749.2 million. This revision was the result of consolidating in this project funds previously considered in other CIP projects.

AUTOMATED WEATHER OBSERVING SYSTEM (AWOS)

Vendors: Qualimetrics, Inc., Sacramento, California (AWOS), and AAI Corporation, Hunt Valley, Maryland (ASOS)

Background

AWOS measures wind velocity, temperature, dew point, altimeter setting, cloud height, and visibility through automated sensors. After gathering the information, the system disseminates it to pilots via computer-synthesized voice. FAA has procured and will install 200 AWOS units primarily at airports without towers or human weather observers. AWOS equipment is available commercially and was procured to fill an immediate need for automated weather information during the development of the more sophisticated Automated Surface Observing System (ASOS). In addition to obtaining the weather information provided by AWOS, ASOS identifies types and amounts of precipitation and displays weather information for use in airport towers.

Under the AWOS project umbrella, FAA also contributes funds to a joint program administered by the National Weather Service (NWS) to procure, install, and maintain ASOS for FAA and the Department of Defense. FAA plans to procure and install 537 ASOS units at both nontowered and towered airports.

AWOS Progress and Problems

The AWOS project's costs have grown since last year and are anticipated to increase this year. In addition, maintenance problems and schedule delays have beset the AWOS project.

The total estimated costs for AWOS have increased by \$13.7 million, from \$216.2 million last year to \$229.9 million this year. There are three reasons for the \$13.7 million increase. First, \$3.0 million is needed to make ASOS' voice message format compatible with international standards. Second, \$6.7 million was requested and approved to cover costs for the ASOS component deferred from prior years. Third, \$4.0 million was added to acquire additional AWOS units as directed by the House and Senate Appropriation Committees in their fiscal year 1993 conference report.

In addition to cost increases already approved, the program office has submitted a request for an additional \$14.8 million that may increase the project's total costs to \$244.7 million. This increase will be primarily to purchase modems for ASOS in fiscal years 1993 through 1995. In a reorganization, FAA transferred the responsibility for purchasing modems from a central procurement office to the program office. The requested increase will also be

used to establish telecommunication lines and cover increases in contract costs for ASOS.

FAA began commissioning AWOS in 1989 and has received all 200 AWOS units ordered. However, FAA is still experiencing problems with its AWOS maintenance contractor, Qualimetrics. As of November 1992, FAA had installed 164 AWOS units and commissioned 156 of them. According to the current schedule, all 200 AWOS units will be installed and fully operational by March 1994. While AWOS' reliability has exceeded the program's requirements, the availability of the AWOS equipment has suffered because the contractor has not had enough personnel to fix the system when it breaks down. Qualimetrics could not afford to finance a large enough inventory of spare parts to maintain FAA's systems with minimal downtime and had only five to six maintenance technicians to service all federally owned sites in the 48 contiguous states and Alaska.

To overcome its problems maintaining AWOS, FAA has procured approximately 1 million dollars' worth of spare parts for the contractor to use and is negotiating a new 1-year maintenance contract with Qualimetrics. The contract will have three additional 1-year options for FAA to exercise. At the end of each year, FAA will evaluate Qualimetrics' performance and determine whether the contractor can cost-effectively perform site maintenance. If it does not renew the contract with Qualimetrics, FAA may assume responsibility for maintaining the AWOS sites.

Although FAA has commissioned over three-quarters of the 200 AWOS units purchased, it did not commission the first ASOS as scheduled in September 1992. Operational readiness for the first ASOS site is now planned for July 30, 1993. As of November 1992, FAA had received 111 ASOS units and installed 95 of them. Commissioning was delayed by 7 months because FAA did not have modems and telecommunication lines to link ASOS with FAA's air traffic control network. The program office expects initially to commission up to 10 ASOS sites. FAA still expects its last ASOS site to be operational by May 1997.

Two-Year AWOS Funding History

Dollars in millions

	<u>FY 1992</u>	<u>FY 1993</u>
Total estimated F&E costs as of	\$216.2	\$229.9
Cumulative F&E funds appropriated through	\$144.3	\$170.3
Cumulative F&E obligations through	\$133.8	--

CENTRAL WEATHER PROCESSOR (CWP)

Vendor: Harris Corporation, Melbourne, Florida

Background

The CWP program collects, synthesizes, and disseminates weather data to various users within the air traffic control system. This program comprises three subprojects: the Meteorologist Weather Processor (MWP), the follow-on Meteorologist Weather Processor system (MWP II), and the Real-time Weather Processor (RWP). MWP distributes weather data to meteorologists at major FAA air route traffic control centers. RWP is being developed to distribute weather information to air traffic controllers.

CWP Progress and Problems

FAA has finished installing MWP, is in the early stages of developing MWP II, and is considering restarting work on RWP. CWP's estimated costs have increased from \$136.5 to \$152.0 this past year. The \$15.5 million net increase in the total cost of the three projects is due to the inclusion of MWP II in this year's CIP and to a \$3 million decrease in the estimated cost of RWP.

The Harris Corporation's contract lease for the \$25 million MWP component will expire in 1995. MWP II is designed to replace the leased MWP systems and to provide additional weather-processing capabilities by, for example, displaying national radar mosaics at the Central Flow facility. FAA approved the MWP II mission need statement on February 20, 1992; the estimated F&E cost for the MWP II system is about \$18.5 million.

FAA has suspended work on the \$108 million RWP project. However, FAA is considering restarting the project following the release of an FAA report indicating that RWP is still needed. An FAA group has reviewed the functional weather requirements for air traffic controllers and has validated the need for RWP. This type of requirements analysis is usually considered an early phase of a project's development.

However, the RWP project, which FAA views as a prototype of a production system, is about 6 years old and has had development problems that may limit FAA's future procurement options. The software developed by the contractor thus far may not be compatible with a production system. For example, the current RWP system's software does not meet all of FAA's requirements and has not been validated by the system's users. Also, the RWP software was developed to run on one type of computer, and FAA's tests have shown that the software is not easily transferrable to other types of computers. If FAA decides not to use the software developed

thus far for the final RWP, it may have to have a production contractor develop new software. In either event, RWP or a similar system will serve as a key conduit for getting weather information from other systems to air traffic controllers.

Two-Year CWP Funding History

Dollars in millions

	<u>FY 1992</u>	<u>FY 1993</u>
Total estimated F&E costs as of	\$136.5	\$152.0
Cumulative F&E Funds appropriated through	\$75.2	\$79.2
Cumulative F&E obligations	\$72.8	--

FLIGHT SERVICE AUTOMATION SYSTEM (FSAS)

Vendor: E-Systems, Inc., Garland, Texas

Background

FSAS is designed to automate and improve pilots' access to national aeronautical and meteorological information, simplify flight plan filing, and replace the present labor-intensive and inefficient manual technique of providing flight services. This project provides for the establishment of 61 Automated Flight Service Stations (AFSS) and the consolidation of 318 Flight Service Stations (FSS).

FSAS Progress and Problems

Total project costs for FSAS have increased by \$28.2 million, from \$504.3 million to \$532.5 million. This net change includes three increases totaling \$46.3 million and two decreases totaling \$18.1 million. The increases include (1) \$17.8 million for a new project that would replace Model 1 Full Capacity equipment at AFSSs with a new computerized workstation that extensively uses commercial off-the-shelf software, (2) \$16.8 million for a Graphic Weather Display System project contained in the current CIP as part of FSAS, and (3) \$11.7 million for expanding the AFSSs. The decreases include (1) \$8.4 million in the power conditioning system recommended by the CIP Steering Committee because funds from prior years were unobligated, (2) \$6.7 million in costs for a new computer replacement project for which the final requirements have not been determined, and (3) \$3.0 million in transfers to other FSAS-related projects.

Total FSAS project costs may grow to \$607 million if FAA approves four pending financial baseline change notices. The \$74.5 million increase includes (1) \$39.4 million to complete the phased replacement of FSAS equipment; (2) \$14.6 million to finish installing, supporting, and ensuring the operational efficiency of the AFSS computerized support operations system; (3) \$12.2 million to replace the existing deteriorating graphic weather display system; and (4) \$8.3 million to complete 25 power conditioning system sites.

FAA has commissioned 13 of the 21 Model 1 Full Capacity Flight Service Data Processing Systems (FSDPS). In addition, 59 of the 61 Automated Flight Service Stations (AFSS) are operational and 40 of the 61 have been commissioned with Model 1 Full Capacity equipment. According to the FSAS program manager, last-site implementation will occur in Miami in February 1994 rather than in Minneapolis in December 1993 because Hurricane Andrew destroyed the equipment that had been commissioned in Miami in 1992. However, the CIP's last-site implementation date remains June 1994. In addition, FAA has consolidated and relocated staff for 207 FSSs. FAA plans to

complete consolidation of 318 FSSs in 1995, as originally scheduled in the CIP.

Last year we reported that FAA had a plan to address problems in supporting AFSS. Specifically, FAA planned to purchase spare parts to maintain the AFSS equipment through 1995 and, in 1995, to replace some AFSS hardware and upgrade the FSDPS software to maintain the system until 1998. In addition, FAA planned to replace hardware at the FSDPSS and the Aviation Weather Processors in 1998. However, rather than purchasing new equipment and software in 1998, FAA now intends to lease all equipment, software, and data streams necessary for flight service operations. According to the FSAS program and business managers, FAA decided to lease flight service operations in November 1992 because leasing would make state-of-the-art equipment more readily available for the agency than purchasing. FAA is currently developing the strategy needed to make this change in the program. Until a strategy is developed, time frames, impact on current FSAS projects, and costs cannot be determined. However, FAA program officials believe that over time leasing will be more cost-efficient than purchasing.

Two-Year FSAS Funding History⁷

Dollars in millions

	<u>FY 1992</u>	<u>FY 1993</u>
Total estimated F&E costs as of	\$504.3 ⁸	\$532.5
Cumulative F&E funds appropriated through	\$375.8	\$379.8
Cumulative F&E obligations	\$325.3	--

⁷Because costs for leasing flight services have not been determined, funding information is for the current FSAS program.

⁸Our report last year identified \$561.8 million in total F&E costs. This figure has been reduced by \$57.5 million because FAA did not approve \$55.7 million to expand the computer replacement project and \$1.8 million was counted twice in the total F&E costs.

MICROWAVE LANDING SYSTEM (MLS)

Vendors: Wilcox Corporation, Kansas City, Missouri; Allied-Signal Aerospace Company's Bendix Communication Division, Baltimore, Maryland; and Raytheon Corporation, Marlboro, Massachusetts

Background

MLS is designed to allow aircraft to land and depart under poor weather conditions. FAA considers MLS technically superior to the current Instrument Landing System (ILS) because MLS will allow aircraft to fly a variety of advanced procedures, such as curved approaches, and will meet other requirements that ILS cannot satisfy. According to international agreement, FAA must install approximately 160 MLSs on international runways by January 1, 1998.

MLS Progress and Problems

The cost of the MLS project has not increased since we issued last year's report; however, FAA experienced a 10-month delay in awarding the development contract for the first article MLSs.

As we reported previously, FAA plans to buy a total of 1,280 MLSs at an estimated cost of \$2.6 billion by the year 2008. This figure includes \$99.3 million to develop and implement 30 Category I systems,⁹ which were developed by Hazeltine, Wilcox, and Allied-Signal's Bendix Communication Division; \$1.5 billion to develop and implement 1,250 Category II and III systems; and \$1.0 billion for program support, regional site preparation, and the MLS demonstration program.

Since 1984, FAA has been acquiring the 30 Category I MLSs. Four of these systems have been installed and are operating--two at FAA's Technical Center in Atlantic City, New Jersey, and one each at John F. Kennedy and Midway airports. The remaining 26 systems will be delivered beginning in June 1993, a delay of about 1 year since we reported last year. The first of these systems is scheduled to be installed in August 1993. All 30 systems will be used for testing, developing approach procedures, and operational purposes. FAA does not plan to procure any more Category I MLSs.

⁹An MLS is categorized by different minimum standards of height and visibility for the safe descent of aircraft using the system. Category I equipment allows aircraft to descend to a height of 200 feet above the ground when the runway visual range is at least 1,800 feet. Category II equipment allows aircraft to descend to a height of 100 feet above the ground when the runway visual range is at least 1,200 feet. Category III does not have a height minimum. Instead, it has three subcategories requiring a runway visual range of at least 700 feet, 150 feet, and 0 feet.

Instead, FAA plans to procure 1,250 Category II and III MLSs and use them to provide Category I, II, and III services. In June 1992, after a 10-month delay, FAA awarded two full-scale development, limited-production contracts to the Wilcox and Raytheon corporations at a cost of \$148 million. Each contract supports the development and testing of six first article Category II and III MLSs and contains an option to purchase six additional systems. This development is expected to take 46 months; delivery of the first system is expected in 1996.

After FAA awarded the contracts, Allied Signal's Bendix Communications Division filed a bid protest with GAO's Office of General Counsel over FAA's decision. The protester stated that it had a technically superior, albeit more costly, Category II and III MLS design and requested a reevaluation of the award decisions. On January 29, 1993, GAO denied this protest.

The first Category II and III MLSs are scheduled to be operational in 1997. At this time, FAA plans to install the first article systems developed by Wilcox and Raytheon. However, FAA is delaying its decision to start the production of these systems for two reasons. First, FAA plans to conduct independent operational testing and evaluation on the development systems before awarding the full production contract. This was not originally planned. Second, because the agency is doing research to develop a satellite-based navigation system to be used for precision landings, FAA plans to delay the decision to advance full production of Category II and III MLS until it determines the feasibility of using satellite navigation for precision landings. FAA expects to make this feasibility decision in 1995, at approximately the same time as the development of 12 Category II and III MLSs is completed. Initially, satellites may support Category I approaches; however they may support all types of approaches in the long term. As we reported in November 1992,¹⁰ FAA's decision to replace the ILS with MLS may be premature because satellite technology may provide the capabilities and benefits of MLS.

At the end of the development period, FAA plans to award production contracts for the remaining 1,226 Category II and III MLSs to the contractors that are developing MLS. These systems would be installed at all current ILS locations. About 160 systems will need to be installed on international runway ends by January 1, 1998, for FAA to meet its international commitment for MLS. By 2000, FAA plans to procure 464 Category II and III systems, including those currently under development (phase 1), and to procure the remaining 786 MLSs after 1999 (phase 2). FAA currently plans to have all 1,250 systems procured by 2008. After FAA

¹⁰Airspace System: Emerging Technologies May Offer Alternatives to the Instrument Landing System (GAO/RCED-93-33, Nov. 13, 1992).

installs MLSSs at all of the ILS locations and has satisfied the additional need for MLSSs, FAA plans to announce a termination date and transition plan for decommissioning all ILSs.

Funding changes in FAA's 1992 financial plan may decrease the possibility of FAA's procuring 464 Category II and III MLSSs by 2000. According to a draft budget plan, FAA has cut the funding it plans to award during phase 1 of the MLS project from \$1.1 billion to \$736.6 million. This occurred largely because planned annual MLS funding was reduced from \$160 million per year to \$80 million per year beginning in 1995. MLS program office officials stated that this cut would not allow them to fulfill their international commitment. Other FAA officials have stated that the agency may not be able to procure all 464 systems under phase 1 because of the reduction in funding and whatever systems the agency does not procure under phase 1 will be moved into phase 2.

Two-Year MLS Funding History

Dollars in millions

	<u>FY 1992</u>	<u>FY 1993</u>
Total estimated F&E costs as of	\$2,623.7	\$2,623.7
Cumulative F&E funds appropriated through	\$255.2	\$300.2
Cumulative F&E obligations	\$221.4	--

MODE SELECT (MODE S)

Vendor: Joint venture of Paramax Systems Corporation, Paoli, Pennsylvania, and Westinghouse Electric Corporation, Linthicum, Maryland

Background

Mode S is a secondary surveillance radar. A secondary surveillance radar--or air traffic control beacon interrogator (ATCBI)--identifies, locates, and tracks aircraft by using signals to interrogate equipment (transponders) on board the aircraft. Consequently, it can detect only aircraft equipped with transponders. Mode S is about four times more accurate than the secondary surveillance radars currently being operated by FAA. Also, it is designed to interrogate up to 700 aircraft individually and has a data communication channel that permits ground-to-air exchange of aviation-related information, including air traffic control and weather data.

In terminal and en route sites, FAA has 392 secondary surveillance radars, including 167 ATCBI-5s, 85 ATCBI-4s, and 140 ATCBI-3s, the oldest secondary surveillance radars. Because of the limitations of the automated-processing equipment, each radar can interrogate only up to 250 aircraft. To replace the ATCBI-3s, which use 1960s technology, FAA is procuring 137 Mode S systems, including installation and spare parts. FAA plans to implement 108 of these system at terminal sites and 25 of them at en route sites. Four systems will be used for training and technical support.

Mode S Progress and Problems

During the last year, the costs of the Mode S project increased slightly, but the last-site implementation date was not delayed. According to FAA, the total estimated costs of the project grew by \$1.7 million, to a total of \$425.7 million. This increase was needed to fund additional requirements for spare parts. In addition, if FAA approves new requirements considered for fiscal year 1995, the project's total costs could increase by \$12.5 million. This increase would finance, among other things, test sets and software changes. The date for implementing the first Mode S system remained 1993.

Because the software that supports the Mode S surveillance and data communication components is still under development, FAA will continue to use an incremental strategy to implement the system. First, because it is becoming increasingly difficult to maintain the current aging secondary surveillance radars, FAA will implement an interim beacon system, which is based on the Mode S hardware. According to FAA, this interim system will be as accurate as current secondary surveillance radars. Also, it will have neither the capacity to interrogate aircraft selectively nor a data

communication channel. FAA plans to implement about 37 of these interim systems in terminal sites equipped with ASR-9 primary surveillance radars. The operational test and evaluation (OT&E) of this system was completed in November 1992. As of February 18, 1993, the estimated first-site implementation date for this interim system is May 1993. Each interim system will be upgraded to a full system once the software is developed to support a full Mode S system. To avoid cost increases and schedule delays during the software's development and testing, FAA last year renegotiated the Mode S contract to gain control over these activities.

Second, FAA will implement a complete Mode S system for terminal sites. This system will be able to interrogate up to 400 aircraft selectively and to operate a data communication channel at 75 percent of its specified capacity. The OT&E of this system is expected to be completed by August 1993, 8 months later than scheduled. This delay occurred because FAA requested software changes to support the deployment of the system. The first-site implementation date for this system is October 1993. By August 1994, the Mode S system will be upgraded to interrogate up to 700 aircraft selectively and to operate its data communication channel at full capacity.

Third, FAA will implement a Mode S system for en route sites using a back-to-back antenna. This back-to-back antenna will improve the target update rate of the system from about 12 seconds to about 6 seconds and increase the capacity of the data communication channel. FAA is simultaneously developing two software versions for the en route Mode S system to ensure timely deployment of Mode S. One version will support the system using one side of the back-to-back antenna as a single-face antenna; the other will support the system using both sides of the back-to-back antenna. If problems prevent the deployment of the back-to-back software, the single-face software will be deployed. When these problems are resolved, en route Mode S systems that have the software to use a single-face antenna will be upgraded with the software to use a back-to-back antenna.

The OT&E of the en route Mode S with a single-face antenna is estimated to be completed by April 1994, 10 months later than expected. This delay is the result of the schedule slippage in the OT&E of the terminal version of Mode S. The first-site implementation date for this system is July 1994. The OT&E of the Mode S with a back-to-back antenna is estimated to be completed by December 1994. First-site implementation of this version is planned for February 1995. Last-site implementation is scheduled for December 1996.

Two-Year Mode S Funding History

(Dollars in millions)

	<u>FY 1992</u>	<u>FY 1993</u>
Total estimated F&E costs as of	\$424.0	\$425.7
Cumulative F&E funds appropriated through	\$397.8 ¹¹	\$403.1
Cumulative F&E obligations	\$361.2	--

¹¹FAA's Mode S program office revised the fiscal year 1992 cumulative appropriation from \$396.2 million to \$397.8 million as a result of a reprogramming action that did not occur until after we released last year's report.

RADAR MICROWAVE LINK (RML) REPLACEMENT AND EXPANSION

Vendors: American Telephone and Telegraph (AT&T) Technologies, Greensboro, North Carolina, and Alcatel, Inc., Richardson, Texas.

Background

The objective of this program is to replace equipment used for transmitting radar data to Air Route Traffic Control Centers (ARTCC) and to form a communications network between ARTCCs. The program is composed of the following projects: (1) the Radio Communications Link (RCL) Backbone Network, (2) the Low Density RCL (LDRCL) Phase I, and (3) the Routing and Circuit Restoral (RCR) Phase I.¹² RCL is the main component of the program. It consists of microwave transmitters and signal repeaters that have been installed at 818 sites across the country. LDRCLs are low- to middle-capacity versions of RCL for areas with a low volume of communications traffic. RCR would provide equipment to allow information to flow between the ARTCCs and to form new communications paths in the event of a catastrophic failure in the network.

Both the new RCL and the previous RML systems use microwave technology to transmit data. In the RCL system, however, 400 additional sites have been added to create a nationwide network, primarily connecting ARTCCs. Currently, the ARTCCs communicate via leased lines. The new system is expected to provide several benefits. First, the network linking the ARTCCs will give FAA an alternative to using leased lines. Second, the new system will provide more capacity for transmitting voice and radar data than the RML equipment. Third, in FAA's view, replacing the old equipment will reduce maintenance costs. Finally, the new system will be able to transmit both analog and digital data, whereas the RML equipment can carry only analog data.

The data that can be carried on the RCL network can also be carried on the future Leased Interfacility NAS Communications System (LINCS). FAA recently signed a contract with MCI Corporation to lease lines and create LINCS. FAA is currently comparing the costs and benefits of LINCS and of the RCL network.

RML Replacement and Expansion Progress and Problems

Since our last report, the total F&E cost estimate for this project remains \$313.3 million. However, the suspension of the RCR

¹²LDRCL and RCR each have subsequent phases to meet anticipated ATC requirements. To be consistent with past reports, the information presented here does not incorporate information on these later phases.

component of the program has created uncertainty over future funding requirements. The status of the three components is described below.

RCL

According to the RCL project manager, FAA completed RCL in November 1992. This project was a major accomplishment for FAA because the equipment was installed at 818 sites and virtually all of the communications traffic that formerly ran on the old RML system is now running on the new system. The final cost of the RCL Backbone was \$275 million, within last year's estimate. The prime contract was awarded to AT&T Technologies in 1985.

LDRCL

According to project officials, FAA has begun to install equipment for four LDRCL systems (located at 10 sites) and has ordered equipment for an additional 17 systems (43 sites). FAA is currently reviewing the schedule for LDRCL. No official schedule exists. The LDRCL project manager estimates that the first site will be operational in July 1993 and the last site in April 1995. Last year, the project manager's estimates for these dates were July 1992 and April 1994.

The former and current project managers said that one reason for the schedule slips was instability created by the sale of the prime contractor. The prime contract for LDRCL was awarded to a division of Rockwell International in April 1991. In September 1992, Rockwell sold this division to Alcatel, Inc. The former project manager expressed satisfaction with the new prime contractor but said that time was lost in making the transition between companies and in training new staff. The current project manager also said that recent delays had occurred because operational test and evaluation has not proceeded as quickly as originally anticipated.

RCR

FAA stopped work on the RCR component of the program because officials believed that they would not receive an affordable offer for the RCR project that they originally envisioned. FAA officials are considering two major options, or a combination of the two: (1) to utilize an existing U.S. Air Force contract, supplemented with other systems, to purchase off-the-shelf equipment or (2) to expand the LINCS contract in place of RCR.

Two-Year RML Replacement and Expansion Funding History¹³

Dollars in millions

	<u>FY 1992</u>	<u>FY 1993</u>
Total estimated F&E costs as of	\$313.3	\$313.3
Cumulative F&E funds appropriated through	\$273.3	\$283.3
Cumulative F&E funds obligated through	\$251.3	--

¹³Funding numbers do not include subsequent phases of LDRCL and RCR. The total estimated F&E cost of these subsequent phases is \$58 million.

TERMINAL DOPPLER WEATHER RADAR (TDWR)

Vendor: Raytheon Company, Sudbury, Massachusetts

Background

TDWR is a weather radar designed primarily to detect hazardous weather conditions--such as wind shear and microbursts--around airports and to send this information to air traffic controllers. Additionally, TDWR will detect gust fronts, wind shifts, and precipitation. FAA is procuring 47 TDWR systems.

TDWR Progress and Problems

Costs of the TDWR project have increased, and first-site implementation has been delayed. Since last year, FAA's total estimated F&E cost has increased by \$10.1 million to \$350.7 million. This increase is due to (1) technical service support costs that the project now has to absorb, (2) an increase in the cost of backup engine generators, and (3) a requirement for improved data archiving capability. The project office has also submitted a request for a \$19.1 million change in the project's financial baseline for possible increases in the costs of the contract, implementation, and engine generators. FAA has not formally approved this change.

According to the program manager, TDWR's first-site implementation has slipped by 2 months, from April to June 1993. The delay in first-site implementation was caused by FAA's need to integrate the TDWR systems with the Low-Level Windshear Alert Systems (LLWAS), since both TDWR and LLWAS are designed to provide windshear data to controllers. However, the TDWR/LLWAS integration software will not be available until August 1994, more than 1 year after first-site implementation. According to the TDWR program manager, the CIP milestone for last-site implementation remains 1996.

TDWR is currently in the operational test phase of its development. A contractor's delay caused the operational tests on the system in Oklahoma City to be conducted later than planned, and all of the system tests could not be completed. The radar system being tested also had problems being customized for local conditions, handling short interruptions of power, and operating its remote maintenance monitoring system without failures. Additional operational testing will be done at the Memphis TDWR site this spring.

Two-Year TDWR Funding History

Dollars in millions

	<u>FY 1992</u>	<u>FY 1993</u>
Total estimated F&E costs as of	\$340.6	\$350.7
Cumulative F&E funds appropriated through	\$317.6	\$337.6
Cumulative F&E obligations	\$286.7	--

VOICE SWITCHING AND CONTROL SYSTEM (VSCS)

Vendor: Harris Corporation, Melbourne, Florida

Background

VSCS is designed to replace existing communications systems with an expandable, highly reliable system for both ground-to-ground and air-to-ground communication. VSCS is an integral part of FAA's plans for modernizing the ATC system because it provides the communication capabilities for the new ISSS work stations being purchased under the AAS contract. Intended to increase controllers' efficiency, the VSCS will allow safer handling of anticipated increases in air traffic. VSCS is also designed to allow the automatic transfer, or reconfiguration of, voice frequencies.

After developing prototypes for 5 years, the Harris Corporation was awarded a contract on December 31, 1991, to complete the VSCS project and deliver at least 25 VSCS production systems. The contract includes time for continuing the development of VSCS so that Harris can upgrade the prototype system to the full production system. The prototype system can handle communications for up to 60 air traffic controller positions. The full production system will be able to handle up to 430 controller positions. After FAA accepts the prototype upgrade, Harris is then authorized to start limited production of five VSCS systems. Finally, full production is planned after VSCS' operational test and evaluation is successfully completed.

VSCS Progress and Problems

VSCS' costs have increased by 400 percent since 1983, and the project's first-site implementation has slipped by 6 years during the same period. In the past year, additional delays have extended the schedule for implementing VSCS, and total costs for the project have increased by \$7.2 million because of changes recommended by the air traffic organization to make the VSCS automatic reconfiguration capability more useful. Additionally, changing plans for consolidating air traffic facilities and other development problems could further increase VSCS' estimated costs.

Harris has encountered software development and integration problems in upgrading the prototype to the production version. FAA believes that Harris underestimated the effort needed to upgrade the prototype. Because of the current software problems, delivery of the first prototype upgrade system to its testing facility was delayed from June 30, 1992, to January 11, 1993. The VSCS project office also estimates that first field-site implementation will slip by 8 months, from June 30, 1994 to February 28, 1995. Last-site implementation will similarly be delayed by 8 months, from

July 1996 to March 1997. These dates are now consistent with milestones in the CIP.

FAA is currently negotiating a contract modification to incorporate these changes in the VSCS schedule and to alter some VSCS requirements. Some changes to contract specifications will be required to resolve several issues raised during testing by controllers and maintenance technicians. As a result of problems in developing software and changes in requirements, Harris has proposed an increase of \$203 million to the contract. VSCS program officials believe, however, that they will not need to increase the total VSCS estimate of \$1.4 billion for two reasons. First, FAA believes that the final negotiated contract increase will be less than Harris has proposed. Second, when FAA increased the total F&E costs by almost \$500 million 2 years ago, it overestimated the contract costs that were actually negotiated with Harris in December 1991. However, further increases are possible, depending on final negotiation of the modification. FAA expects that the modification will be completed in June 1993.

A likely change to FAA's air traffic facility consolidation plans will increase VSCS' costs substantially. The current total estimated F&E cost includes 25 VSCS systems: 20 for ARTCCs in the continental United States, 2 for air traffic control facilities in Alaska and Hawaii, 1 for the New York terminal radar approach control (TRACON), 1 for the Southern California TRACON, and 1 for the FAA Academy in Oklahoma City. However, FAA is now likely to maintain additional TRACONs rather than consolidate them into the ARTCCs as originally planned. The contract with Harris includes FAA options for up to 18 systems that could be used for these additional TRACONs. However, the current total cost estimate does not include these options. The cost estimates for the options vary with the size of the system, ranging from about \$13 million to \$24 million per system. Therefore, if FAA changes its original consolidation plan and exercises all of these 18 options, VSCS' costs would increase by between \$234 million and \$432 million.

Two-Year VSCS Funding History

Dollars in millions

	<u>FY 1992</u>	<u>FY 1993</u>
Total estimated F&E costs as of	\$1,399.8	\$1,407.0
Cumulative F&E funds appropriated through	\$468.2	\$714.2
Cumulative F&E obligations through	\$460.1	--

SECTION 3

EMERGING TECHNOLOGIES IN THE CIP

The Capital Investment Plan (CIP) describes FAA's air traffic control (ATC) modernization program funded through the facilities and equipment (F&E) appropriation. The CIP is a dynamic document that incorporates new technologies and products derived from continuing research. Thus, each year the CIP includes new capabilities projects that, if implemented, are expected to improve the safety and efficiency of the national airspace system. FAA has included 16 projects in the new capabilities section of the 1992 CIP. All but 1 of these 16 projects are separate from the 12 projects FAA added to this year's CIP. In this section, we provide information on several of the important new capabilities projects.

To identify key emerging projects, we developed the following criteria. First, the projects must be categorized as new capabilities in the 1992 CIP. Second, F&E funding for each project must total approximately \$100 million between fiscal years 1992 and 2000. Third, funding for these projects should begin sometime between fiscal years 1992 and 1994. Using these criteria, we identified the following six key new capabilities projects:

- aeronautical data link,
- airport surface traffic automation (ASTA),
- aviation weather products generator (AWPG),
- global navigation satellite system (GNSS),
- oceanic automation system (OAS), and
- terminal air traffic control automation (TATCA).

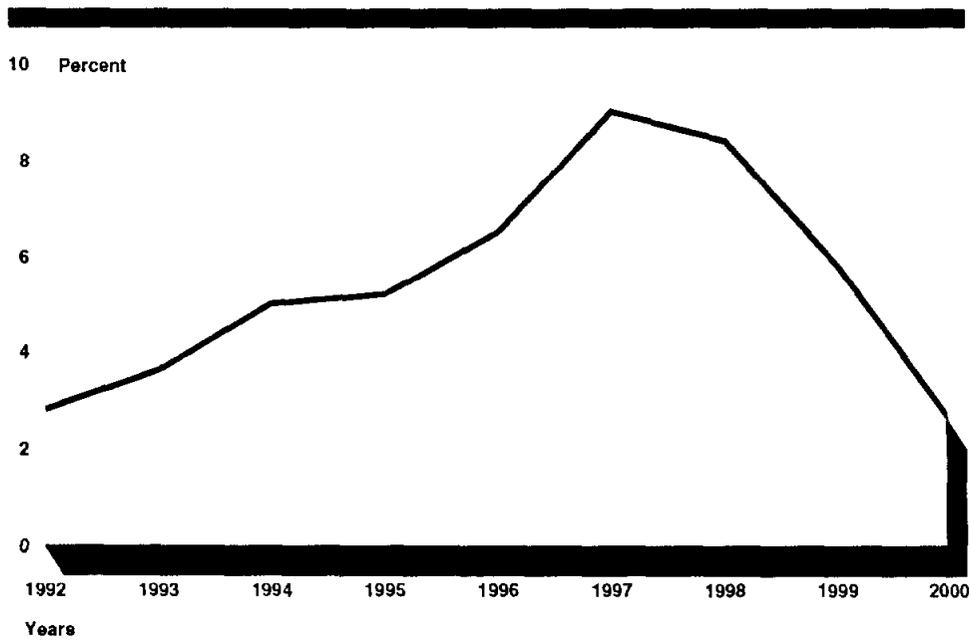
FAA's 1992 CIP has identified all but AWPG as "cornerstone" projects, that is, significant contributors to the agency's ATC modernization.

INCREASES IN F&E FUNDING FOR NEW CAPABILITIES PROJECTS

The CIP organizes projects into five chapters. The active, original NAS Plan projects are listed in chapter 2, and the newer projects are found in the other four chapters. Because an increasing number of NAS Plan projects are expected to be completed as the decade progresses, the estimated total F&E costs for projects in the other four chapters will increase. As figure 3.1 shows, the 16 new capabilities projects, which are located in chapter 6 of the CIP, are projected to take up an increasingly large percentage of the total F&E funding during the remainder of

the decade. This percentage ranges from a low of 3 percent in 1992 to a high of 9 percent in 1997.

Figure 3.1: Percent of Estimated F&E Funds Required for the New Capabilities Projects in the CIP (1992-2000)



Source: FAA's Financial Plan for Facilities and Equipment Appropriations, October 1992.

The six projects that we have identified as significant contributors to the ATC modernization will account for a growing portion of FAA's funding. Total estimated F&E costs for these six projects range from between 54 percent of the total funding for the new capabilities section in 1993 to all of this funding by 1999.

REALIZATION OF BENEFITS FROM NEW PROJECTS
DEPENDENT ON REMAINING WORK

These six projects are expected to contribute extensively to FAA's modernization into the next decade. ASTA, TATCA, and OAS could greatly improve the flow of aircraft on airport surfaces, in the airspace surrounding airports, and across the oceans. These projects are expected to provide users with more direct routes and increase capacity while reducing controllers' work load. ASTA and OAS will depend on the successful implementation of an aeronautical data link and GNSS for their benefits to be fully realized. By connecting aircraft with ground automation systems, the aeronautical data link could reduce misunderstanding of verbal

communications, thereby improving safety, according to FAA. GNSS is expected to be used to guide aircraft (as well as other types of transportation) across the oceans, over the nation's domestic airspace, on approaches to runways around the world, and on airport surfaces. While not identified by FAA as a cornerstone project, AWPG is important because it is designed to integrate National Weather Service and FAA weather sensor data to provide pilots, air traffic controllers, and other users with real-time weather data. Increasing the timeliness of weather information may save fuel and increase safety. Research is ongoing for each of these six projects; each is now receiving F&E funding or will begin to receive F&E funds in fiscal year 1994.

While these new technologies promise to increase the safety and efficiency of the national airspace system, these projects are in the early stages of the acquisition process, and FAA has much work to complete before they are fielded. FAA approved a mission need statement for all six projects in 1991 or 1992. This is the first step in the acquisition process prescribed in the Office of Management and Budget's Circular A-109 and in FAA's order on acquiring major systems. At subsequent key decision points in the acquisition process, FAA will need to revalidate the mission need statement. Since all six projects are in the early stages of this process, requirements need to be formulated, alternatives evaluated, and prototypes tested before production contracts can be executed and the systems can be implemented.

Because all of these projects are in early stages of development, their cost estimates may change significantly, depending on the final definition of the system. For example, the costs of GNSS have increased substantially since last year because the required augmentation for GPS has been better defined. Also, according to the OAS program manager, decisions about procurement strategies could change the cost estimate for the project. Currently, estimates of total cost for OAS range from \$142.6 million to \$399.6 million through the year 2000.

According to the 1992 CIP, the schedules for most of these new projects are being developed. Only for OAS and data link have schedules been defined, although for data link the schedule is being reviewed and may be changed. For the four projects that do not have schedules outlined in the CIP--ASTA, AWPG, GNSS, and TATCA--the program offices have developed tentative schedules for acquisition. Because these schedules are preliminary, they could change after each project has finally been defined or if delays occur in other CIP projects upon which these new projects depend.

NEW PROJECTS DEPENDENT ON OLDER NAS PLAN AND CIP PROJECTS

Of the six projects we have identified, four depend upon the completion of older NAS Plan or other CIP projects. They are ASTA,

AWPG, data link, and OAS. For example, ASTA relies on ASDE-3, the Airport Movement Area Safety System, and Mode S for its early stages of implementation.

Data link is essential to some of the earlier NAS Plan projects, as well as to a variety of CIP projects under development, because it provides a standard communications platform. Among those CIP projects are ASTA, AWPG, GNSS, and OAS. Without data link, these systems cannot be fully utilized.

INFORMATION ON THE STATUS OF THE SIX PROJECTS

The following summaries of these six emerging projects include (1) general information on the projects and the impact they will have on the ATC system, (2) total F&E cost estimates for the projects and scheduled implementation dates, and (3) a description of the impact these emerging projects may have on other projects in the CIP and of what other CIP projects need to be completed before these new technologies can be implemented.

AERONAUTICAL DATA LINK

Project Description

Aeronautical data link (hereafter referred to as data link) is designed to improve ground-to-air communications by connecting aircraft and ground automation systems. It is being developed because many misunderstandings currently occur when controllers and pilots communicate orally with each other. Better communications should increase controllers' and pilots' productivity. Data link is a digital communication system that will provide a variety of weather and other ATC information. With data link, both controllers and pilots will have printed menus that display options for changing altitude, speed, route clearances, and route modifications. The controller will send printed messages to the pilot, and the pilot will respond by pushing an acknowledgement button. The pilot may also request any of these options from his or her own menu. This procedure should reduce the possibility of miscommunications during voice transmissions and the need for both parties to clarify their original message.

Since the early 1980s, FAA has been developing data link, which was an original NAS Plan project. The original project was designed to construct the data link processor and associate software. The software will utilize Mode S, a secondary radar system that has not yet been fully deployed, to transmit weather information. In addition, a tower data link system was deployed to provide predeparture clearances to the airlines. Twenty-four data link processors and 30 tower data link systems were acquired for this project.

Recently, FAA added a second data link project to the CIP. This project is expected to continue to upgrade the software for the original data link project and to procure an additional 30 tower data link systems. As part of this project, FAA signed a contract to develop software that will provide some weather information and air traffic control services. To disseminate this information, FAA must also develop an Aeronautical Telecommunications Network Router in accordance with international standards so that data can be sent to pilots and controllers via a variety of equipment, such as Mode S, satellites, or very high frequency radio. Limited field testing of the operational data link software may begin in 1995.

Cost and Schedule Information

FAA's mission need statement for data link estimated that both data link projects would require \$283.4 million in F&E funds through 1999. This statement identified a requirement of \$59.2 million for the original project and \$224.2 million for the second project. The \$59.2 million has since been reduced in the current financial plan to \$50.3 million. Of this \$50.3 million,

\$42 million will be spent for hardware, limited software, and several tower data link systems, and \$7 million will be spent for follow-on data link software. By the end of fiscal year 1992, the original project will be completed. According to FAA's current financial plan, the second data link project is estimated to require \$183 million in F&E funding, beginning in 1993. Of this sum, \$65.3 million will be used for software, 30 tower data link system sites, and the necessary routers. This project is estimated to be fully implemented by the year 2002.

According to the program manager, the data link program is currently under reevaluation for two reasons. First, the hardware and software being developed under the original data link project depend on Mode S. Since Mode S is not yet operational, FAA is considering storing the processors that have already been procured until they can be used. This may not occur until the second phase of the data link software, which will not depend upon Mode S, has been developed (i.e., late 1995). Second, FAA originally planned to upgrade the data link processors and the data link services because the agency believed that airborne users' demand for communications via data link would be greater than the original hardware could satisfy. However, because Mode S is not yet operational, only a limited number of processors have been implemented. Hence, upgrading the data link processors has been postponed until at least 1996, depending upon airborne users' needs. Data link services would be enhanced thereafter and would require the remainder of the unobligated F&E funds.

Impact on Other NAS Plan or CIP Projects

Because data link provides a standard communications platform, it is essential to a variety of other CIP projects under development, including, for example, AAS, AERA, Automatic Dependent Surveillance, Mode S, and Oceanic Satellite Communications. Data link is also included in the new capabilities projects, such as ASTA, GNSS, Oceanic Support, and TATCA. Without data link, these systems cannot be fully used.

According to the program manager, when data link becomes operational, it may be able to phase out backup voice communications systems, such as the backup emergency communication (BUEC) system; however, FAA has no plans to phase out voice communications entirely. Instead, voice communications will back up data link, or text communications. The current backup voice system would no longer be necessary because it would provide a second level of redundancy. This phaseout could not occur until 2005 or 2010 because all aircraft must first be equipped with data link.

AIRPORT SURFACE TRAFFIC AUTOMATION (ASTA)

Project Description

ASTA combines automation, surveillance, and communications projects that are designed to improve the monitoring of movements on the airport's surface. FAA has identified the need for an automated surveillance system that clearly and reliably identifies the position of surface traffic within an air traffic controller's area of responsibility. ASTA is being designed to

- enable pilots and controllers to identify all aircraft and vehicles in the area and to monitor and display any vehicle's current location and destination;
- alert pilots when a runway is in use for landing or takeoff;
- provide automatic visual and aural alerts to air traffic controllers of potential and actual runway incursions;
- improve traffic planning capabilities so that controllers can sequence departures to optimize capacity and reduce delays; and
- transmit taxi route clearances and other instructions between the tower and aircraft, through aeronautical data link.

FAA is presently developing an interim safety alerting system, using the Airport Movement Area Safety System (AMASS), which relies on existing surface radar surveillance, and three parallel projects under ASTA. Initial plans call for installing surface automation systems at airports equipped with the ASDE-3 radar. Full automation systems are planned for approximately 40 airports, and smaller intrusion detection systems are designed for an additional 60 airports.

A full ASTA system will rely on both ASDE-3 and AMASS. ASDE-3 is a ground surveillance radar that is designed to prevent runway incursions. It has been under development for a number of years. AMASS is a separate project in the CIP that is currently under development at the San Francisco International Airport. AMASS will track targets, process information through safety logic, and generate aural and visual conflict alerts for the air traffic controllers. It relies on ASDE-3 for surveillance. AMASS demonstration and evaluation is expected to continue through June 1993 and may lead to a production decision to add AMASS as an enhancement to the ASDE-3.

To provide a complete display of aircraft and vehicle movements and to identify targets on the airport surface, ASTA will

supplement ASDE-3's surveillance with differential Global Positioning System (GPS) position reports from aircraft and Mode S target identification data. The system will use selected surface sensors to provide information about activity on both the airport's surface and in the nearby airspace, apply safety logic, and generate conflict alerts. Also, ASTA provides the automation platform for traffic-planning activities and the controller/computer interface for generating surface data link messages about taxi routes.

For airports at which an ASDE-3 will not be installed, FAA plans to procure a low-cost marine radar to provide surface surveillance.

In addition, FAA is installing runway status lights as part of the ASTA project. Radars, such as ASDE-3, will be used to survey the status of vehicles on or near the airport. These radars will send signals that will control lights at taxiway and runway intersections. If another vehicle is about to land on a runway, is on rollout after landing, or is about to take off, lights will alert the pilot that the runway is "hot" and will warn the pilot not to enter or cross the runway until it is clear.

ASTA Enhancements

Enhancements to ASTA are being developed simultaneously with ASTA in order to improve traffic planning, two-way data communications, and lighting system interfaces. Many technical standards issues are currently being defined. Efforts in this category have enough uncertainty that they have not been included in a recent ASTA competition to reduce the risk and the costs.

Cost and Schedule Information

FAA estimated in 1991 that it would require \$150.8 million in F&E funds through 1998 to complete the ASTA program. However, in its October 1992 financial plan, FAA increased this estimate to approximately \$206 million in F&E funds. Of this sum, a large portion (between \$150 million and \$200 million) will be required for production contracts to equip airports with systems that track and identify both aircraft and ground vehicles. Estimates for average unit costs for this equipment range between \$1.3 million and \$1.6 million. These costs are low because the ASDE-3 radar will exist, and once GPS is operational in late 1993, FAA expects that GPS avionics will rapidly be available on a significant number of aircraft. FAA plans to install full ASTA units at the 40 busiest airports--those that will have an ASDE-3. An additional 60 airports will have an ASTA subsystem installed, which will provide runway incursion protection only.

FAA sought comments on draft specifications for an ASTA system in March 1992. A contract for the project's design is expected to

be awarded in fiscal year 1994. Thereafter, FAA plans to award two prototype contracts for off-the-shelf equipment. This award is tentatively scheduled for late 1995. After these prototypes have been tested operationally, FAA plans to make a production decision, perhaps by early 1997. Deployment of the system is expected to occur late in 1998. In the interim, AMASS will be providing the initial capability. These dates are tentative because ASTA relies on data link, another technology that is under development. Furthermore, GPS may have an impact on the type of system that FAA decides to deploy.

Impact on Other NAS Plan or CIP Projects

According to the program office, successful implementation of ASTA relies on the completion of other NAS Plan and CIP projects under development, including AMASS, ASDE-3, ASR-9, Mode S, and data link. Hence, the ASTA program is not expected to replace any of these systems before the year 2000. FAA believes that ASTA will provide the evolutionary path for changes in surveillance. As GPS avionics equipment expands, reliance on ASDE-3 will diminish. The introduction of intelligent vehicle technology, currently being developed for highways, can easily be adapted for the surveillance and tracking of ground vehicles. Since ASTA is the automation system that uses these sensor data, changes in surveillance technology may allow FAA to reduce its reliance on radar technology without redesigning major systems.

AVIATION WEATHER PRODUCTS GENERATOR (AWPG)

Project Description

Weather impedes the smooth and efficient flow of air traffic, causing approximately 40 percent of aircraft accidents and 65 percent of air traffic delays of more than 15 minutes. Pilots and air traffic control specialists receive weather information from FAA and the National Weather Service (NWS).

The value of the current system to aviation system users is limited for two reasons. First, weather forecasts are generated from data collected twice a day from locations separated by approximately 250 miles, and the forecasts are available only in 6-hour increments. Pilots and air traffic control specialists require accurate weather forecasts that are updated more often. Second, the current weather information is not presented in a readily understandable format. With the latest generation of supercomputers, newly installed weather observing systems, high-speed data communications, and modern computer-generated graphics, it is now possible to present weather forecast information in a format that meets aviation users' needs.

The AWPG program is designed to provide needed aviation weather services by using the new generation of weather observing systems and the planned NWS supercomputer, which is scheduled to be installed in 1993. As part of AWPG, NWS will generate an aviation weather forecast database, called the Aviation Gridded Forecast System (AGFS). AGFS forecast data will be generated every 3 hours and will provide forecast data for up to 6 hours in 1-hour increments. AGFS' initial resolution will be about 20 miles. AWPG will use the AGFS forecasts to depict weather graphically for pilots, airline dispatchers, and air traffic controllers. AWPG will also provide a near real-time and short-range forecast depicting hazardous airspace. This forecast depiction will be derived from the Next Generation Weather Radars (NEXRAD), TDWRs, and available data on lightning. FAA, NWS, and the National Center for Atmospheric Research have jointly been developing the computer programs needed for the AWPG program.

AWPG will be implemented initially using the AGFS forecast data as generated by NWS. It will also use existing or planned FAA weather support systems, such as MWP II and RWP, to support Air Route Traffic Control Center (ARTCC) operations. In addition, it will use the commercially provided weather graphic systems at the Flight Service Stations; traffic management systems at the Air Traffic Control System Command Center and the ARTCCs; the Direct User Access Terminal (DUAT) and data link for pilots; and commercial weather services that support airline dispatch offices. Almost all of these services will be leased through commercial weather service companies rather than acquired through additional

federal capital investment. Services are planned to start in 1996, and planned enhancements will be added through the year 2000.

Cost and Schedule Information

FAA has developed total cost estimates for AWPG that range from \$105.6 million to \$220.3 million. However, in its October 1992 financial plan, FAA estimated that \$103.9 million in F&E funding would be required by the year 2000 and that additional funding would be required after this date.

This project is in the demonstration and validation stages in which alternatives are being considered. FAA currently plans to provide AWPG information via commercial weather service companies using DUAT and MWP II beginning in 1996. Thereafter, AWPG data could be provided through RWP to AAS' Initial Sector Suite System. AWPG may eventually become a stand-alone system. Because AAS, MWP II, NEXRAD, and RWP are under development, information about costs and schedules may change.

In addition, information from the terminal airspace is scheduled to be incorporated into AWPG through the Integrated Terminal Weather System (ITWS), another new capability that FAA is developing. Combining these two systems could provide a four-dimensional system that would receive weather and forecast data from NWS many times per hour, providing air traffic controllers and pilots with a better picture of weather conditions.

Impact on the Other NAS Plan and CIP Projects

The successful implementation of AWPG is linked to the completion of other NAS Plan and CIP projects, such as AAS, MWP II, NEXRAD, and RWP. However, if one of these systems is not completed, AWPG may use other platforms to gather data and distribute the needed weather information. FAA also believes that AWPG may eventually be able to enhance or replace some of these systems.

GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

Project Description

Currently, the Department of Defense (DOD) is implementing satellite technology for use in communications, navigation, and surveillance. FAA has been working with DOD and the airlines to develop a system based on satellite navigation for civil and military aviation purposes. Initially, this system will be based on the Global Positioning System (GPS), which is expected to be operational by late 1993. GPS is a satellite-based radio navigation system designed to provide multiple aviation, maritime, and surface users with continuous and highly precise navigation, velocity, and time information anywhere on earth and in any weather condition. GPS is a DOD system and does not provide the integrity¹ and position accuracy² needed for all types of civil aviation uses.

The GNSS project provides the necessary augmentations to meet civil navigation requirements so that GPS can be used for en route and terminal navigation, nonprecision approaches, and precision approaches. These augmentations include the purchase of (1) wide area differential correction stations, (2) local area differential correction stations, and (3) a GPS integrity channel.

Differential GPS (DGPS) is a method for improving the performance of GPS positioning. DGPS will correct any error in the GPS position by comparing the satellite-derived GPS position with the true geographic position at a precisely surveyed location. The correction is then transmitted to the user to improve information about the position. Wide area and local area differential GPS have been identified as two ways to provide precision approach capability. Wide area DGPS corrects any errors in a set of GPS parameters over wide geographic areas and transmits these corrections to users via geostationary satellites. To provide this capability, FAA plans to procure 20 wide area DGPS ground stations. Local area DGPS corrects any errors found in the GPS position over local geographic areas by deriving corrections at stations and broadcasting these corrections to users within the station's line of sight. FAA plans to procure 680 local area DGPS ground stations.

The GPS integrity channel will measure basic GPS signal parameters to determine whether the signals have gone out of tolerance and will issue an integrity alert for those that have.

¹Integrity refers to a navigation system's ability to provide timely warning when a position error exceeds a specified limit.

²Accuracy refers to the degree of agreement between a measured and a true position.

This information will be broadcast over a geostationary satellite link.

Cost and Schedule Information

Augmenting GPS for civil aviation is expected to cost \$97.7 million in total F&E funding by the year 2000. This is a significant increase over the estimate of \$18.7 million that we reported last year. This change occurred because, in the 1991 CIP, the GNSS project was designed only to procure a monitor system so that GPS could be used for supplemental en route navigation and nonprecision approaches. This project has since been enlarged to include the augmentations needed to enable civil aviation to use GPS exclusively for en route and terminal navigation, nonprecision approaches, and precision approaches. According to the program manager, significantly more money was needed to augment GPS, and therefore the funding estimate for the project was increased.

Developing and implementing the necessary augmentations for GPS will continue past the year 2000. For example, FAA plans to begin implementing wide area DGPS stations in 1996 and local area DGPS stations in 1998. Total deployment will be reached in 2006.

Before the development of these augmentations has been completed, FAA can begin implementing GPS for certain stages of navigation. According to the Satellite Navigation Plan (1992-97), GPS will begin providing supplemental en route navigation and nonprecision approaches by 1994. In 1995, GPS will be augmented for special Category I precision approaches,³ and FAA expects that GPS will be used as a supplemental aid for Category I precision approaches by 1998. Concurrently, FAA will be evaluating the feasibility of using GPS for Category II and III precision approaches. FAA expects to finish this evaluation by 1995. Thereafter, if feasible, FAA may begin developing the use of Category II and III precision approaches.

Impact on Other NAS Plan and CIP Projects

Satellite technology could allow FAA to phase out older ground-based navigation equipment, including the nondirectional beacons, very high frequency omni ranges, distance measuring equipment, tactical air navigation systems, and at least Category I instrument landing systems. However, the various augmentations highlighted above must first be in place. Furthermore, if GPS is used to provide precision approaches, aeronautical data link may need to be completed. Because these augmentations are not in

³Special Category I precision landing service will permit certain aircraft to land using Category I minimum standards of height and visibility at selected airports.

place, FAA has not yet developed a plan to phase out the older ground-based navigation equipment.

Some primary radars, such as the ASR-9s, could also be phased out because GPS combined with aeronautical data link could provide for surveillance of the domestic airspace. This coverage would be similar to that provided over the oceans by Automatic Dependent Surveillance, another new capabilities project. However, FAA does not yet have any formal plans to phase out its primary radars.

OCEANIC AUTOMATION SYSTEM (OAS)

Project Description

Currently, control of oceanic airspace is not highly automated. Because air traffic controllers cannot plan traffic flows before an aircraft reaches oceanic airspace, pilots must have their flight plans verified before entering into this airspace. During peak periods, a large number of aircraft must be funneled into a small set of oceanic routes, and traffic leaving coastal airports may be delayed or given less-preferred altitudes to accommodate these large flows. Consequently, oceanic users are frequently unable to obtain maximum fuel efficiency, minimum travel times, and access to preferred takeoff times and flight paths that are free of turbulence. These problems are expected to worsen because oceanic air traffic is forecasted to have a higher growth rate than domestic air traffic, primarily in the areas of highest density.

OAS is designed to improve air traffic services to all aircraft flying in the large areas over the Pacific and Atlantic oceans. It is expected to automate the control of oceanic airspace, much as the Advanced Automation System will automate the control of domestic airspace. The program is designed to combine into a common system hardware and software packages from various systems under development. These systems include elements of Automatic Dependent Surveillance (ADS), Dynamic Ocean Track System (DOTS), and Oceanic Display and Planning System (ODAPS). OAS is expected to be used largely to control airspace over the ocean; however, it could also provide some limited communications.

FAA has a three-step process for developing OAS. First, the agency will begin upgrading ODAPS, which is designed to provide automation assistance for oceanic air traffic control. Originally, ODAPS was to be fully installed at the Oakland and New York Air Route Traffic Control Centers by 1991, but it has not yet reached operational readiness at New York. Once it reaches this stage, FAA plans to replace ODAPS' plan view display with an interim situation display, while trying to maintain the rest of the older ODAPS hardware. Second, FAA plans to add ADS to ODAPS' software functions. ADS will implement satellite ATC surveillance and communications in the oceanic and nonradar environments. At the time that the first ADS software enhancement is added to ODAPS, OAS is expected to begin because controllers will have an operational tool to control traffic. Finally, FAA is considering adding the track advisory information from DOTS.

Cost and Schedule Information

In the mission need statement for OAS, FAA has developed total cost estimates that range from \$142.6 million to \$399.6 million. In FAA's F&E plan, this project is estimated to cost \$169.1 million,

of which \$1.1 million was spent before 1993. F&E funding for this project will be used to upgrade portions of ODAPS and maintain other portions of it. FAA estimates that ODAPS will be upgraded sometime between 1994 and 1995. FAA has recently awarded a contract to downlink information, via ADS, to identify an aircraft's location for a controller. FAA still needs to conduct operational testing and evaluation and end-to-end testing of the ground and satellite networks, award a contract to uplink information from the controller to the aircraft using ADS software, and meet internationally accepted standards and procedures. By late 1994 or 1995, FAA estimates that ADS will reach operational capability. At that time, ODAPS should be integrated with ADS, and thereafter, only the OAS program is expected to receive funding. DOTS is estimated to be completed in 1993; afterwards, FAA could choose to add the track advisory portion to OAS.

Impact on Older NAS Plan and CIP Projects

The progress of OAS depends on the development of other NAS Plan and CIP projects, such as ADS, DOTS, and ODAPS. Since ODAPS is the project nearest to completion, OAS may initially depend on ODAPS. Consequently, OAS will begin to enhance and replace certain components in ODAPS to better meet future ATC needs. ADS and elements of the DOTS projects will be added to ODAPS as they are completed. After the year 2000, OAS is expected to be an independent project, and ODAPS, ADS, and perhaps DOTS could be terminated.

TERMINAL AIR TRAFFIC CONTROL AUTOMATION (TATCA)

Project Description

Currently, congestion and delays in the terminal airspace restrict the number of aircraft that can land at airports at various times and during inclement weather. Consequently, many airports need more capacity. Both congestion and delays are expected to worsen as the demand for terminal airspace grows in the future. TATCA is designed to increase the ATC system's capacity through the installation of new technology and automation aids. The TATCA program comprises three projects: the converging runway display aid (CRDA), the Center/Terminal Radar Approach Control (TRACON) automation system (CTAS), and the controller-automated spacing aid (CASA).

CRDA

CRDA is a software project that provides controllers with geometric spacing aids for aircraft in the terminal area. These aids allow controllers to space aircraft more precisely for landing and departing on converging runways. The CRDA software functionality was nationally deployed to 62 air traffic control facilities in July 1992.

CTAS

CTAS is the main component of TATCA. Although CTAS was initially designed by NASA Ames, FAA controllers contributed significantly to its development. It provides controllers with a four-dimensional flight path for aircraft that the controllers can use for analysis and projections. It also provides controllers with advisories. As designed, CTAS has four integrated components with the following expected capabilities:

- The traffic management adviser (TMA) sequences and schedules arriving aircraft in the Air Route Traffic Control Center (ARTCC), approximately 200 miles from the runway. TMA acts as the first step in minimizing delays.
- The descent adviser (DA) assists controllers in the ARTCC by providing recommended descent clearance information, including speed, heading, and altitude advisories. This information helps aircraft arrive on schedule with minimum fuel consumption.
- The final approach spacing tool (FAST) assists TRACON controllers in spacing aircraft accurately during their final approach and landing. FAST provides both turn and speed advisories that assist in sequencing and spacing aircraft.

- The expedite departure path tool (EDP) assists ARTCC and TRACON controllers in sequencing and timing departing aircraft from an airport. EDP provides controllers with speed, heading, and altitude advisories, and it will also put aircraft flying fewer than 200 miles into another terminal's arrival sequence.

CASA

CASA is a follow-on project to CRDA. It enhances the software packages, enabling controllers to stagger aircraft for landing on asymmetric runways. CASA will also work to merge routes farther out from the airport.

Cost and Schedule Information

Total F&E funding for TATCA is estimated to be \$135 million through the year 2000. Of this sum, the mission need statement estimates that \$41 million could be required through 1996.

Of the three TATCA projects, CRDA is being implemented, portions of CTAS are being field tested, and CASA is being researched. The CRDA software is already being used in St. Louis and was deployed nationally in 1992. The TMA and FAST portions of CTAS are being evaluated in the field. The first operational TMA will be deployed in 1994. A prototype FAST is being installed at the Dallas TRACON in 1993. FAST is expected to be operational by 1995. The DA and EDP portions of CTAS are still being researched. A prototype DA is to be developed in 1994 and will be operational by 1996. A prototype EDP is planned for 1995, with operational deployment in 1997.

Impact on Older NAS Plan and CIP Projects

According to the program manager, TATCA is not dependent on other NAS Plan or CIP projects, nor is it designed to replace any projects. However, TATCA could provide some of the same functions as the Advanced Automation System (AAS). For example, TATCA is designed to automate the control of airspace within 200 miles of an aircraft's destination. Automated En Route Air Traffic Control (AERA), part of the AAS project, is designed to automate the control of en route airspace. The TATCA program office is working with the AAS program office to ensure that TATCA can be incorporated into, or interface with, AAS.

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