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STATEMENT OF

CARL R. PALMER, ASSOCIATE DIRECTOR

INFORMATION MANAGEMENT AND

TECHNOLOGY DIVISION

BEFORE THE

SUBCOMMITTEE ON TRANSPORTATION,

AVIATION AND MATERIALS

OF THE

HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

ON

FAA'S ADVANCED AUTOMATION SYSTEM

035210

Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to comment on FAA's plans to modernize its air traffic control system through the Advanced Automation System--commonly called AAS--and to provide our latest assessment of FAA's acquisition strategy and the soundness of the $3.2 billion AAS investment to meet the future safety and efficiency needs of the nation's air transportation system.

Our testimony today is based on work requested by the House Appropriations Committee. We were asked to evaluate the technical and economical soundness of the AAS investment. Based on our current evaluation, we remain concerned that (1) the technical risks involved in the AAS program are not adequately mitigated by the acquisition strategy and (2) that the advanced automation features, that are supposed to provide the primary benefits, are not being operationally simulated before the investment commitment. In addition, our evaluation of available benefit/cost analyses shows that the AAS investment, as currently defined, may not be economically justified.

In our earlier report, we expressed our concerns about the AAS acquisition strategy and the incomplete testing of advanced automation functions.[1] In another report, we questioned FAA's

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[1] 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).

plans to make a production decision on the Host computer system without full performance testing.[2] We will report on our latest evaluation of the Host program in June 1986. Today's testimony addresses only the AAS program. (The appendix provides a more detailed explanation of the objectives and scope of our review.)

THE AIR TRAFFIC CONTROL SYSTEM

Computers support FAA's air traffic control mission--a service provided to promote the safe, orderly, and expeditious flow of air traffic by maintaining the necessary separation between aircraft.

Air Route Traffic Control Centers control air traffic that is en route or between airports and operating under instrument flight rules. These centers ensure aircraft separation and provide traffic advisories and weather information to pilots. A typical center is responsible for more than 100,000 square miles of airspace and scores of air routes, which are like electronic highways to pilots. The center's airspace is divided into geographical areas called sectors, which define the area for which the controllers are responsible. There are 20 en route centers in the continental United States and 4 offshore centers. Terminal Radar Approach Control facilities sequence and separate aircraft arriving at or departing from airports, while Air Traffic Control

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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).

Towers handle traffic that is in the immediate vicinity of major airports. There are approximately 188 Terminal Radar Approach Control facilities and 400 Air Traffic Control Towers at major airports across the country.

Today, to provide essential aircraft position and flight plan information to controllers, IBM 9020 computers, deployed between 1969 and 1977, operate at FAA's en route centers. These computers take inputs from many radars, identify and track the targets, associate the tracks with flight plans, and display the aircraft identification and position location. The computers also take flight plan data, perform necessary updates, and print flight progress strips. Changes to flight plans require coordination and pencil marking by controllers. The 9020 computers also use the radar and flight plan data to provide two safety-related warnings--Conflict Alert, when two aircraft are predicted to have less than standard separation within the next 2 minutes, and Minimum Safe Altitude Warning, when an aircraft is predicted to be below a predetermined safe altitude within the next several minutes.

AIR TRAFFIC CONTROL COMPUTER MODERNIZATION PLANS

Before presenting the results of our evaluation, I will briefly describe what the AAS program is expected to accomplish and its present status. The AAS--at $3.2 billion--is the largest single program in FAA's $12 billion National Airspace System Plan, which is intended to modernize and improve air traffic control and airway facilities services. The plan assumes that, unless aging and technically obsolete facilities are modernized, FAA will be unable to keep pace with the nation's air traffic demands. The goal of the plan is to increase safety, capacity, productivity, and economy by implementing more automation and by consolidating facilities. To gain near-term capacity increases and to provide the time needed to develop the AAS, FAA is installing the new Host computer system at centers that control aircraft en route between airports. The Host computer will allow processing of existing air traffic control software on new equipment. In the short-term, terminal operations around major airports are scheduled for minor equipment upgrades. The AAS is FAA's longer term program and is expected to (1) enable the consolidation and replacement of en route and terminal facilities, (2) increase controller productivity and system availability, (3) reduce operating costs, (4) save fuel and (5) automate many of the functions currently performed by controllers, thus dramatically changing the way air traffic is controlled.

The AAS and advanced automation functions are scheduled for deployment in several steps, each of which is expected to provide increased capability.

1991-1993. Controller workstations with new displays, workstation software, and a local communications network will be deployed at en route centers to operate using existing air traffic control software and the Host computers. FAA refers to this step as the Initial Sector Suite System or ISSS.

1993-1994. The full en route AAS will replace the existing en route air traffic control software and most data processing hardware, and add the first set of advanced automation functions--called Aera 1. Aera 1 functions will predict the future location of aircraft and check for potential conflicts.

1994-1998. All of the 188 terminal radar control facilities will be consolidated into 23 centers, which will be called Area Control Facilities, and the tower automation portion of the AAS will be deployed at selected airport towers.

1997-1999. The second set of automation functions, called Aera 2, will be added for en route control. Aera 2 functions will provide controllers several alternative resolutions to potential conflicts identified by the AAS and will improve coordination with other controllers.

2000 and beyond. The third set of automated functions, Aera 3, is not yet fully defined. It is hoped, however, that with these functions, the computer will be able to select the proper resolution of potential conflicts and communicate course and altitude changes directly to the aircraft.

The AAS acquisition is being conducted in two phases. Phase 1 is a design competition between the IBM Corporation and Hughes Aircraft Company. Awarded in August 1984, both contracts amounted to approximately $247 million and require on-paper system designs by mid-1987. The design competition phase has recently incurred a 6 month delay and a cost increase of over $120 million. This happened because not all Aera 1 requirements were included in the contracts; new requirements, such as color displays, were added; and FAA and the contractors had to clarify other requirements.

In March 1987, FAA plans to issue a Request for Proposals for phase 2--a concurrent development and production contract that will be awarded to one of the contractors in early 1988. The Congress will be asked to make the $3.2 billion investment commitment to this system in the spring of 1987 when FAA requests appropriations for fiscal year 1988.

EVALUATION CRITERIA

We applied the following criteria to assess whether the AAS program represents a technically and economically sound investment.

First, technical, operational, and economic risks associated with the AAS program should be clearly identified and minimized. We would expect FAA to have completed a detailed and systematic analysis of such risks, identifying potential problems, the potential effect of these problems, and steps taken to reduce these risks or their effect. Risks exist when (1) significant hardware or software changes are made, (2) new or untried technologies or development methods are used, or (3) new functions or applications are performed. Risks associated with other interdependent systems or programs also need to be considered.

Second, the acquisition strategy should be designed to minimize these risks and to maximize system effectiveness. We would expect a major system acquisition program with significant technical, operational, and economic risks to require strict adherence to the phasing and extended competition principles fundamental to Office of Management and Budget Circular A-109. This circular recommends four separate acquisition phases: (1) concept exploration, (2) concept demonstration, (3) full-scale development and testing, and (4) production. An important facet of this guidance is that the production commitment should not be made until a system's performance is tested in a realistic operational environment. The importance of following this approach was recently affirmed in the February 1986 Interim Report of the President's Blue Ribbon Commission on Defense Management. This report concluded that full-scale development testing of weapons systems is critical to improve system performance and that systems should not go into high-rate production without operational test results. The report also stated that we should "fly and know how much it will cost before we buy."

Third, the economic and intangible benefits of the program should justify the expected investment and operating and maintenance costs.

AAS TECHNICAL AND OPERATIONAL RISKS ARE SIGNIFICANT

FAA's current air traffic control system is one of the largest and most complex real-time control systems in the world. Replacing this system would be an extremely complex and risky undertaking even without the addition of new capabilities and new technologies. In the AAS program, virtually all air traffic control computer hardware and software will be replaced, and important new capabilities with stringent performance and reliability requirements will be added. Operational risks are significant because many of today's routine procedures handled by controllers are eventually supposed to be performed and communicated by computer. Complexity and risks are caused by the cumulative effect of redesigning the software; using a new computer language; designing a system with very high availability requirements; replacing the hardware, including controller workstations; incorporating new automated functions; and interfacing with other systems still in development.

The redesign of the present software into a distributed processing system in a high level language is complex and risky. The intricately woven programs and complex logic of the current air traffic control software will make redesign difficult. The current software has been referred to as an "intertwined mess" due to numerous coding changes made over 15 years. The addition of new functions, many of which have not been developed and tested or even operationally simulated, increases this difficulty.

According to the AAS Program Manager, the AAS will use a new programming language called Ada. This language, sponsored by the Department of Defense, is still being developed and is relatively unproven for large real-time system applications such as the AAS. FAA's strenuous AAS availability requirements, combined with a new distributed architecture, also increase technical risks. FAA requires the system to be operational or available to perform emergency mode functions 99.99999 percent of the time. This requirement means that system outages cannot exceed 3 seconds per year. Full services must be provided 99.9995 percent of the time. At this level, the system cannot be out for more than about 2.6 minutes per year.

The distribution of complex functions across a sophisticated, multi-component architecture of new software, hardware, and communications systems also increases the development risks. Further, the high resolution, flat color video display of the controller workstation, and the capacity requirements of the local communications network are pushing the state of the art and represent development, producibility, and reliability risks.

Anticipating the extension of the system to perform full automation functions that have not yet been fully defined further adds to the complexity and risks. The advanced automation functions of Aera are the source of significant labor-saving features for FAA controllers and the principal source of most airspace user benefits. Significant questions about the automated functions of Aera remain unanswered. For example, in July 1985 an FAA committee, charged with overseeing Aera development, raised 87 questions about the Aera functions. The Aera committee classified some of these questions as critical to the development of both Aera 1 and Aera 2 and indicated that some could be answered by testing and simulation and should be resolved before the AAS production decision. FAA, however, does not have an approved plan to perform operational simulation of Aera functions before the production decision.

Many of the other systems the AAS will interface with or depend on are also still being developed and thus represent risks to the planned evolution of the AAS. Problems have been experienced in related programs. Performance testing of the Host computer, which must be operational at all centers before the controller workstations are installed, has been delayed due to software conversion difficulties. Because of program difficulties, the Mode S surveillance system, which will provide more accurate position information and enable direct aircraft to computer linkages, will be tested concurrently with operational installation to meet deployment milestones. Also, any slippage in the development of the critical Voice Switching and Control System, which permits automated controller voice communications, would delay workstation deployment.

Achieving the requirements for overall system performance, system capacity, and high availability makes the AAS development and production a very challenging task like only a few in or out of the government--it is as complex as they come. Failure to adequately identify and mitigate risks increases the likelihood of unsatisfactory performance, including poor system reliability; cost increases; and schedule delays in the development and production phase.

FAA's CURRENT ACQUISITION STRATEGY DOES NOT ADEQUATELY MITIGATE RISKS

FAA's two-phase acquisition strategy differs from that recommended for the acquisition of major systems like the AAS. Rather than using a four-phase process with successive approvals based on demonstrated results and extended competition to minimize risks, as recommended by Office of Management and Budget Circular A-109, FAA incorporates only one decision point before committing to a combined development, test, and production phase. In addition, FAA's strategy incorporates full production of the most costly element--the controller workstation--concurrent with the development of the most complex software and hardware elements.

FAA contends that its acquisition strategy is sound. However, we disagree that the acquisition strategy provides a sufficient basis to make a sound production decision.

FAA's design competition phase will culminate in:

--A complete on-paper system design from both contractors for the Initial Sector Suite System and the full en route and tower AAS systems, including the Aera 1 advanced automation features. Contractors will also show how their designs can be extended to perform Aera 2 and Aera 3 functions.

--A prototype of the controller workstation console, a simulated display of typical air traffic control situations, and a demonstration of how effectively and safely controllers interact with the prototype console.

--Computer model simulations of top-level design issues and the principal functions and operations of the system, with overall system performance model analyses and trade-off analyses.

--Life cycle cost estimates.

We believe system design documentation, trade-off analyses, and computer model simulations are important to select among design alternatives. However, we believe they are inadequate to ensure that a proposed system, when developed and tested, will meet its critical performance and availability requirements.

Because performance models rely on simplifying assumptions about complex and not well understood system interactions, simulations must be validated through testing of actual hardware and software to reliably predict system performance. In the current FAA acquisition strategy, no AAS testing (other than a limited demonstration of the controller workstation console) will be performed and no software will be developed before the production commitment is made. Therefore, neither FAA nor the contractors will validate the contractors' models to ensure that proposed systems will perform as required. An official of the Federal Computer Performance and Simulation Center told us that it is dangerous to rely on unvalidated models to ensure that system performance requirements will be met.

The danger of relying on paper designs, even supported by extensive computer simulations, is illustrated by the Navy's recent experience with its SUBACS program.[3] This program is similar to the AAS in that it uses a distributive architecture to distribute and communicate data. The local communications network's performance capabilities were modeled based on assumptions about the complexity of the network's operating system and the time required for processing. Subsequent communications network tests,

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[3] SUBACS Problems May Adversely Affect Navy Attack Submarine Programs (GAO/NSIAD-86-12, Nov. 4 1985).

however, showed that actual performance was only one-sixth as fast as the model predicted and the system required. The designers had underestimated the complexity of the network's operating system and had assumed the computer program would require far fewer lines of code than were actually needed. This problem had a major cost, schedule, and performance impact on the Navy's plans to improve its submarines' command and control systems. The system has been redesigned at substantial cost. The SUBACS contractor program director told us that performance models should be validated with actual performance tests to use them successfully in an acquisition.

We also believe that FAA's planned demonstration of the controller workstation will not ensure that it will either perform as required or be operationally suitable. The primary demonstration is a contractor-conducted display simulation of a prototype workstation console without its computers, communications equipment, or software. The demonstration will show how the input and output devices will perform, and the screens will show simulated displays of typical air traffic control situations. Accessibility for maintenance purposes will also be demonstrated. However, problem recognition and diagnosis will not be demonstrated. Hardware and software reliability will also not be demonstrated, even though high reliability is critical to meeting FAA's stringent availability requirements. Thus, FAA will not have operationally tested this workstation in a realistic environment before making a production decision; instead it will rely on the design documentation, computer performance model simulations, and the results of a limited demonstration of one subsystem to ensure that requirements will be met.

As a result of our concerns about FAA's reliance on computer performance simulations and the limited demonstration of the prototype workstation, we continue to believe that FAA has not adequately identified and mitigated AAS development risks. This increases the need for an acquisition strategy that minimizes risks. We believe that FAA's strategy of delaying developmental testing until after production commitment is made increases rather than decreases the economic risks.

FAA contends that an independent organization, the FAA Operational Test and Evaluation staff, will assess the operational readiness of the AAS before the production decision, thus reducing the risk the AAS will not meet operational requirements. An official from this organization, however, told us his group will not have enough information to fully evaluate the program since no operational readiness testing will be completed until 18 months after the production contract award. The staff plans to recommend that the production contract be awarded on the condition that they continue their oversight until test results are available. This information is not reflected in FAA's January 1986 response.

FAA also states that additional testing before making the production decision, as recommended by Circular A-109, is not justified. According to FAA, additional testing would add 40 months to their schedule, cost an additional $300 million, and cause the loss of $3.8 billion in FAA and user benefits. We disagree that it would take 40 months to obtain sufficient system performance information and that lost benefits would be as large as FAA claims.

FAA's current development and testing plans call for critical AAS hardware and software elements to be subjected to extensive performance and operational tests about 2 years after the production contract award. Thus, delaying the production contract award until these tests are completed would add about 2 years to the schedule. However, the added time would provide important additional information about AAS system performance and effectiveness. By that time, tests would have shown whether

--controller workstation functional and performance requirements can be met at the maximum expected workload when operating with the Host computer system;

--some portion of the en route AAS input, output, and display processing requirements can be met; and

--some AAS tower requirements can be met.

FAA should have considered these or other intermediate milestones as possible alternatives to its current acquisition strategy. The agency should also have considered revising the AAS program to achieve earlier development and testing of the most critical AAS elements.

We did not attempt to prepare an optimized development and test schedule. However, on the basis of FAA's current plans, it appears that critical en route AAS functions could be developed and tested within 24 to 27 months after the conclusion of the design phase. The extra cost of continuing a second contractor for this period of time would be roughly $200 million, or about seven percent of AAS investment costs. We also noted that FAA had testified last year that implementing a full-scale development program would result in about a 2 year delay. No changes in FAA's test program occurred between the 2 year and 40 month estimates. In addition, unless the second contractor represents a truly viable competitor and its design is a good alternative, the extra cost of continuing a competition may not be a good choice. In this case, FAA could develop and test one system at little or no added cost before awarding a production contract.

I will now discuss our evaluation of the economic soundness of the AAS and show that FAA's claim of $3.8 billion in lost benefits caused by earlier testing is overstated.

AAS BENEFITS MAY NOT EXCEED COSTS

FAA has not completed a separate officially approved benefit/cost analysis or independent cost estimate for the AAS. Currently it is performing such an analysis at the direction of House Joint Resolution 465 on Further Continuing Appropriations for Fiscal Year 1986, and plans to complete it by early 1987. Consequently, we reviewed the most current benefit/cost information available. We evaluated the benefit/cost information provided in FAA's 1982 Response to the Congress[4] and the 1985 unapproved draft MITRE benefit/cost study[5] of the advanced automation program that includes both the Host system and the AAS.[6] Our evaluation indicates quantifiable AAS benefits may not exceed AAS costs.

While our analysis of the draft MITRE study indicates that the quantifiable benefits may be less than AAS costs, we recognize that other unquantified and non-quantifiable benefits, such as increasing safety, eliminating old equipment, and providing better controller working conditions, should also be considered. The

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[4] Response to Congressional Recommendations Regarding the FAA's En Route Air Traffic Control Computer System (DOT/FAA/AAP-82-3, Jan. 1982).

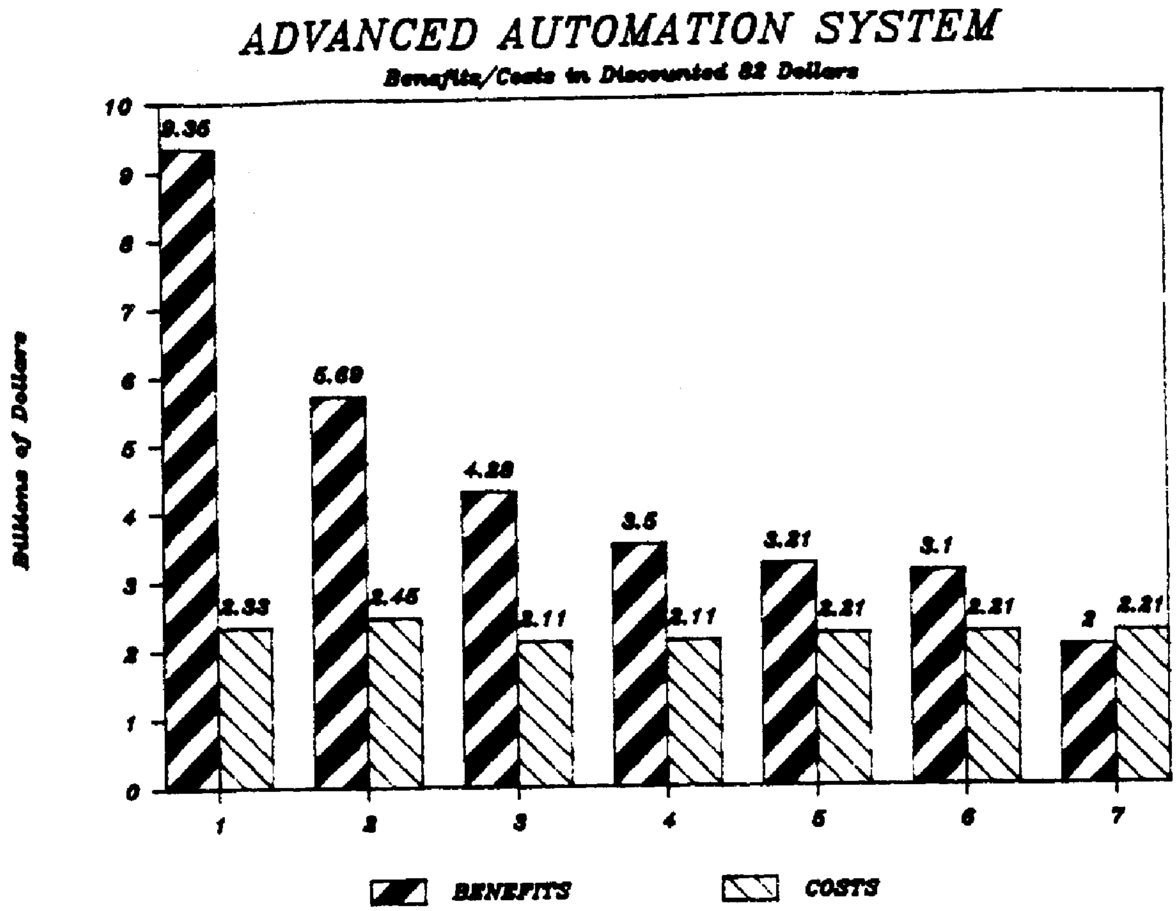
[5] Benefit/Cost Study For The Advanced Automated Air Traffic Control System (DOT/FAA/AAP-84-32, Draft April 1985).

[6] We did not evaluate a third estimate by Martin Marietta because Martin Marietta officials told us the estimate was based on one expert's opinion and needed to be validated by an extensive analysis.

total benefits of Aera's advanced automation features appear to outweigh significantly the modest costs of developing these features.

I would like to direct your attention to the chart, which depicts the two economic analyses we reviewed and the adjustments we made to the MITRE study figures. Columns 1 and 2 compare the benefits and costs estimated in the FAA and MITRE studies, discounted to the same base year of 1982. In its 1982 response to the Congress, FAA justified the Host, AAS, Aera, and Mode S programs, estimating that benefits would be about four times as great as costs. The 1985 MITRE study estimated that quantifiable benefits from these same programs would be about two times as large as costs.

To gain a perspective on currently estimated benefits, let me explain their composition. In the MITRE study, external user benefits, many of which were not quantified in the 1982 response to the Congress, were estimated to constitute about 85% of the total benefits and come from (1) reduced aircraft fuel consumption ($1.2 billion), (2) reduced airline operating costs ($1.4 billion), and (3) airline passenger time savings ($2.2 billion). Internal FAA benefits, primarily from increased controller productivity ($1 billion), account for the remaining 15 percent of the total.



LEGEND

(1) Benefits and costs per FAA's 1982 Response to Congressional Recommendations.

(2) Benefits and costs per unapproved 1985 MITRE benefit/cost study of the Advanced Automation Program. Figures are discounted to 1982 dollars.

(3) Benefits adjusted by GAO to reflect reduction due to savings attributed to Host computer system and En Route Metering II (not attributable to AAS). Costs adjusted by GAO to reflect reduction due to Host computer system costs.

(4) Benefits adjusted by GAO to reflect conformance to supporting study methodology referenced in 1985 MITRE study.

(5) Benefits adjusted by GAO to reflect AAS program implementation change.

(6) Benefits adjusted by GAO to reflect revised OMB fuel price forecast.

(7) Benefits adjusted by GAO to reflect elimination of passenger time savings.

Columns 3 through 7 show the effect of adjustments we applied to the 1985 MITRE study figures. Column 3 shows reduced benefits of $1.4 billion and reduced costs of $340 million to eliminate benefits and costs properly attributable to the Host computer program and related enhancements. We deducted these benefits and costs because they are incurred and achieved independently of the AAS program. Column 4 reduces benefits another $784 million to reflect the actual phasing in of the Aera program benefits, as indicated by the supporting analysis cited in the MITRE study. Column 5 shows another $288 million benefit reduction and a $102 million cost increase due to AAS program slippage and cost growth from increased requirements. Column 6 reduces the benefits by $113 million due to Office of Management and Budget revised long-term oil price forecasts. However, the magnitude of the recent decline in the price of oil is not fully reflected even in the revised forecast. If this recent decline is sustained over a long period of time, benefits would be reduced much more.

At this point, approximately $1.1 billion of the remaining $3.1 billion in benefits is attributable to passenger time savings. To obtain the large total savings, MITRE assumed that no flights would be user-preferred, fuel-efficient routes until Aera 1 was implemented with the AAS. At that time, all flights could be granted user-preferred routes and these routes would yield a time savings of 3 minutes or less on most flights and approximately 6 minutes on a 5 hour cross-country flight. MITRE essentially added up all the few minutes saved by millions of passengers over 17 years and then multiplied that by $20.50 per hour--the assumed average hourly earnings of an airline passenger.

We believe some of the assumptions and the methodology used to develop this estimate are questionable, particularly the assumption that no flights can be granted user-preferred routes until AAS/Aera 1 is implemented. As we will explain shortly, many flights are flying user-preferred routes under the current system. In addition, the amount of time passengers save might be immaterial to an individual passenger who would be saving at most only a few minutes of flight time. The Office of Management and Budget supports the view that such small increments of passenger time savings, less than 15 minutes, are immaterial and should not be used to justify FAA programs such as the AAS. Column 7 shows the impact of eliminating the passenger time savings benefits. As indicated, the remaining $2 billion of quantifiable AAS benefits no longer exceed costs.

The remaining $2 billion in benefits may fall farther due to the lower price of fuel and several questionable assumptions. For example, the MITRE study assumed that no user-preferred direct routes would be granted until Aera 1 was implemented, and then it assumed that all requests would be granted. User-preferred direct routes not only affect passenger time, as noted earlier, but also operating costs and fuel savings. Although FAA does not keep records of direct routes granted, we found that a significant number is now granted and that FAA is working to increase that number. Further, we found that most preferred altitude requests are granted now. Also, uncertainties about Aera and controller workstation productivity estimates could further reduce benefits.

FAA's air traffic growth forecasts have also historically overstated actual traffic growth. The MITRE study projected continuing high growth rates beyond FAA's forecast period. This could further inflate future air traffic estimates. Air traffic growth affects all categories of benefits, and to the extent air traffic growth is lower than predicted, benefits would also be lower. Finally, significant uncertainty also exists about the AAS cost growth; the program has already encountered significant cost growth (at least 50% in the design competition phase), and, as we pointed out earlier, FAA's acquisition strategy increases the risk of further cost growth.

SUMMARY

Under the best of circumstances, the technical and operational risks associated with developing the AAS are high. The software and other key AAS components are extremely complex and some of the technology required is pushing the state of the art. Combined with these are the technical and operational challenges associated with the dramatic change in the way air traffic will be controlled, which serve to increase these risks. Interdependency of systems critical to the AAS (Host computer, Mode S, and Voice Switching and Control System) increase AAS risks. The economic risk of a $3.2 billion investment in AAS will make any major development problems encountered economically significant.

FAA's two-phase acquisition strategy differs from that recommended for the acquisition of major systems like the AAS. Rather than minimizing risks using a four-phase process with successive approvals based on demonstrated results and extended competition, FAA incorporates only one decision point before committing to a combined development, test, and production phase. This combined phase incorporates full production of the most costly element, the controller workstation, concurrent with the development of the most complex software and hardware elements. FAA will have only system designs, limited workstation console demonstrations, and unvalidated performance simulations on which to base its production decision, because actual development will not have taken place and performance tests are thus not possible. With the technical risks and the economic stakes involved, we believe this represents an unacceptably high risk to the government.

Further, FAA's current benefit estimates for the AAS are questionable and an independent cost estimate has not been prepared. Based on our analysis, the resulting low benefit to cost ratio clearly does not justify an accelerated acquisition strategy--that is, one that requires production of the controller workstations concurrent with the development and testing of all other complex components in order to install them early. We are not arguing against introducing the new workstation before the full AAS is implemented, only against rushing into full production of the workstation before the rest of the system has been developed, tested, and its performance proven.

We continue to believe that follow-on air traffic control automation is needed to address system needs, potential improvements, and deficiencies not corrected by the near-term Host computer system program. However, the capacity and capabilities provided by the Host computer systems should provide the time needed to properly develop the AAS. We believe that incorporating a development and testing phase before the AAS production decision would be a more prudent acquisition strategy.

Introducing another phase into the acquisition strategy, thus permitting operational performance testing of critical elements (including the controller workstation and en route AAS hardware, software, and communications technology) would improve both the basis for the production decision and the final design for full-scale production. Reduced concurrency of production of the controller workstations with the development of software and other complex components would serve to minimize both technical and economic risks. We believe that a development and operational testing phase, without concurrent production, needs to be incorporated into the FAA's acquisition strategy to reduce risks. We estimate that FAA's current development and test schedule would provide significant system performance information to make a more prudent production decision about 2 years later than their currently scheduled decision point. Thus, it would not require the 40 months time claimed by FAA. In addition, optimizing the schedule to develop and test critical elements early could provide even more information in that timeframe. We believe that continuing with the current strategy, especially without the operational testing of Aera functions, could result in significant performance and reliability inadequacies, cost increases, and unrealized benefits.

House Joint Resolution 465 on Further Continuing Appropriations for Fiscal Year 1986 directed FAA to complete a realistic benefit/cost analysis. This analysis, supplemented by operational simulation and testing of the new Aera functions, should be very valuable to the Congress prior to making its major funding commitment.

PROPOSED COURSE OF ACTION

We plan to do additional work on the AAS program and related systems. However, based on our work to date, we believe changes are needed in FAA's program in order to minimize the risks of the AAS acquisition and to ensure that the AAS effectively meets the future safety and efficiency needs of the nation's air transportation system. Therefore, we believe the Congress should consider directing FAA to:

(1) revise its current acquisition strategy to incorporate a contract phase to develop and operationally test prototype models of critical components under realistic conditions before the decision and contract are made for full production quantities. At a minimum, critical components should include the controller workstation, en route AAS hardware and software, and the local communications network;

(2) reexamine the AAS features and requirements to identify the most inexpensive and cost-effective alternatives and to revalidate its requirements before proceeding to the development and testing phase; and

(3) verify the benefit estimates and the operational suitability of Aera 1 and 2 functional enhancements by operational

simulation as soon as is practicable and before proceeding with the full-scale production.

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This concludes my testimony, Mr. Chairman. I will be pleased to answer any questions that you or others may have at this time.

OVERALL OBJECTIVES AND SCOPE OF GAO'S WORK ON FAA AIR TRAFFIC CONTROL COMPUTER MODERNIZATION PROGRAMS

In June 1983 the Chairman, Subcommittee on Transportation, House Committee on Appropriations, asked GAO to monitor FAA's implementation and management of the $12 billion National Airspace System Plan. Two GAO divisions--the Resources, Community, and Economic Development Division (RCED) and the Information Management and Technology Division (IMTEC)--are conducting this review.

The Chairman asked IMTEC to focus on the automated air traffic control programs. In June 1985, we reported[1] on FAA's short-term Host computer system and recommended that the Secretary of Transportation consider deferring the production decision and performing more realistic performance tests. In another report,[2] we expressed concern about FAA's Advanced Automation System (AAS). The House Appropriations Committee directed FAA to respond to both reports. The Transportation Secretary reviewed our Host computer concerns and determined that risks from not conducting performance testing were not sufficient to warrant delaying the Host program. A January 1986 letter to the Chairman responded to our AAS concerns stating that the AAS acquisition strategy is sound and will not be changed.

In October 1985, the Subcommittee requested us to provide our observations on the soundness of FAA's AAS investment decision from a technical, economic, and managerial perspective, including the soundness of the agency's benefit/cost analysis. The Subcommittee later asked that we also assess FAA's January 1986 response to the Chairman.

To respond to the Subcommittee's request that we review the AAS benefits and costs, we analyzed the most current benefit/cost information available. We evaluated FAA's 1982 Response to the

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

[2] 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).

Congress and the 1985 unapproved draft MITRE benefit/cost analysis of the advanced automation program. Our work in the benefit/cost area primarily focused on the appropriateness and support behind claimed AAS benefits. Because AAS cost estimates were being revised by FAA, we did not attempt to validate the cost estimates used in FAA's benefit/cost analyses.

To respond to the Subcommittee's question on the technical, economic and managerial soundness of the AAS, we conducted our work primarily at Department of Transportation and FAA Headquarters in Washington, D.C., and at FAA's Technical Center in Pomona, New Jersey. We also worked at the MITRE Corporation in McLean, Virginia; Computer Technology Associates, McLean, Virginia; RCA, Moorestown, New Jersey; and Martin Marietta Corporation, Washington, D.C. We reviewed FAA, contractor, and subcontractor documents on the planning, management, and design of the AAS. We reviewed literature related to the use of performance models and discussed the use of models with an official of the Federal Computer Performance and Simulation Center. We also interviewed Transportation, FAA, and contractor officials.