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Testimony

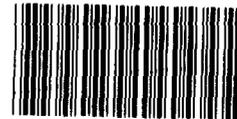
Before the Subcommittee on Aviation,  
Committee on Public Works and Transportation,  
House of Representatives

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AIR TRAFFIC CONTROL

Advanced Automation System  
Problems Need To Be  
Addressed

Statement of Allen Li,  
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Development Division



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Mr. Chairman and Members of the Subcommittee:

We are pleased to testify today on the Advanced Automation System (AAS)--the largest project in the Federal Aviation Administration's (FAA) program to modernize the nation's air traffic control system. As currently envisioned, AAS will be installed in five distinct segments and will replace and enhance controllers' work stations and supporting automation systems throughout the country. The estimated cost of AAS rose from \$2.5 billion in 1983 to \$4.8 billion when the production contract was signed with International Business Machines Corporation (IBM) in 1988. The current cost estimate is \$5.1 billion. Over the years, we have periodically reported on the cost and schedule problems and risks associated with FAA's acquisition of AAS. In our testimony today, we will describe the current AAS schedule and cost problems, causes of these problems and future uncertainty, and key AAS issues that will face the new leadership at FAA. This statement is based upon past reports, our ongoing AAS review for the House Appropriations Committee's Subcommittee on Transportation and Related Agencies, and an analysis of recent developments. (See appendix III for a list of related GAO products.)

In summary, we found that

- Schedule and cost problems have worsened over the past year. Last week, FAA and IBM agreed on a 14-month delay--first proposed by IBM in November 1992--for a key initial segment of AAS. The total delay in this segment is now about 3 years from the milestones established in 1988. Because of recent problems, the cost of AAS may increase by another \$235 million. In addition, delays in AAS have forced FAA to initiate several costly interim projects to sustain the current air traffic control system.
- Several major factors have led to the current schedule and cost problems and have created uncertainty over the future of the project. First, FAA and IBM significantly underestimated the effort required to develop AAS--a highly complex technological undertaking. As a result, FAA and IBM set schedules that proved unrealistic when IBM encountered technical difficulties. Second, FAA did not provide needed oversight of IBM's performance. For example, FAA did not have good quantitative information on IBM's progress in software development. Third, FAA was indecisive in resolving some basic requirements issues. One basic unresolved issue is the extent of consolidation of air traffic control facilities, which will be an important variable in determining how many facilities receive AAS equipment. We believe the frequent turnover in Administrators at FAA--9 in the last 10 years--has contributed to the delay in reaching a consolidation decision.

-- Given problems experienced over the past 5 years and likely changes in FAA's consolidation plan, FAA faces two challenges; namely, addressing immediate schedule and technical problems and determining whether the plan for each segment of AAS is the most appropriate way to meet the needs of the air traffic control system. FAA has been reviewing the AAS project, and the Secretary of Transportation is also considering a review of AAS. In our opinion, any strategy arising from such reviews would be most effective if it contained the following four elements: (1) establishing realistic schedules, (2) reaching more-timely closure of requirements issues, (3) submitting a firm consolidation plan, and (4) critically evaluating the current plan and need for each segment of AAS.

We would now like to discuss in more detail the AAS project, the problems that FAA and IBM have encountered, and key AAS issues that need to be addressed.

### BACKGROUND

AAS will provide a new automation system that includes improved work stations for controllers, computer software, and processors. It is being developed to replace current equipment and to allow the air traffic control system to accommodate forecasted increases in traffic through the use of modern equipment and advanced software functions. AAS is a complex technological project containing several million lines of programming code, extensive computer-human interface, and stringent requirements for performance and reliability.

FAA's air traffic control mission is to promote the safe, orderly, and expeditious flow of aircraft. Air traffic controllers maintain separation between aircraft by utilizing information processed by computers and displayed on video screens at controllers' work stations. FAA uses three types of facilities to control aircraft: airport towers, terminal facilities, and en-route centers. Airport towers control aircraft on the ground and in the vicinity of the airport. Terminal facilities sequence and separate aircraft from the point at which tower control ends to about 20 to 30 miles from the airport. At that point, en-route centers assume control of the aircraft and maintain control until the aircraft enters terminal airspace at its destination.

AAS is scheduled to replace computer hardware and software and controller work stations at en-route centers, terminals, and towers. The project was originally designed to accommodate the consolidation of FAA's current 230 terminals and en-route centers into 23 facilities. Although a final decision has not yet been made, FAA is leaning towards a much less ambitious consolidation strategy that would result in about 200 terminal and en-route facilities.

FAA introduced the AAS project in 1983 and decided to pursue a two-phase acquisition strategy. First, the agency awarded competitive design contracts to IBM and Hughes Aircraft Company in 1984. FAA expended about \$700 million during this first phase. In 1988, FAA awarded a contract to IBM to complete the second acquisition phase, namely the development and production of AAS.

In 1983, the total cost estimate for AAS was projected to be \$2.5 billion and completion was scheduled for 1996. When the contract with IBM was signed in 1988, FAA estimated the project would cost \$4.8 billion and be completed in 1998. Since that time, the projected costs have increased to \$5.1 billion, and the estimated completion date has slipped to 2002.<sup>1</sup> Appendix I provides FAA's figures on how the actual and estimated appropriations for AAS are currently allocated. As indicated in the appendix, about 47 percent of the estimated funds for AAS, or \$2.4 billion, have not yet been appropriated.

#### AAS Will Be Implemented In Five Segments

As currently defined in the production contract, FAA and IBM will implement the system in five segments. The first segment is the Peripheral Adapter Module Replacement Item (PAMRI), which will replace existing communications equipment that connects en-route centers with external systems, such as radars. In addition to replacing the aging Peripheral Adapter Module equipment, the PAMRI will provide increased interface capabilities with external systems. The PAMRI segment is almost completed; 18 of 20 sites are operational.

The second segment of AAS is the Initial Sector Suite System (ISSS). ISSS will be installed at the nation's 20 continental en-route centers. It will replace mechanical flight strip printers,<sup>2</sup> controller display screens, and associated display processing systems with state-of-the-art color display work stations called common consoles, new software, and modern computer communications networks. ISSS will interface with the primary computer system used by en-route centers, known as the Host computer. ISSS is a critical segment of AAS because hardware and software being developed for later segments will be based upon ISSS. Thus far,

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<sup>1</sup>These cost estimates include actual and anticipated appropriations for FAA's Research, Engineering, and Development and Facilities and Equipment accounts.

<sup>2</sup>Flight strips provide controllers with basic status information, such as aircraft routes, altitudes and air traffic clearances. Controllers presently mark up the paper versions to record changes in status and to coordinate information with each other. Each strip provides information on one flight.

most work by FAA and IBM has been on the ISSS segment of the project.

The third AAS segment is the Terminal Advanced Automation System (TAAS). TAAS will replace the Automated Radar Terminal System (ARTS), which is the main computer system used at terminal facilities for controlling approaching and departing aircraft. TAAS will also provide new controller work stations to replace existing radar screens. TAAS will incorporate hardware elements (including common consoles), networks, and software already developed for ISSS. One difference between TAAS and ISSS is that ISSS does not involve the replacement of a primary computer system.

The fourth segment of AAS is the Tower Control Computer Complex (TCCC). At selected airport towers, TCCC will replace radar displays and paper flight strip systems with new work stations for tower controllers. TCCC will also provide towers with the capability to better interface with terminal facilities.

The fifth and final step in the evolution to full AAS is the Area Control Computer Complex (ACCC). ACCC is designed to replace the PAMRI and the Host computers used by en-route centers and to combine the en-route (ISSS) and terminal (TAAS) systems into what FAA calls an Area Control Facility. ACCC is also expected to provide new advanced software functions, known as Automated En Route Air Traffic Control (AERA). FAA expects AERA functions to allow controllers to handle more planes and to grant more aircraft requests for routes requiring less fuel.

#### SCHEDULE AND COST PROBLEMS HAVE WORSENE

Since its introduction in the 1983 National Airspace System Plan, the AAS project has experienced significant schedule delays and cost growth. These problems have grown more serious during the past year. Schedule delays have led FAA to initiate costly interim projects and will defer anticipated benefits further into the future.

#### Schedule Problems Have Become More Acute

In November 1992, IBM announced a 14-month delay in ISSS--a key initial segment of AAS. This brought the total estimated delay in this segment to about 3 years over the milestones set in the 1988 contract. In its announcement, the contractor stated that it would be unable to meet the schedule for factory testing of the ISSS segment of AAS. In response, FAA sent a "cure" notice to IBM stating that the proposed delay was detrimental to the agency and that FAA might terminate the contract if IBM did not provide an adequate plan for addressing the problems. IBM responded with a plan in December 1992. Last week, FAA and IBM agreed on a new schedule for the AAS segment incorporating the 14-month slip.

Other segments of AAS have also experienced schedule problems. For example, FAA officials recently indicated that the TAAS segment will be delayed an additional 5 to 7 months, for a total delay of about 2 years from the milestone set in the contract.

#### The Cost of AAS Has Grown

FAA's current estimated total cost for AAS is \$5.1 billion, an increase of 6 percent since 1988. Furthermore, the agency has identified about \$235 million in additional costs that may eventually have to be added to the total cost of the project. These additional costs are due to underestimation by FAA and IBM of the work needed to produce operationally suitable ISSS and TAAS. While FAA officials told us they hoped to take action to offset this increase, they could not provide us with any concrete cost savings for AAS.

Additionally, FAA is considering other changes to AAS which may alter the agency's total cost estimate for the project. For example, FAA plans to change the design and quantities of equipment for the tower (TCCC) segment. Also, likely changes to FAA's facility consolidation plans would require FAA to exercise some contract options not yet factored into its cost projections for AAS. FAA is unsure whether these changes will increase or decrease costs for AAS.

#### Delays In AAS Have Led to Costly Interim Projects

Because of delays in AAS, FAA has been forced over the years to start some costly interim projects to sustain and enhance current hardware and software. For example, FAA initiated the \$435 million Interim Support Program to bridge the gap between current and future automation systems at terminal facilities. Last year, FAA began an \$80 million project to buy advanced versions of ARTS to install at some of its larger terminal facilities. Over the past few months, FAA has initiated additional plans for three projects to sustain its en-route centers until AAS can be installed. These three projects are estimated to cost over \$200 million. For example, FAA plans to replace processors scheduled to be supplanted by ISSS at eight en-route centers. Costs for these interim projects are not included in the \$5.1 billion estimate for AAS.

AAS schedule delays defer benefits to be gained by replacing this older equipment. Benefits are expected to accrue largely in the form of savings in time for passengers and reductions in fuel costs for airlines. The costs and benefits of each AAS segment are currently being evaluated by the Volpe National Transportation Systems Center, a unit of the Department of Transportation's Research and Special Programs Administration. Therefore, the amount of benefits being deferred by delays in AAS is uncertain.

SEVERAL MAJOR FACTORS HAVE LED TO CURRENT PROBLEMS  
AND CREATED UNCERTAINTY OVER THE FUTURE OF AAS

Several major factors have led to current problems and future uncertainty with the AAS project. In 1988 FAA and IBM agreed to an AAS design that was too ambitious and established schedules that proved to be unrealistic when IBM encountered technical difficulties. Also, FAA did not exercise adequate oversight of IBM's progress in software development. In addition, FAA has not been decisive in resolving basic requirements issues and the extent of consolidation of air traffic control facilities.

The Plan for AAS Was Too Ambitious

In our opinion, one of the major causes of the current AAS problems stems from the fact that FAA's initial plan was too ambitious. In the early 1980s, FAA decided to replace the fundamental hardware and software in en-route facilities, terminals, and airport towers in one large project over a period of 13 years. In addition, this project was to have been incorporated within a consolidation plan that would have affected every en-route and terminal facility in the country. Both FAA and IBM underestimated the effort required to replace key hardware and software components throughout the air traffic control system.

As a result of their misjudgment of the effort required for AAS, FAA and IBM set schedules which proved unrealistic when IBM encountered technical difficulties. The issue of unrealistic schedules was highlighted in an April 1992 Volpe Center report done at the request of the House Committee on Appropriations.<sup>3</sup> The Volpe report stated that overly aggressive schedules were overtaken by factors such as unresolved requirements, design rework, and software rework.

We have identified several unresolved development problems that have led to IBM's current difficulties in meeting agreed-to schedules:

- System stability. An FAA project official described stability of the system as the most important issue facing the AAS project at this time. One aspect of this problem is that IBM has encountered difficulty in satisfying requirements for a large number of common consoles working together. The AAS contract requires ISSS to sustain 210 common consoles operating at peak load. At present, IBM has only been able to reach a level in which 56 common

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<sup>3</sup> "An Assessment of the Status and Technical Risk of Federal Aviation Administration's Advanced Automation System Software Development" (IR-MA-1298-2) Volpe National Transportation Systems Center and Intermetrics, Inc., April 1992.

consoles work together for any significant length of time. The FAA AAS Program Manager attributed the stability problem to multiple causes, including the absence of adequate software testing tools at IBM.

- Electronic flight strips. Automation of the current paper flight strip system may be the most difficult change for controllers to accept. Flight strips, which are currently printed by mechanical printers, contain information about an aircraft's route of flight, altitude, airspeed and destination. Controllers write on the strip to reflect changes in this information and to record instructions given to the pilots. En-route, terminal, and tower facilities all currently use paper flight strips, and AAS requires the replacement of all current systems with automated versions that will be displayed on the controllers' screens. Controllers will have to learn new motions, keystrokes, procedures, and display formats.

IBM has experienced difficulty in gaining controller acceptance of its automated flight strip system. As currently designed, electronic flight strips have been judged by user advisory groups as not "operationally suitable." FAA has not yet solidified the changes it believes are necessary to make the system suitable for operational use.

- Reconstitution of the Host computer data base. Under ISSS, the Host computer will continue to supply flight data (and other information) to the ISSS common consoles. These common consoles will have their own processors with which controllers will be able to store and update data. As a result, in the event that the Host becomes inoperative and is not able to process and communicate data, the common console processors will be able to continue to update flight data independent of the Host. However, when the Host is reactivated, it will have a different set of flight data than will exist in the common console processors. The Host and the common console processors will not be able to work together if there are inconsistencies in their respective databases.

#### FAA Did Not Provide Adequate Oversight

Concerned about FAA's oversight of IBM's software development efforts, the April 1992 Volpe report recommended that FAA increase the number of staff positions within the project office's software development branch from three to between six and eight people. FAA has subsequently added two staff members to this branch. To enhance oversight further, FAA announced last week that it was placing the ISSS Program Manager on site at IBM.

The Volpe report also noted that the official schedule reports did not provide a realistic assessment of the amount of software development completed and remaining. Early in the contract, both IBM and FAA realized that the number of software builds--increments in which the software is built and tested--was inadequate. Therefore, they increased the number of builds from six to nine. As recently as last summer, FAA and IBM indicated that they were making good progress on ISSS because they were working on the last software build. However, as recognized in the Volpe report, this was a poor indicator of progress because testing for many key ISSS functions was deferred.

The Volpe Center recommended that FAA improve its schedule assessment process. An FAA project official stated that the agency has instituted an independent cost and schedule risk analysis capability which helped the agency identify part of the current ISSS schedule slips prior to IBM's November announcement of the 14-month delay in that segment. However, FAA still has a very limited capability for providing information on the real progress of software development. We asked for documentation that could be used to provide a quantitative assessment of IBM's progress in meeting ISSS requirements. FAA project officials stated that such information was not yet available, but the agency was trying to develop such performance measures.

#### FAA Has Not Been Decisive in Resolving Requirements Issues

FAA has experienced difficulty in resolving requirements for ISSS, which has contributed to the problems experienced by the project. The Volpe report addressed the issue of unresolved requirements. The report said that, in areas such as electronic flight strip definition and controller screen display formats, the lack of resolution of requirements issues implied high schedule and technical risk for ISSS. According to IBM project officials, the lack of clarity and decisiveness by FAA in resolving requirements issues is an important contributing factor to the AAS schedule problems.

The Volpe report recommended that FAA enhance the process for resolving ISSS requirements issues. One recent action taken by FAA has been to designate three top officials--from FAA's AAS program office and the Air Traffic and Airway Facilities units--to make final decisions on requirements issues.

#### Lack of a Consolidation Plan Creates Uncertainty

FAA has been indecisive regarding the extent to which it will consolidate en-route and terminal facilities scattered throughout the country. Until this decision is made, the AAS project office will not know how many facilities will receive AAS equipment and what capability will be required of that equipment.

FAA's original plan was to meld the 230 facilities into 23 Area Control Facilities. However, FAA now is leaning toward a "limited consolidation plan" which would consist of 22 en-route facilities with ISSS and/or ACCC, 10 large terminal Metroplex Control Facilities equipped with TAAS, and 170 other terminal facilities which would be upgraded but not with full TAAS systems.

Limited consolidation would represent a change in several technical and cost assumptions on which the TAAS and ACCC segments were based. For example, AAS was premised on having TAAS processors at 23 operational sites. Under limited consolidation, however, TAAS would be used at only the 10 large terminals, while flights at the other 170 terminals would be controlled by non-TAAS facilities. FAA is not yet sure of the impact of these changes on the cost of TAAS, but the amount of terminal airspace traffic controlled by TAAS software would be much less than expected. ACCC's design will also be affected by the decision on consolidation, since it is dependent on TAAS hardware and its requirements were based on a consolidation of terminals and en-route centers.

FAA has not yet delivered a facility consolidation plan to the Congress, despite direction from the House Committee on Appropriations that it do so by February 1, 1992. This plan is a key variable in FAA's acquisition strategy for AAS. As we noted in our recent transition report,<sup>4</sup> the leadership at FAA has changed several times over the last decade, during which the agency has had 9 different Administrators and Acting Administrators. We believe this turnover in leadership has contributed to the difficulty the agency has faced in reaching a consolidation decision.

#### IMPORTANT ELEMENTS OF STRATEGY FOR ADDRESSING AAS SITUATION

Given problems experienced over the past 5 years by FAA and IBM and likely changes in FAA's consolidation plan, FAA faces two different types of challenges: (1) addressing immediate schedule and technical problems and (2) determining whether the plan for each segment of AAS is the most appropriate way to meet the needs of the air traffic control system. Over the past few months, FAA has been reviewing its plans for AAS. Additionally, the Secretary of Transportation is now considering a review of the AAS project.

In our opinion, any strategy arising from these reviews would be most effective if it contained the following four elements: (1) establishing realistic schedules, (2) reaching more timely closure of requirements issues, (3) submitting a firm consolidation plan, and (4) critically evaluating the current plan and need for each segment of AAS. To make decisions about the future of the AAS

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<sup>4</sup> Transportation Issues (GAO Transition Series) (GAO/OCG-93-14TR, Dec. 1992).

project, the Department of Transportation and FAA will need more information on each AAS segment--including costs, schedules, benefits, and risks. More information on these issues should become available later this year. For example, the Volpe Center is expected to report on its cost/benefit analysis of the individual segments of the AAS in mid-1993.

In our ongoing work for the House Appropriations Committee, we are reviewing FAA's analysis of its automation needs. Although the segments of AAS share varying degrees of interdependence, our preliminary analysis indicates that individual segments could be canceled or modified while retaining many of the benefits of the other segments. Our observations on the impact of canceling AAS segments are provided in appendix II.

### CONCLUSIONS

The AAS project is a very complex, ambitious undertaking. It involves substantial software development, changes how air traffic controllers use their equipment, and requires FAA to convert from old to new equipment while maintaining the highest standards of safety for the travelling public. Also, AAS is by far the most costly project in FAA's air traffic control modernization plan.

Given the substantial complexity and cost, we believe that FAA management must exercise closer supervision of IBM's progress and address schedule and technical problems in a more timely manner. Recently announced management initiatives must be carried through. Furthermore, in light of the problems experienced over the past 5 years and likely changes in FAA's consolidation plan, we think that FAA leadership must now address whether the current plan for each segment of AAS is the most appropriate way to meet the needs of the air traffic control system.

This concludes my prepared statement. I would be happy to answer any questions that you might have at this time.

**AAS ACTUAL AND PROJECTED APPROPRIATIONS**  
(Dollars in millions on a fiscal year basis as of 3/1/93)

| ITEM                          | 1982-88 |     | 1989-93 |       | 1994-<br>completion |       | Total cost |       |
|-------------------------------|---------|-----|---------|-------|---------------------|-------|------------|-------|
|                               | RE&D    | F&E | RE&D    | F&E   | RE&D                | F&E   | RE&D       | F&E   |
| 1. Design competition phase   | 417     | 277 |         |       |                     |       | 417        | 277   |
| 2. Acquisition phase:         |         |     |         |       |                     |       |            |       |
| Prime Contract:               |         |     |         |       |                     |       |            |       |
| PAMRI                         |         |     |         |       |                     | 10    |            | 10    |
| ISSS                          |         |     |         |       |                     | 450   |            | 450   |
| TAAS                          |         |     |         |       |                     | 460   |            | 460   |
| TCCC                          |         |     |         |       |                     | 424   |            | 424   |
| ACCC/AERA                     |         |     |         |       |                     | 244   |            | 244   |
| Not segmented                 |         | 60  |         | 1,229 |                     | 232   |            | 1,520 |
| Total prime                   |         | 60  |         | 1,229 |                     | 1,820 |            | 3,108 |
| Tech. support                 |         | 20  |         | 234   |                     | 256   |            | 509   |
| Implementation support        |         | 22  |         | 94    |                     | 212   |            | 328   |
| Training                      |         |     |         | 7     |                     | 60    |            | 67    |
| En-route center modernization |         |     |         | 348   |                     | 66    |            | 414   |
| FAA in-house                  |         |     | 19      |       |                     |       | 19         |       |
| Subtotals                     | 417     | 379 | 19      | 1,912 | 0                   | 2,413 | 436        | 4,704 |
| Total program                 | 796     |     | 1,931   |       | 2,413               |       | 5,140      |       |

- Notes: (1) Columns may not add due to rounding.  
(2) Funding for AAS has been provided through both the Research, Engineering and Development (RE&D) and Facilities and Equipment (F&E) accounts.

Source: FAA's Advanced Automation Program Office

GAO OBSERVATIONS ON AAS SEGMENTS

PAMRI: The PAMRI portion of AAS is almost completed. Significant savings would not result from terminating or modifying this segment.

ISSS: The equipment that FAA is most concerned about in the en-route environment are the controller screens and data processors, which are about 20 years old. FAA has an interim plan to replace the processors that support the Host computer at 8 of the 20 en-route centers. The agency has no active plans to replace the controller screens, but is testing various screens that may be capable of supplementing or replace current equipment.

ISSS is dependent only upon PAMRI; therefore, ISSS could be completed without the completion of the remaining segments. Completing ISSS under its current design would provide en-route controllers with new work stations, automated flight strips, and new data processors. The Host computers--which were installed in the late 1980s--would not be replaced.

TAAS: TAAS is designed not only to provide new work stations, but also to replace the Automated Terminal Radar Systems (ARTS), the main computer system currently supporting terminal facilities. FAA has upgraded various terminal facilities in terms of additional computer capacity and is replacing components such as keyboards to improve reliability. These upgrades will continue over the next few years. However, FAA does not believe these upgrades are a permanent solution. For example, the upgrades do not replace controller screens.

Termination of TAAS would affect the development of ACCC. FAA's original plan was to (1) install ISSS in an en-route center, then (2) consolidate a terminal facility by installing a TAAS system in the en-route center, and finally (3) modify the TAAS software to establish an Area Control Facility under ACCC. Without TAAS, there would be no TAAS software to modify for the main computer system for ACCC.

According to the AAS Program Manager, TAAS and TCCC can exist without the other. However, FAA expects to receive benefits from the two segments working in cooperation. They are expected to have a common software interface and share information, such as environmental data and the status of aircraft.

TCCC: FAA has already made plans to modify its original approach to TCCC. The project has been divided into two phases, the first of which replaces equipment that provides information on

the airport environment. The second phase of TCCC would provide new consoles for tower controllers, including automated flight strips and new radar screens. Radar displays to be replaced by TCCC are relatively new, having been installed since 1989.

ACCC: A limited consolidation plan would change the original assumptions upon which ACCC was based; that is, to combine en-route and terminal air traffic control automation functions performed by ISSS, TAAS, and other terminal systems into an Area Control Facility. If TAAS is eliminated or changed significantly, ACCC becomes a segment focused on replacing the Host computer (the primary computer that will be supporting ISSS), and providing enhanced capabilities advanced software.

RELATED GAO PRODUCTS

Transportation Issues (GAO Transition Series) (GAO/OCG-93-14TR, Dec. 1992).

Air Traffic Control: Justifications for Capital Investments Need Strengthening (GAO/RCED-93-55, Jan. 14, 1993).

Air Traffic Control: Advanced Automation System Still Vulnerable to Cost and Schedule Problems (GAO/RCED-92-264, Sept. 18, 1992).

FAA Budget: Key Issues Need to Be Addressed (GAO/T-RCED-92-51, Apr. 6, 1992).

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

Air Traffic Control: Software Problems at Control Centers Need Immediate Attention (GAO/IMTEC-92-1, Dec. 11, 1991).

Air Traffic Control: FAA Can Better Forecast and Prevent Equipment Failures (GAO/RCED-91-179, Aug. 2, 1991).

Air Traffic Control: Status of FAA's Modernization Effort (GAO/RCED-91-132FS, Apr. 15, 1991).

Air Traffic Control: FAA's Advanced Automation System Contract (GAO/IMTEC-91-25, Mar. 5, 1991).

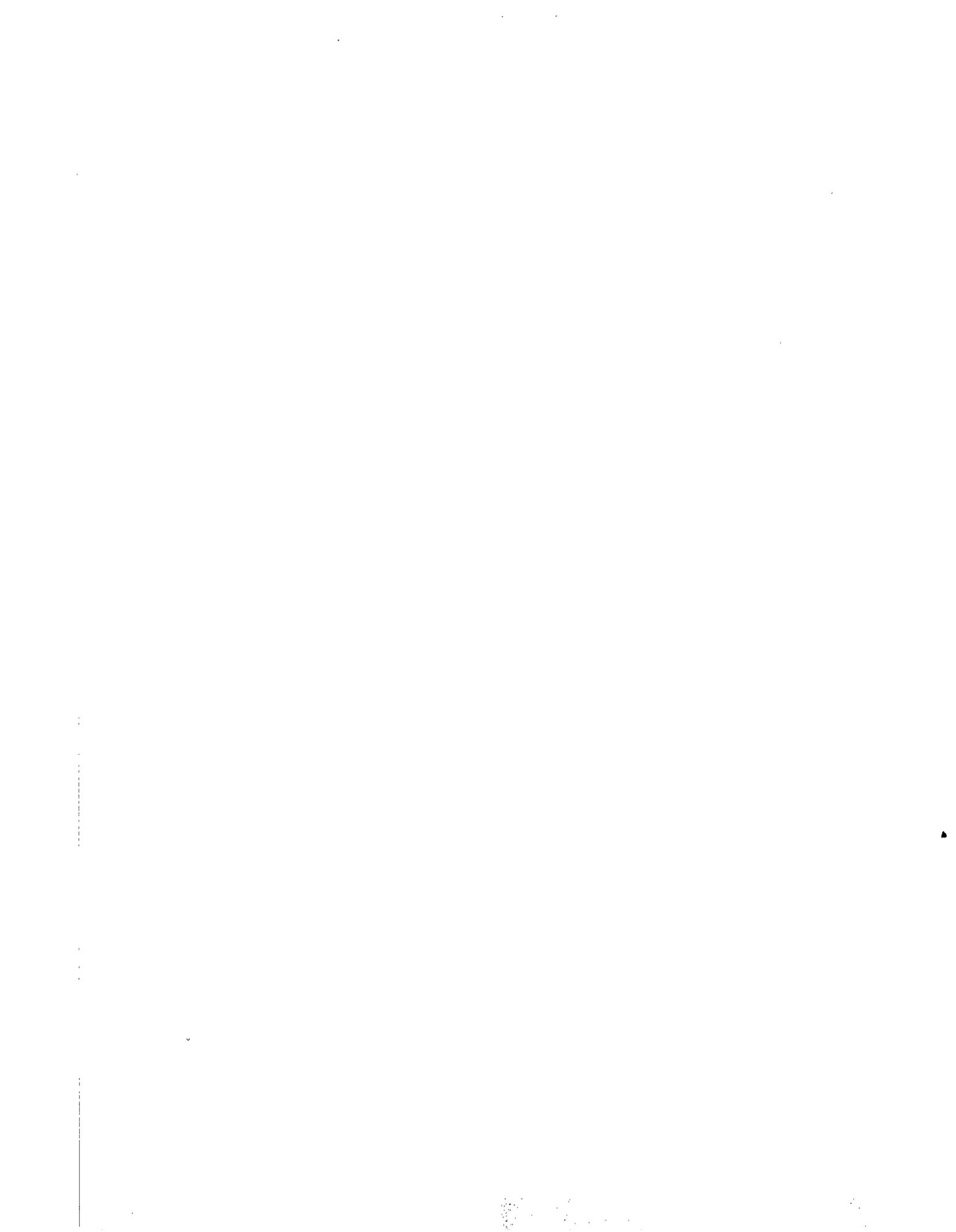
Air Traffic Control: Continuing Delays Anticipated for the Advanced Automation System (GAO/IMTEC-90-63, July 18, 1990).

FAA Encountering Problems in Acquiring Major Automated Systems (GAO/T-IMTEC-90-9, Apr. 26, 1990).

Federal Aviation Administration's Advanced Automation System Investment (GAO/T-IMTEC-88-3, Apr. 12, 1988).

Air Traffic Control: FAA's Advanced Automation System Acquisition Strategy Is Risky (GAO/IMTEC-86-24, July 8, 1986).

GAO Questions Key Aspects of FAA's Plans to Acquire the Multi-Billion Dollar Advanced Automation System and Related Programs (GAO/IMTEC-85-11, June 17, 1985).



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