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Federal Aviation Administration's
Advanced Automation System Investment

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Before the Subcommittee on Transportation,
Committee on Appropriations,
United States Senate



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Mr. Chairman and Members of the Subcommittee:

We are pleased to be here today to discuss the Federal Aviation Administration's (FAA) plans to modernize the air traffic control computer system by acquiring the Advanced Automation System (AAS). This Committee asked us to evaluate FAA actions in response to Committee direction to obtain more technical information and modify test plans before awarding the AAS contract. Our evaluation shows that FAA appears to have generally complied with this direction. The results of this evaluation are included in an attachment to my testimony.

As requested, I will also address the results of a benefit/cost study FAA performed in response to direction from the Conference Committee on FAA's Fiscal Year 1986 Appropriation. The Conference Committee asked FAA--before awarding the multi-billion dollar AAS contract--to demonstrate that 1) AAS is a prudent investment, and 2) the selected alternative is the most cost-beneficial way to achieve FAA's objectives. We agree that modernization of this nation's air traffic control system is important and should be a priority. However, it is not clear to us that FAA's benefit/cost study reasonably analyzed or properly compared plausible alternatives to its preferred approach. Thus, FAA may not have defined the most cost-beneficial investment.

My testimony is based on our review of the ongoing AAS program. Because the review is still in process, our observations are preliminary. Further, the benefit/cost study, prepared by MITRE Corporation under FAA direction, was just completed and the draft has not been approved by the Department of Transportation. This draft study was made available to us in late February 1988.

AAS is being acquired to increase controller productivity, reduce FAA's operating costs, save fuel and passenger time, and allow FAA controllers to handle anticipated air traffic increases more safely and efficiently. AAS will replace FAA's aging air traffic control computer systems with new hardware, software, and controller workstations. Improvements are expected to result primarily from the use of modern equipment and development of new software functions--called AERA--intended to automate some controller functions and allow more aircraft to fly user-preferred, fuel-efficient routes.

The draft study states that modernizing the air traffic control computer system is a good investment and our limited analysis has not disclosed anything that would cause us to disagree with this conclusion. However, FAA's analysis does not document that it has defined the most cost-beneficial system. FAA concluded that the most cost-beneficial approach was to close about 180 terminal control facilities--which control aircraft around airports--and provide their functions at 23 large centers that

would control traffic both around airports and at higher altitudes. In contrast to the Conference Committee direction, we found no evidence that FAA fully analyzed or properly compared a range of alternatives for AAS program elements. For example, the study failed to properly compare alternatives that consolidate terminal control facilities with alternatives that do not consolidate these facilities.

Regarding the facility closures, FAA plans to close terminal control facilities beginning in 1995. Examples of consolidation include closing the terminals now at Albany, Binghamton, Buffalo, Elmira, Rochester, Rome, and Syracuse, New York and transferring their functions to Nashua, New Hampshire. Similarly, the terminal control facilities at Gulfport, Jackson, and Meridian, Mississippi will be closed and their functions moved to Memphis, Tennessee.

According to the draft study, the driving force behind FAA's consolidation plans is the economies of scale that can be achieved. These economies of scale would include reducing the number of personnel and backup equipment since there would be fewer facilities. The draft study also discusses several disadvantages, including (1) increased vulnerability to the loss of air traffic control services in the event of fire, earthquakes, or other catastrophies, (2) problems associated with personnel relocations, and (3) the need for additional controllers during transitions from the old to the new facilities. Another

disadvantage, cited in a related study, is the likelihood of local opposition to the adverse economic impact often associated with closing major federal facilities.

FAA did not directly compare non-consolidated terminal control alternatives to consolidated terminal control alternatives with similar capabilities. Using data from the study, we were able to estimate the impact a non-consolidation alternative would have on terminal control area costs and benefits. The alternative we evaluated replaces terminal equipment with modern computers and new workstations. It does not include electronically displayed flight plan information--relying instead on the current practice of using paper flight strips. (FAA's study did not contain information that would allow us to estimate the costs and benefits of a system that includes electronically displayed flight information.)

The results showed that under this terminal control alternative, costs could be reduced by over \$750 million while giving up benefits of approximately \$200 million. This alternative also appears to alleviate the disadvantages of consolidation, but a complete analysis would need to address other operational considerations. Therefore, although we do not necessarily advocate this alternative, we believe this analysis illustrates that a proper comparison requires that terminal alternatives be independently evaluated.

Further, our preliminary analysis of the draft study disclosed that it used (1) an unsound methodology to estimate AAS benefits, and (2) a sampling plan to measure the inefficiency of the present system that may overstate the benefits. On the other hand, FAA's study is based on an Office of Management and Budget approved discount rate that differs from the one preferred by GAO. The rate used by FAA tends to substantially understate net benefits. Despite these concerns, we have no reason to believe that the AAS project is not a good investment. In addition, while FAA did not quantify safety improvements, it recognized that such improvements would come from modernizing the system. Further discussion regarding these concerns is contained in the attachment to my testimony.

I would also like to discuss briefly FAA's use of passenger time savings as the largest expected AAS benefit. The study reports that FAA's full-consolidation alternative has costs of \$3.8 billion, benefits of \$7.3 billion, and yields \$3.5 billion in net benefits.¹ We estimate that \$4.2 billion of the expected \$7.3 billion in benefits is made up of time saved by passengers due to more efficient flights. For example, if a flight carrying 300

¹The numerical results used here from the benefit/cost study are risk-adjusted numbers. This follows the Conference Committee's direction to FAA to assess technical risk associated with acquiring the AAS. Incorporating these risk assessments reduces the expected benefits and increases expected costs. The study points out that these expected results should be used by decisionmakers.

passengers saved five minutes due to AAS, the savings would be 1500 minutes or 25 hours. FAA valued a passenger hour as worth \$25. Totalled over the millions of flights controlled by FAA during the lifetime of AAS, the savings are in the billions. Further analysis shows that 71 percent of the \$4.2 billion in passenger time savings is in increments of less than 15 minutes. Both GAO and the Office of Management and Budget have questioned the value placed on small passenger time savings. We further question whether savings of a few minutes for many passengers should be the major factor in justifying a multi-billion dollar program.

I would also like to point out that an independent cost estimate, which was also required by the Conference Committee, concluded that AAS costs could total \$5 billion or about \$1.6 billion higher than the program office's December 7, 1987, estimate of \$3.4 billion. The Analytical Sciences Corporation prepared this estimate, and its report recommends that FAA adopt this higher estimate for planning and budgeting purposes because it reflects a more realistic assessment of the complexity and challenges of the AAS program. FAA, however, disagrees with the independent cost estimate and has decided not to adopt it.

We believe FAA needs to fully analyze other terminal control facility alternatives, including some that require little or no facility consolidation. The contract FAA plans to award in July

1988 will not provide the flexibility necessary to acquire the number and types of equipment needed to implement a non-consolidation alternative. We also believe it is important that FAA not lock itself into an approach that precludes non-consolidation. Therefore, FAA should (1) not award the contract until it has identified the number and types of equipment needed for a non-consolidation approach, and (2) amend the request for proposals to permit acquisition of this equipment in the event a non-consolidation alternative is selected. FAA officials told us they believe such an amendment could be initiated and negotiated without delaying the contract award and have begun looking into making the needed changes.

Finally, if FAA still chooses to consolidate facilities, we believe that, in light of the potential impact of facility closings on local economies, FAA should consult with key congressional committees and local officials before proceeding.

Mr. Chairman, this concludes my prepared remarks. Additional information is included in the attachment to my testimony. I will be pleased to answer any questions you or other members of the Committee may have concerning my testimony.

ATTACHMENT I

BACKGROUND

FAA's air traffic control mission is to promote the safe, orderly, and expeditious flow of both civilian and military aircraft. Air traffic controllers maintain the necessary separation between controlled aircraft utilizing information processed by computers and displayed on video screens at controllers' workstations. Displayed information includes aircraft identity, location, altitude, speed, and direction. Additional flight information such as the route, destination, and expected arrival time is provided on paper "flight strips."

FAA uses three types of facilities to control aircraft--tower, terminal, and enroute. About 400 Airport Air Traffic Control Towers provide visual control for aircraft on the ground and prior to take-off and landing. The 188 Terminal Radar Approach Control facilities sequence and separate aircraft arriving at or departing from airports under their control. Some of these facilities control traffic for more than one airport. Air Route Traffic Control Centers control aircraft which are enroute between airports. Twenty of these centers are in the continental United States.

AAS is intended to allow the air traffic system to safely and efficiently accommodate expected large increases in traffic. FAA

believes AAS will provide benefits to FAA and users by increasing controller productivity, saving fuel and passenger time, and reducing operating costs. AAS is planned to replace outdated computer hardware, software, and controller workstations at enroute, terminal, and tower facilities. These improvements are expected to result primarily from the use of modern equipment and development of advanced software to automate some controller functions and allow more aircraft to fly user-preferred, fuel-efficient routes. These functions--called AERA--will use sophisticated software to predict the future position of aircraft in enroute airspace, check for potential conflicts, and provide controllers with alternatives to resolve predicted conflicts.

FAA concluded the most cost-beneficial approach was to close about 180 terminal control facilities and perform their functions at 23 large centers, which will be called Area Control Facilities. FAA plans to consolidate about 30 terminal facilities beginning in 1995, and the remaining facilities beginning in 1998. Examples of consolidation include closing the terminals now at Albany, Binghamton, Buffalo, Elmira, Rochester, Rome, and Syracuse, New York and transferring their functions to Nashua, New Hampshire. Similarly, the terminals at Gulfport, Jackson, and Meridian, Mississippi will be closed and their functions moved to Memphis, Tennessee.

Two contractors--International Business Machines Corporation and Hughes Aircraft Company--are competing to win a contract to develop, produce, and install AAS. FAA plans to award this contract in July 1988 and implement the system over a 12-year period. Total undiscounted program costs are expected to be \$5 billion.

FAA'S CONSOLIDATION PLANS

In December 1985, the Conference Committee on FAA's Fiscal Year 1986 Appropriations directed FAA to provide Congress with an independent benefit/cost study before requesting acquisition phase funds. We evaluated the draft study the MITRE Corporation prepared under FAA direction. Our preliminary results indicate that, although AAS appears to be a sound investment, FAA may not have defined the most cost-beneficial system configuration.

To ensure that FAA defines the most cost-beneficial system, the Committee directed FAA to evaluate a full range of alternatives for each element of the AAS program. Instead, FAA evaluated and compared alternatives as total system investments. This approach provides information to determine whether a system is a good investment, but does not ensure the most cost-beneficial system is chosen. To illustrate, FAA expects to achieve significant economic benefits by consolidating terminal control facilities into large centers. However, FAA did not fully analyze

or properly compare a range of alternative terminal control facility configurations, capabilities, and locations to verify this assumption.

Alternatives Considered

The draft study compares total costs, benefits, and other factors for alternative investments. The study points out that the alternatives were defined to be technically feasible solutions to modernize and upgrade the air traffic control system. The alternatives were developed by varying the functional capabilities provided, the degree of terminal control facility consolidation, and the development strategy. Although the report includes seven alternatives, only four were fully analyzed.

Two of these four alternatives involved consolidating terminal control facilities. FAA's currently-planned full-consolidation of about 180 terminal control facilities into 23 centers showed the highest return on investment. It was estimated to cost \$3.8 billion, provide \$7.3 billion in total benefits, and yield \$3.5 billion in net benefits. The draft study also points out that consolidation adds large costs for such things as building expansions, communication links, and new radar. The other consolidation alternative was developed to alleviate some of the disadvantages of full consolidation, which are discussed later. This alternative would still consolidate most terminal control

facilities at 22 centers, but would consolidate large terminal control facilities at 19 other locations. Thus, the terminal control facilities would be consolidated into 41 centers. This less concentrated consolidation alternative was estimated to cost \$4.3 billion, provide \$7.3 billion in total benefits, and yield \$3.0 billion in net benefits. This alternative costs more primarily because additional building, power systems, and communication link costs are required to consolidate at additional locations.

The two other alternatives did not consolidate any terminal facilities. The first of the two alternatives simply replaced existing equipment with modern equipment without providing any enhanced capability. It was estimated to have a net benefit of \$140 million. The second alternative replaced the equipment and provided some enhanced capabilities. It had an estimated net benefit of \$760 million. These alternatives did not yield large benefits because they do not include AERA functions. Since the majority of AAS benefits come from AERA, the exclusion of AERA benefits caused these two alternatives to have substantially lower net benefits. Also, since AERA benefits accrue to aircraft at higher altitudes, they are not directly affected by whether or not terminals are consolidated. We are concerned that the study does not allow a proper comparison of the benefits and costs between consolidated and non-consolidated terminal control solutions. This is because the study only compared total benefits and total costs

for each alternative. No alternative was considered that included AERA benefits without consolidation.

To estimate what impact non-consolidation would have on costs and benefits in the terminal area only, we looked specifically at the non-consolidation alternative that provides enhanced terminal capabilities. This alternative replaces terminal equipment with modern computers and new workstations. It does not include electronically displayed flight plan information--relying instead on the current practice of using paper flight strips. We found that using conservative assumptions, total costs could be reduced by over \$750 million, while giving up benefits of approximately \$200 million compared to FAA's preferred consolidation alternative. Although we are not advocating any specific alternative, we believe this analysis illustrates that a proper comparison requires that terminal control alternatives be evaluated separately from other program elements. Thus, we believe FAA needs to evaluate and properly compare this and other terminal control alternatives before deciding how to modernize terminal facilities.

Both FAA and contractor officials stated that the AAS architecture is sufficiently flexible to allow a range of terminal control system configurations without affecting the large AERA benefits. For example, FAA officials pointed out that tower systems are being deployed to 258 airport towers, and that these systems could be enhanced to provide the computer processing

functions for many existing terminal control facilities. In fact, the Department of Defense is considering using an enhanced AAS airport tower configuration to modernize its terminal control facilities. Also, where an operational need for consolidating large terminal control facilities exists--such as the Los Angeles basin, Dallas/Fort Worth, and Chicago--the AAS design also includes systems to meet those requirements.

Disadvantages of Consolidation

According to the draft benefit/cost study, FAA's consolidation plans also involve disadvantages, including 1) vulnerability to catastrophic failures, 2) controller relocations and expected attrition, and 3) the need for two sets of controllers during transitions. The reported concerns are highlighted below.

Consolidation increases vulnerability to a catastrophic failure. If an Area Control Facility suffers a total failure, both enroute and terminal control services would be interrupted in the affected airspace. Since these services are now provided at separate locations, a single facility failure does not interrupt all air traffic services. To prevent a single failure from interrupting all services, FAA plans to have Area Control Facilities backup each other if a facility fails. The study, however, questions the operational suitability and effectiveness of

these backup plans because staff at the backup facility would be unfamiliar with the airspace and may be unable to accommodate the sudden increase in controlled aircraft.

Consolidating terminals also requires many controllers to move, entailing large moving costs, possible attrition, and other hardships on the people and communities affected by relocation. The draft study estimates that FAA's plan to move controllers will cost about \$52 million. Another MITRE study estimates that about 15 percent of controllers told to relocate could resign or retire early. Replacing them would require training new controllers for up to several years to become fully qualified. These training costs, however, were not included in the benefit/cost study.

Finally, consolidation requires additional controllers during transition to the new facility. Controllers are needed at both the old and new facilities for up to 3 months until the new system is fully operational. After this time the additional controllers would no longer be required. The draft study, however, did not include costs to hire or train these controllers.

In addition, a separate contractor study concluded that the impact of facility closures and likely opposition to closures may be a major factor in the ultimate decision about consolidation. This study points out that the average terminal control facility employs 35 people, and that larger facilities employ over 70

people. Closing these facilities could adversely affect the economy of the communities where they are now located. The study also notes that the community receiving the terminal functions would benefit. The study points out that communities faced with the loss of a terminal control facility would use whatever influence was available to them to oppose the closure.

FAA'S BENEFIT/COST STUDY

Our preliminary analysis of the draft study disclosed that (1) the survey of flights used to estimate AAS benefits was methodologically unsound, and (2) the sample of flights chosen to measure the inefficiency of the present system may overstate the benefits.

AAS benefits depend largely on the degree to which existing and anticipated inefficiencies in the air traffic control system are reduced. New technologies are expected to reduce inefficiencies that currently force pilots to fly less than optimal altitudes, speeds, and routes. A separate contractor collected information which was then used to measure current system inefficiencies to project the benefits that would flow from system improvements. We found many weaknesses in the data collection instrument, data collector training, and other factors, which raise questions about the validity of the information collected. For example, data were collected only during regular business hours

even though the air traffic control system is a 24-hour operation. No determination was made to ensure that limiting collection time in this way did not bias the results.

The method used to analyze the survey data was also biased and thus overstates the current system's inefficiency and may overstate the benefits AAS can provide. This occurred because the data collected included all categories of short fuel-inefficient flights, but did not include data for several major categories of longer, more fuel-efficient flights. The contractor then projected the results from the sampled flights to all flights, thereby overstating the amount of inefficiency in the system. The amount of resulting error cannot be calculated from the data collected.

Although the benefit cost analysis uses a discount rate of 10 percent--recommended by the Office of Management and Budget for cost/benefit analyses--GAO prefers a rate that includes the cost for money based on the cost to the government in the year of the funding. Using the rate preferred by GAO would substantially increase benefits.

As the draft study points out, the largest benefit of the AAS is the amount of time saved by passengers due to the more efficient flights the system makes possible. For example, if a flight carrying 300 passengers saved five minutes due to the AAS, the saving would be 1500 minutes or 25 hours. Valued at \$25 an

hour, the saving would be \$625 for the flight. Totalled over the millions of flights controlled by the AAS over its life, the savings are in the billions. Both GAO and the Office of Management and Budget have questioned the value placed on small passenger time savings. Basically, we question whether savings of a few minutes for many passengers should be the major factor in justifying a multi-billion dollar program. In fact, 71 percent of all passenger time savings is in increments of less than 15 minutes.

TECHNICAL INFORMATION AND TEST PLANS

Responding to Committee direction contained in a March 16, 1987, letter, FAA 1) directed the AAS contractors to perform risk reduction activities, including demonstrating that their chosen hardware and software technologies will meet AAS performance requirements, 2) added tests before authorizing full controller workstation production, and 3) reviewed the need to simulate AERA functions and decided not to simulate them before awarding the contract.

Risk reduction activities included demonstrating that such things as communications network components, software development procedures, the controller workstation, and methods to detect and recover from hardware or software failures will meet AAS requirements. To illustrate, FAA required the contractors to show

that models of local communications network components could meet FAA's required response time under the maximum predicted work load. For software, the contractors were required to develop a high level design for the workstations using the Ada programming language. FAA checked each design to ensure that consistent definitions and procedures were applied. FAA will also verify that the contractors adhere to acceptable software procedures in developing other software units.

These risk mitigation activities generally corresponded to Committee direction, and FAA believes the results provide increased confidence that the designs can be implemented. FAA will also perform a qualitative assessment of these risk reduction tasks and will summarize the remaining technical and schedule risks associated with each contractor's design. This information will be considered when FAA selects the winning contractor. Further responding to Committee direction, FAA plans to continue risk reduction activities after contract award by requiring the contractor to submit a complete risk management plan. This plan will identify risks, develop risk reduction alternatives, and continue demonstrating that hardware and software will meet performance requirements.

FAA also modified its AAS test plans to include limited workstation tests with a partial configuration of AAS Terminal Advanced Automation System hardware and software before

authorizing full workstation production. FAA recently amended the AAS request for proposals to include controls to ensure that full workstation production is not authorized until the contractor has successfully completed required tests. According to FAA, however, the final operational test requirements documentation is not yet complete. Therefore, we were unable to fully evaluate the adequacy of FAA's test plans.

The Committee was also concerned that the effectiveness of AERA software functions has not been shown. FAA reviewed the possibility of simulating the functions before contract award to demonstrate AERA's operational suitability and benefits. FAA concluded it is not necessary or desirable to delay the AAS contract award to validate AERA suitability and benefits. FAA believes the first set of AERA functions--called AERA 1--does not involve significant risks and is sufficiently mature to proceed without requiring simulations. FAA recognizes that the second set of functions--called AERA 2--involves both technical and operational risks. Therefore, FAA plans to simulate AERA 2 functions after contract award but before giving the requirements to the contractor. FAA also points out that AAS does not depend on AERA for basic air traffic control functions and that AAS is needed to replace an obsolete system.