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INFORMATION MANAGEMENT
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B-206887

The Honorable William Lehman
Chairman, Subcommittee
on Transportation
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

Subject: GAO Questions Key Aspects of FAA's Plans To Acquire the Multi-Billion Dollar Advanced Automation System and Related Programs (GAO/IMTEC-85-11)

In May 1984 we provided our preliminary observations regarding the Federal Aviation Administration's (FAA's) efforts to acquire a more automated air traffic control system.[1] In that report, we observed that FAA's commitment to the Advanced Automation System (AAS) design for modernizing air traffic control software and hardware before fully defining advanced automation functions may constrain the flexibility of the AAS to meet future requirements. The agency believes its acquisition strategy, which incorporates advanced automation functions in an evolutionary manner as they become defined and as operational feasibility is established, will satisfy its operational requirements and will properly mitigate risks.

This interim report responds to your request of May 10, 1984, and subsequent discussions with your office that we continue to evaluate aspects of (1) the AAS computer hardware and software replacement program, (2) the Automated En Route Air Traffic Control (AERA) program (which defines advanced automation functions to be implemented by the AAS program), and (3) the Mode S program (which improves FAA's aircraft surveillance and data communications capability). Although this report expresses concerns about FAA's acquisition approach, we were unable to fully assess some key factors because of the complexity of the programs and the time available. Therefore, until we complete our evaluation, we are not providing conclusions and recommendations. You also requested our

[1] Interim Observations on FAA's Plans For Major Systems Acquisitions (GAO/IMTEC-84-14, May 4, 1984).

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evaluation of FAA's acquisition of an interim computer system called the Host, which we provided in a separate report.[2]

As agreed, we evaluated (a) the adequacy of information that will be available to FAA and the Department of Transportation (DOT) to make the AAS acquisition decision in July 1987, (b) FAA's assertion that its acquisition strategy will provide significant controller productivity benefits from early deployment of new controller workstations, and (c) FAA's June 1984 response to the House Committee on Appropriations' request that FAA clarify its assumptions on using Mode S to meet long-term aircraft surveillance needs. We could not fully evaluate FAA's justification for its AAS acquisition strategy because of FAA's lack of documentation of its justification analysis, and our untimely access to current benefit/cost information. We focused our review of FAA's June 1984 Mode S response on the percentage of aircraft that will install Mode S equipment and the potential role of space-based technology to meet communications, navigation, and surveillance requirements. Our objectives, scope, and methodology are described in detail in appendix I.

BACKGROUND

The AERA, AAS, and Mode S programs are important components of FAA's National Airspace System Plan. Prepared in 1981, it outlines FAA's plans to modernize the nation's air traffic control system. A 1984 study estimated that the overall plan will cost about $12 billion to implement.

The AERA research and development program identifies concepts and defines advanced automation functions intended to automate the work of controllers more fully. These functions will allow increased use of more fuel-efficient routes and will identify and resolve violations of aircraft separation standards. While costs to implement AERA are small (about $260 million) relative to total AAS costs, significant benefits to FAA and airspace users are expected from these functions. When AERA specifications[3] are defined, they are provided to the separately managed AAS program to be developed and implemented by the AAS contractor. The AERA automation functions are expected to be implemented over a 15-year period.[4]

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[2]Federal Aviation Administration's Host Computer: More Realistic Performance Tests Needed Before Production Begins (GAO/IMTEC-85-10, June 6, 1985).

[3]The AERA program is defining functional and performance specifications. These specifications describe the activity to be automated and the performance characteristics needed to achieve FAA's operational requirements.

[4]AERA will be implemented in three stages called AERA 1, AERA 2, and AERA 3. A description of these stages is contained in appendix II.

The AAS program includes the replacement of the existing software, hardware, and controller workstations, as well as a new backup capability, and new highly complex advanced automation software to perform AERA 1 and AERA 2 functions. AAS has a two-phased acquisition strategy: design competition and acquisition or production. FAA awarded two design competition phase contracts in August 1984 for a total of $246.7 million. The Advanced Automation Program office--manager of the AAS--estimates that AAS costs will total $3.2 billion through 1994.

The separate Mode S program will improve FAA's aircraft surveillance capability and provide a data communications capability. Mode S equipment will provide more precise aircraft position information through the AAS computers to air traffic controllers and will transmit printed messages to the aircraft. FAA recently awarded a $222 million contract for 137 Mode S sensors. A second contract, expected in 1991, will improve Mode S coverage by providing 60 additional sensors at a cost of about $120 million. More complete descriptions of the AERA and AAS programs are contained in appendix II. A more complete description of the Mode S program is contained in appendix III.

SUMMARY OF FINDINGS

We found that FAA will not perform some planned simulation tests of the advanced automated functions of AERA prior to including the specifications in the AAS acquisition contract, and that FAA's future plans to test and validate AERA specifications are uncertain at this time. We also found that the agency will not conduct developmental or performance tests of the proposed AAS hardware and software prior to the production decision. Consequently, DOT and FAA may lack adequate information to make a sound and objective AAS production decision in July 1987. Without this information, the agency may acquire computer hardware and software requiring costly and time-consuming modifications to fully achieve FAA's mission needs. In addition, although FAA's ability to obtain controller productivity gains from early deployment of new controller workstations figured largely in its acquisition strategy justification, current estimates indicate that these benefits will be significantly less than the estimate used to justify the strategy.

In its June 1984 congressional response addressing Mode S, FAA stated that 97 percent of aircraft will be equipped with Mode S equipment at the owners' expense by the year 2000. FAA believes this high equipage rate will result in significant benefits. FAA also stated that alternatives to Mode S will not be feasible for at least 25-30 years. We found disagreement, however, about the number of aircraft which will use Mode S equipment, as well as the length of time required to deploy more capable alternative systems. A more detailed discussion of Mode S is provided in appendix III.

FAA ACQUISITION STRATEGY DIFFERS FROM RECOMMENDED GOVERNMENT ACQUISITION STRATEGY

To minimize cost, performance, and schedule problems, Office of Management and Budget (OMB) and DOT guidance recommend that major systems be acquired in four distinct phases. The preferred acquisition strategy includes a series of defined events, with appropriate tests and evaluations leading to a decision on whether and how to proceed to the next phase. The four phases are: (1) concept exploration, when alternative design concepts to be pursued further are selected; (2) concept demonstration, when prototype systems or subsystems are tested for performance against mission needs; (3) full-scale development and testing, when performance capabilities of operational models are tested and when the decision is made to select a system for full production; and (4) production, when the chosen system is produced, installed, and accepted.

For the AAS, FAA selected an acquisition strategy having only two phases: (1) design competition and (2) acquisition. The design competition phase combines many tasks required of both the concept exploration and concept demonstration phases (phases 1 and 2 of the preferred approach). Some full-scale development for one subsystem is also included. The production decision--committing FAA to the bulk of the $3.2 billion AAS investment--will occur at the end of this phase. In the preferred approach, system performance would be tested before the full production contract is awarded to one of the two design competition phase contractors. FAA's acquisition phase calls for concurrent full-scale development, testing, and production.

FAA stated that it chose this strategy to (1) obtain near-term benefits from installing new controller workstations about 2 years earlier than it estimates the preferred approach would have allowed; (2) shorten the overall acquisition cycle; and (3) provide a phased introduction of new technology to the work place.

FAA MAY MAKE ITS AAS PRODUCTION DECISION WITHOUT ADEQUATE INFORMATION

FAA's current approach to acquiring the AAS may result in a premature commitment to this $3.2 billion investment. When FAA awards the AAS acquisition phase contract in July 1987, it may not have adequate information to assure that (1) the specifications provided by the AERA program for the AAS contract are well defined and (2) the chosen AAS design will meet FAA's system performance requirements.

Regarding the first issue, FAA plans to include the specifications for AERA's advanced automation functions in the AAS acquisition phase contract without conducting simulation tests to provide additional assurance that the specifications are well defined. The AERA program had planned to conduct simulation tests of advanced automation functions before providing the specifications to the AAS program office. However, problems in developing test software

prevented most of the simulation tests. FAA's future plans to test and validate AERA specifications are uncertain. Regarding the second issue, FAA plans to award the AAS acquisition contract before completing AAS hardware and software development, developmental tests, and before conducting AAS system performance tests. Awarding the acquisition contract without adequately validating advanced automation functions and without having adequate assurance that the system will perform as required could lead to higher costs, schedule delays, and deployment of a system that does not perform as required in an operational environment. Also, estimated benefits may not fully accrue.

Most planned simulation tests will not be conducted

The AERA program office has prepared specifications for some AERA 1 advanced automation functions included in the AAS design competition phase contracts.[5] The AERA program office is now defining AERA 2 concepts and functions and plans to provide AERA 2 specifications to the AAS program office in January 1986. Both AERA 1 and AERA 2 specifications will be included in the AAS acquisition contract without the planned tests to assure that the specifications would result in an operationally useful system. At this time, FAA officials cannot state with certainty what, if any, AERA tests will be performed prior to the AAS acquisition decision.

Software development guidance

Software development and acquisition guidance stresses the importance of adequately specifying the functions software should perform before the agency commits to develop and implement the software. While DOT and FAA have not developed specific software guidance covering programs of the size and complexity of AERA, the Department of Defense has developed guidance for complex software development programs. We believe these recommendations can be applied to FAA's AERA program. The Department of Defense Software Acquisition and Development Working Group analyzed software development problems and recommended[6] more effort in defining specifications adequately and in using risk reduction techniques (such as prototype development testing) before committing to a complete software development program. A GAO report[7] also noted that many software development problems occur because agencies commit to software development programs before complete and accurate specifications are identified.

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[5]FAA expects to add specifications for additional AERA 1 functions to these contracts and make modifications to the specifications already included in the contracts.

[6]Final Report of the Software Acquisition and Development Working Group, Department of Defense, July 1980.

[7]Contracting For Computer Software Development - Serious Problems Require Management Attention To Avoid Wasting Additional Millions (GAO/FGMSD-80-4, November 9, 1979).

Planned tests not conducted

FAA had planned to conduct tests to assess the technical soundness and operational suitability of proposed AERA 1 and AERA 2 functions. Some AERA functions were analyzed using a test facility developed to assess the technical soundness of AERA. FAA found this facility inadequate because of its limited capability to simulate air traffic controllers' workload and environment. For example, the facility could simulate only a few aircraft flights and did not permit the controller to interact with the simulated aircraft. As a result, in 1983, FAA decided to develop a more capable contractor facility to test advanced automation concepts and to develop a new facility at FAA's Technical Center to assess operational suitability. The operational suitability tests were planned to begin in mid-to-late 1984.

Currently, however, the software required to perform most tests is not available. The software is not available primarily because the scope and complexity of its development were underestimated. The ensuing delay in delivering the test software caused the AERA 1 functions not to be subjected to the planned operational suitability tests. The AAS program requires delivery of the AERA 2 specifications in January 1986 for inclusion in the AAS acquisition phase request for proposals. FAA officials have concluded that the planned tests cannot be completed in time to meet the AAS timetable. Therefore, FAA also plans to deliver the AERA 2 specifications to the AAS program without these tests.

If FAA does not conduct developmental tests of AERA advanced automation functions, it will not have the benefit of the test information that would better assure that the functions will be useful to controllers. This can be illustrated by the AERA 1 function--called flight plan conflict probe--that probes the 20-minute look ahead provided by the trajectory estimate function to determine whether aircraft will violate minimum separation standards. A team of controllers that reviewed AERA functions suggested that the flight plan conflict probe function be subjected to an operational suitability test before being incorporated into the AAS acquisition phase contract. They wanted to know if an unacceptably large number of false alerts would result. Large numbers of false alerts may reduce controllers' willingness to use this and related functions. If this were to happen, anticipated AERA benefits might not be realized.

FAA has stated that the AERA functions will be provided to the AAS program as soon as they have been adequately defined. Although AAS officials believe AERA 1 and AERA 2 specifications will be sufficiently well defined to be included in the AAS acquisition contract, some AERA and FAA Technical Center officials have expressed concern about the adequacy of the specifications. The future of the AERA test facility at the Technical Center is still being discussed. FAA officials cannot now state with certainty what, if any, tests will be performed prior to the planned July 1987 acquisition decision. It is unclear how FAA will validate the AERA

specifications without these tests. Consequently, the specifications may not be adequately defined when they are included in the AAS acquisition contract.

AAS performance will not be demonstrated prior to production

FAA plans to award the AAS acquisition phase contract based primarily on its evaluation of system hardware and software designs, a limited demonstration of one subsystem (the controller workstation), analyses of system design alternatives, and estimates of AAS performance produced by the design competition phase contractors. Contrary to the preferred approach defined in acquisition guidance, FAA plans to award the acquisition contract before completing development of the AAS or its subsystems and before completing developmental testing. FAA also will not have conducted tests to demonstrate AAS system performance capabilities. If the acquisition decision is made on this basis, FAA may not have adequate information to be confident that, when deployed, the AAS will meet operational requirements.

Acquisition guidance

OMB Circular A-109 and DOT Order 4200.14B both provide guidance and describe the process which agencies, including FAA, should follow to acquire major systems such as the AAS. The guidance was intended to improve the management process and to minimize severe adverse effects such as inadequate system performance, excessive costs, and delayed implementation.

The OMB circular calls for agencies conducting major system acquisitions to ensure, among other things, adequate tests and evaluations, and to conduct them, where practicable, independent of the developer and user. The preferred approach is to use four separate acquisition phases--concept exploration, concept demonstration, full-scale development, and production. During the full-scale development phase, operational models are produced and tested to determine if the system meets (1) specified technical performance requirements and (2) operational effectiveness and suitability requirements. Obtaining this system performance information before the production decision allows design and engineering changes to be made early and provides enhanced assurance that the system will operate as expected before large amounts of money are spent.

Design competition phase does not provide for complete development

The DOT systems acquisition guidance states that the agency should satisfactorily test system performance prior to awarding an acquisition contract. Following this guidance reduces the risk that costly changes will be needed during production. FAA does not plan, prior to contract award, to complete development of the

AAS or its subsystems, to complete full-scale development testing, or to demonstrate system performance capabilities.

DOT and FAA will base their AAS acquisition decision on information the contractors develop during the design competition phase. During this phase, the contractors are required to prepare an AAS system design, then build and demonstrate a mock-up and a limited prototype of the controller workstation, including data entry and display devices. The prototype demonstration is to be limited to assessing whether the workstations perform the required data entry and display functions and meet physical and human engineering requirements. Contractors must also submit the results of AAS economic and technical analyses such as assessing the economic and technical trade-offs associated with continuing to use Host computers[8] in the AAS. The contractors will also provide the results of computer models designed to predict whether the proposed AAS design will satisfy system performance requirements. Finally, the contractors will show how their proposed AAS design could be extended to accommodate possible AERA 2 and AERA 3 capabilities.

The information described above may be inadequate, however, because AAS system performance will not have been tested. Neither AAS components nor its subsystems will have been fully developed, and developmental tests to verify that hardware and software meet functional and performance specifications will not have been completed. No system performance tests will have been conducted to demonstrate whether the proposed AAS can perform complex air traffic control functions. Also, because the workstation hardware and associated software will not be fully developed prior to production, the demonstration will be limited to the display subsystem, which will use only demonstration software to display examples of selected air traffic situations. There will be no interface with existing software or simulation of interaction with future AAS software. Therefore, FAA will not have confirmed that the workstation can meet the controller/machine interface, processing, or display characteristics required to perform existing electronic flight plan and radar data display functions or the proposed AERA functions.

Host design competition phase testing

In our June 1985 report on the Host computer, we found that system performance testing was inadequate because neither Host design competition phase contractors' system was tested using a realistic workload of the 1990s. However, during the review we recognized that FAA did conduct functional, reliability, and capacity tests. The AAS--a more expensive and complex system than the Host--will not undergo similar key testing prior to a production decision.

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[8]FAA plans to install Host computers starting in 1986 to overcome expected computer capacity shortages. Air traffic control software will remain the same and hardware will be compatible with the existing system.

Comparing the Host to the AAS shows that the AAS is a far more complex acquisition. The Host program will acquire a new central processor that will operate with existing air traffic control software, controller workstations, and backup systems. In contrast, the AAS program includes replacement software, hardware, and controller workstations, as well as a new backup capability and new highly complex advanced automation software. FAA's program budget through 1994 shows that Host costs are expected to total about $540 million, while AAS costs are expected to total about $3.2 billion--almost 6 times greater.

FAA is confident that its evaluation of contractor designs and analyses, coupled with the competitive nature of the design competition phase, will provide sufficient information to make the AAS acquisition phase investment decision. However, we believe the consequences of awarding the contract under these circumstances could be significant. If the operational capability of the AAS is not adequately assessed prior to production, FAA will increase the likelihood that expensive and time-consuming changes will be required to overcome technical or operational problems. If problems are encountered, they could significantly delay the system's operational readiness and affect its safety and efficiency benefits.

CONTROLLER PRODUCTIVITY PROJECTIONS RAISE QUESTIONS ABOUT JUSTIFICATION FOR ACQUISITION STRATEGY

FAA justified its two-phased AAS acquisition strategy in large part on realizing productivity benefits from early deployment of new workstations. According to FAA officials, conducting a full-scale development phase before making the AAS acquisition decision, as recommended by OMB, would increase development costs and delay deployment of new workstations by 2 years--thus preventing FAA from realizing about $200 million in benefits from increased controller productivity. Current FAA estimates, however, show that these benefits are expected to be significantly lower than anticipated. As a result, FAA's justification for this acquisition strategy may be questionable.

In 1981, FAA estimated that workstation deployment would reduce controller positions by 1800, saving about $100 million per year. In 1984, however, FAA estimated that about 800 controller positions would be saved. Using FAA's 1981 formula and its estimated annual cost avoidance of $60,000 per controller, we estimate that the operational cost savings from this more recent estimate would total $48 million per year, rather than $100 million per year.

We also noted that the current workstation productivity be estimated before awarding a production contract. FAA awarded a contract to validate the productivity benefits, but the benefit

estimate before awarding a production contract. FAA awarded a contract to validate the productivity benefits, but the benefit validation contract was cancelled when the tabular display program was terminated. The cancellation of the validation contract resulted in the 800 position figure not being validated. Therefore, the accuracy of FAA's latest, more conservative savings estimate of 800 controller positions is uncertain.

The reduced and uncertain benefits expected from early workstation deployment raise questions about FAA's rationale for adopting its AAS acquisition strategy. FAA has cited other reasons for adopting this strategy, such as shortening the overall acquisition cycle and providing a phased introduction of new technology to the workplace. During this review we were not able to evaluate these reasons fully.

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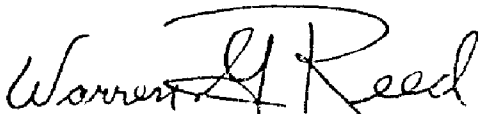
We plan to continue our review of FAA's AAS and associated program acquisitions. We were not able, in the time available, to assess fully (1) the acquisition strategy, (2) alternatives to the current planned approach, (3) the draft benefit/cost analysis, and (4) other key aspects of the program. Therefore, while we have concerns about some aspects of FAA's acquisition approach, we are not providing conclusions and recommendations until we complete our evaluation of the AAS program.

As requested by your office, unless you publicly announce its contents earlier, we plan no further distribution of this report for 30 days from its date of issuance. We will then send copies to the Secretary of Transportation, the FAA Administrator, and other interested parties, and will make copies available to others upon request.

Sincerely yours,



Warren G. Reed
Director

OBJECTIVES, SCOPE, AND METHODOLOGY

Our review responded to the request of the Chairman, Subcommittee on Transportation, House Appropriations Committee, and subsequent discussions with the Chairman's office that we continue to evaluate the Advanced Automation System (AAS) computer hardware and software replacement program, the associated Automated En Route Air Traffic Control (AERA) program, and the Mode S aircraft surveillance and data communications program. Specifically, we evaluated (a) the adequacy of information that will be available to the Federal Aviation Administration (FAA) and the Department of Transportation (DOT) to make the AAS acquisition decision in July 1987, and (b) FAA's assertion that its acquisition strategy will provide significant controller productivity benefits from early deployment of new controller workstations. We also evaluated FAA's June 1984 response to the House Committee on Appropriations' request that FAA clarify its assumptions regarding the use of Mode S to meet long-term, aircraft surveillance needs. The Subcommittee also asked us to consider FAA's February 1985, response to concerns raised in the House Appropriations Committee Report H.R. 98-859, which accompanied the fiscal year 1985 Department of Transportation and related agencies appropriations bill. We reviewed this response and incorporated FAA's position into our analysis where appropriate.

To evaluate the AAS acquisition strategy, we examined documents supporting FAA's chosen strategy. We also compared its strategy to the Office of Management and Budget and DOT major system acquisition guidance to determine how well FAA's approach meets the criteria and mitigates cost, schedule, and performance risks. In addition, we assessed the progress and problems in the AERA program and discussed these issues with FAA officials. However, we could not fully evaluate the justification for the AAS acquisition strategy because of (1) FAA's lack of documentation of its justification analysis and (2) untimely access to current benefit and cost information.

To evaluate FAA's assumptions about Mode S, we reviewed documents related to the Mode S program and discussed FAA's assumptions with FAA officials, representatives of a major user group, and industry officials. We focused our evaluation on FAA's discussion of future plans. Specifically, we focused on FAA's estimate of the percentage of aircraft that will install Mode S equipment and the potential role of space-based technology to meet communications, navigation, and surveillance requirements.

We conducted our work primarily at FAA headquarters in Washington, D.C., and at the FAA Technical Center in Pomona, New Jersey. We interviewed staff members at each site as well as officials from private industry, including FAA contractors. We reviewed DOT and FAA documents related to FAA's planning and management of the AERA, AAS, and Mode S programs.

During our review, we sought the views of responsible officials and incorporated their comments in the report where appropriate. As requested by the Subcommittee Chairman, we did not ask DOT, FAA, or contractors to review and comment officially on a draft of this report. We performed our work in accordance with generally accepted government auditing standards.

AERA AND AAS PROGRAM DESCRIPTIONS

The National Airspace System Plan of December 1981 describes FAA's plans, through 1992, to modernize its air traffic control system. FAA describes the modernization as providing significant benefits to FAA and to airspace users. Benefits expected from the en route and terminal air traffic control modernization--a part of the National Airspace System Plan--include (1) improved safety, fuel savings, and increased controller productivity through higher levels of automation; (2) increased computer capacity and availability through data processing hardware and software modernization; and (3) lower operating and maintenance costs through consolidation of terminal area facilities (currently located at major airports) with en route centers.

FAA's modernization plans for en route and terminal air traffic control include short-term and long-term initiatives. The purpose of the Host computer system acquisition is to alleviate expected short-term computer capacity problems and to provide the capability to implement some short-term enhancements, such as improving the controller's ability to resolve potential aircraft conflicts. Most of the anticipated benefits, however, are to be achieved primarily through two separately managed programs, AAS and AERA. Mode S surveillance and communications capabilities are also expected to contribute to these benefits.

FAA, in its April 1985 draft benefit/cost study, stated that the benefits accruing from these and smaller related programs are estimated at $5.69 billion compared to estimated capital costs of $2.45 billion. The benefits and costs were discounted to 1982 dollars based on a standard practice by which future benefits and costs are reduced to reflect their present value. The AAS program office estimates that $3.2 billion in actual outlays will be required through 1994 to acquire the AAS. This sum includes research and development, facilities and engineering, and some operating and maintenance costs.

Advanced En Route Air Traffic Control (AERA)

The objective of the AERA research and development program is to identify and develop methods to automate the work of air traffic controllers. The AERA program is identifying and defining advanced automation functions, assessing their technical soundness and their suitability for use by controllers, and preparing functional and performance specifications for the AAS program. (The AAS contractor will be responsible for developing and implementing the computer hardware and software for the new functions.)

AERA development and implementation will occur in three incremental stages that FAA calls AERA 1, AERA 2, and AERA 3. The goals of each stage are:

AERA 1 - To provide a set of automated planning tools that present aircraft position information for the controller's use in approving and controlling more flexible, fuel-efficient, "user-preferred" routes. FAA expects these tools or functions to contribute to significant user fuel savings and passenger delay reductions. Specifications to implement four functions--trajectory estimation, flight plan conflict probe, airspace conflict probe, and sector workload analyses--have been provided to the AAS contractors. Nevertheless, FAA is considering contract modifications to incorporate six additional functions.

AERA 2 - To increase controller productivity by analyzing aircraft position information and displaying proposed resolutions of potential conflicts between aircraft to the controller for approval and action. FAA predicts that controllers can handle more aircraft, thus reducing the number of additional controllers required for the traffic increases expected through the year 2010. Specifications for AERA 2 are being completed by the AERA program and are expected to be provided to the AAS program office in January 1986 for inclusion in the AAS acquisition contract request for proposals scheduled for release in July 1986.

AERA 3 - To offer additional controller productivity by its ability to resolve potential conflicts between aircraft and automatically generate air traffic control clearances and directives to pilots. AERA 3 is still in the concept formulation stage, so FAA has yet to begin developing these specifications. Currently, FAA is uncertain when AERA 3 will be incorporated into the AAS program.

Advanced Automation System (AAS)

The AAS program will provide new hardware and software to perform both existing air traffic control functions and the more highly automated functions of the AERA program. FAA's strategy to acquire the AAS calls for design, development, production, testing, and implementation in two phases: (1) design competition and (2) acquisition. Design competition phase contracts were awarded to the International Business Machines Corporation and the Hughes Corporation in August 1984. These contracts total $246.7 million and will run for 35 months. Each contractor is required to provide a system design in response to the government's requirements specifications. Each contractor will also develop and demonstrate prototype controller workstations, called sector suites, and perform extensive cost and technical trade-off analyses among alternative designs, and estimate AAS performance using computer models.

APPENDIX II

The acquisition phase contract is scheduled for award to one of the two design phase contractors in July 1987. During the acquisition phase, full-scale development and test activities, production, and operational testing will be accomplished, and the system will be implemented at 23 locations. The contract will call for the AAS to be implemented in several stages. The first, beginning in 1990, is the installation of the Initial Sector Suite System; it consists of workstations, workstation processors, and a local communications network. The second step, beginning in 1992, is the installation of the full AAS system, consisting of new air traffic control software and new processors to augment or replace the Host computers. After the AAS becomes fully operational in about 1994, FAA plans to consolidate terminal area control functions at the 23 new Area Control Facilities.

According to FAA's February 1985[1] response to Committee concerns, AERA 1 will be implemented with the AAS in 1992. Initial AERA 2 functions are scheduled to be implemented in 1997. While FAA has not developed a schedule for AERA 3, its expected implementation is around the turn of the century. AERA implementation dates have slipped since last year when FAA's schedule called for AERA 2 to be operational in 1994 and AERA 3 to be operational in 1996.

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[1]Response to Congressional Concerns Regarding the FAA's Advanced Automation Program for Air Traffic Control (DOT/FAA/AAP-85-1, February 1985).

ANALYSIS OF FAA's RESPONSE TO A CONGRESSIONAL REQUEST ABOUT MODE S

Current air traffic control surveillance capability is provided by the Air Traffic Control Radar Beacon System (ATCRBS). FAA has initiated steps to replace this system with a new radar beacon capability called Mode S. Mode S will have ground-based radar-beacon stations to transmit signals to aircraft. Aircraft equipped with Mode S-compatible equipment will respond to these signals and Mode S ground equipment will use the information to automatically compute each aircraft's location. Mode S is expected to enhance FAA's surveillance capability and eliminate interference problems experienced with current equipment. The Mode S communications capability is also expected to reduce controller reliance on time-consuming voice communications. The $222 million Mode S system contract, awarded in October 1984, includes 137 ground systems. To improve surveillance coverage, FAA expects to procure 60 additional systems beginning in 1991 at a cost of $120 million. According to FAA, the contractor is progressing satisfactorily.

GAO'S EVALUATION OF FAA's RESPONSE TO CONGRESSIONAL CONCERNS ABOUT MODE S

As requested (in House Appropriations Committee Report No. 98-859, June 11, 1984), FAA clarified certain assumptions about FAA's long-range plans to rely on Mode S for aircraft surveillance. Specifically the Committee asked FAA to provide:

(1) Current estimates of the percentage of aircraft that will use Mode S in 1990, 1995, and 2000.

(2) An assessment of the Mode S payback period and benefit/cost ratio, given the levels assumed above.

(3) An assessment of the likelihood that a space-based surveillance system will be in place by 2000-2010, and the likelihood that Mode S will be compatible with such a system.

(4) Estimates of the percentage of aircraft that will use Mode S in 1990, 1995, and 2000 if pilots believe that a non-Mode S-compatible space-based system will replace it early in the 21st century.

(5) An assessment of the Mode S payback period and benefit/cost ratio, given the estimated percentage of aircraft stated above.

FAA's June 1984 report responded to each of the five issues. Overall, FAA stated that even one generation of Mode S will provide significant benefits because (1) about 97 percent of the total aircraft fleet will have Mode S equipment installed by the year 2000 regardless of the advent of space-based technology, and (2) it will be at least 25-30 years before space-based alternatives are technically or economically feasible. Consequently, FAA stated that Mode S is cost-beneficial and should be viewed as the "back-bone" of its National Airspace System Plan.

We focused our review of FAA's response on its estimate of the percentage of aircraft that will install Mode S equipment and the potential role of space-based technology to meet communications, navigation, and surveillance requirements.

Widespread voluntary installation of Mode S equipment may be questionable

Our discussions with officials representing the Aircraft Owners and Pilots Association, a key organization representing general aviation operators, revealed that this group believes it is unlikely that a large percentage of general aviation operators will voluntarily acquire Mode S equipment. General aviation is the largest portion by far of the total U.S. fleet.[2] For FAA to meet the high equipage levels cited in its estimates, the vast majority of these aircraft would have to install Mode S equipment. While FAA does not plan to make Mode S equipment installation mandatory, it does plan to implement new rules preventing continued production and installation of compatible ATCRBS equipment. The Association representative explained that his group will strongly resist any FAA effort to achieve a high equipage level using the rulemaking process. According to this group, the limited low altitude coverage and data communications capabilities of Mode S will prevent it from offering the level of benefits and services that will attract a large number of general aviation operators.

Space-based alternatives merit a timely and thorough evaluation

FAA's assessment of space-based alternatives to Mode S was that technology breakthroughs would be required to make them feasible, and that it would be at least 25-30 years before such a system could be implemented. By focusing its analysis on a limited range of concepts, FAA may have reached inaccurate conclusions about the potential role and cost-effectiveness of space-based

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[2]According to FAA, the fleet comprises general aviation, commuter airlines, and air carriers. The last two will likely equip with Mode S transponders to receive full benefit of the air traffic control system.

technology. For example, its evaluation of a Mode S-compatible system appears to have led FAA to conclude that it would take at least 25-30 years to implement a space-based system. According to private industry and government officials, space-based alternatives may become available much sooner than FAA predicts and FAA may not have fully evaluated their potential to meet future communications, navigation, and surveillance requirements.

In our May, 1984 report,[3] we observed that a "clean-sheet" approach may be needed to identify current and future air traffic control communications, navigation, and surveillance requirements. Subsequently, we learned that the Radio Technical Commission for Aeronautics had created a special committee to determine those requirements and to make an objective and systematic assessment of technologies which could satisfy the requirements. The committee was formed at FAA's suggestion and FAA is represented on the committee. A recently issued interim report identified tentative requirements for the next 25 years and concluded that a space-based concept may provide a cost-effective solution for user requirements. The committee is exploring and evaluating the technical and economic feasibility of various technology alternatives to satisfy future requirements.

The committee's interim report also asserts that there are no technological roadblocks that prevent using space-based technology. Our preliminary discussions with private industry delineated space-based concepts that, while incompatible with Mode S, do not require technology breakthroughs. In fact, a former FAA administrator stated in 1982 that it probably would take 12-15 years to implement a space-based capability. Industry officials believe space-based systems could become operational within 5-10 years, depending upon the capabilities provided. Multi-purpose satellites providing a wide range of communications, navigation, and surveillance services would be more sophisticated and would take longer to implement than satellites providing only limited services such as data communications.

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[3] Interim Observations on FAA's Plans For Major Systems Acquisitions (GAO/IMTEC-84-14, May 4, 1984).