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AVIATION RESEARCH

Perspectives on FAA's Efforts to Develop New Technology

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Chairwoman Morella and Members of the Subcommittee:

We appreciate the opportunity today to discuss the Federal Aviation Administration's (FAA) research, development, and modernization initiatives. FAA conducts a wide range of research to ensure the safety, security, and efficiency of the U.S. aviation system.

Over the last few years, we have issued several reports and testified before the Congress on various aspects of FAA's research and development activities and the agency's efforts to modernize the air traffic control system.[1] Our testimony today is drawn largely from this body of work and work that this Subcommittee specifically requested on FAA's recent reorganization of the Research, Engineering, and Development (RE&D) and Acquisition programs, particularly FAA's new integrated product teams. We will provide observations on (1) trends in the nature and scope of the research activities in the RE&D program; (2) other sources of research funds that benefit FAA's efforts to develop new technology; (3) FAA's problems and progress in developing new technology and (4) FAA's recent reorganization of RE&D and Acquisition programs.

We would like to summarize our observations and then turn to a more detailed discussion of them.

-- FAA's RE&D budget has grown steadily from $150 million in fiscal year 1988 to $259 million in fiscal year 1995. In response to the 1988 Aviation Safety Research Act, FAA has increased the share of the RE&D budget devoted to human factors, simulation modeling of the air traffic control system, aircraft structures, and fire safety and decreased the share devoted to other research efforts, such as weather. It has also increased spending of RE&D funds on aviation security research and satellite navigation for air traffic control.

-- FAA's RE&D account is only one source of research and development funds that significantly benefits FAA. In addition to $259 million in fiscal year 1995 RE&D funds, FAA has allocated $545 million in its Facilities and Equipment (F&E) account for Engineering, Development, Test and Evaluation. FAA also benefits from research conducted by other federal agencies, such as the National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD). At these two agencies, we identified over $645 million in research that benefits FAA.

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[1]Related GAO products appear at the end of this testimony.

-- Research at FAA provides the basis for acquiring a variety of new air traffic control and safety technologies. Both the RE&D and F&E programs have played an integral part in the modernization effort, and some projects are now deployed at airports. However, in developing and deploying these new technologies, there have been numerous problems that have resulted in cost increases and lengthy delays. A number of these problems, such as inadequate definition of projects, a lack of awareness of the technical complexity and maturity of technologies, and a lack of end-users' involvement, are traceable to weaknesses in FAA's research and development efforts.

-- FAA has embarked on a new management approach that is intended to more closely integrate the information developed in the RE&D program with acquisition functions and end-users such as controllers. For the first time, FAA's RE&D and Acquisition programs are under one office, and the agency has formed integrated product development teams. FAA believes this management initiative will address major problems with its modernization program, such as underestimating the difficulties in developing and acquiring new technologies; however, it is too early to tell if these initiatives will be successful. FAA does not plan to establish integrated product teams for aircraft safety or security efforts, which make up one-third of the RE&D budget.

BACKGROUND

The objective of FAA's RE&D program is to develop and validate the technology and knowledge required to ensure the safety, efficiency, and security of the national airspace system. FAA depends on other organizations, such as NASA and DOD, to provide basic research, while it focuses on applications. The RE&D program's focus in upgrading the national airspace system includes the development and application of high technology for automated systems, more reliable and enhanced communications, and better navigation systems. The Congress directed FAA in the Aviation Safety Research Act of 1988 to expand research and development efforts on safety and simulations of the air traffic control system.

The largest application of research and development at FAA is the modernization of the air traffic control system, which is funded from the F&E account.[2] Many of the modernization projects,

[2]In 1981, FAA launched a 10-year program to modernize the U.S. air traffic control system. The program consisted of 80 projects, funded through the F&E account, for developing and installing new equipment and systems--including radars, computers, and

such as the Advanced Automation System (AAS), have received funding under the RE&D program or have transitioned from the RE&D program into the modernization program. Most of the research for the modernization effort has been funded through the larger F&E account.

SCOPE AND NATURE OF RE&D BUDGET IS SHAPED BY THE AVIATION SAFETY RESEARCH ACT AND ACCIDENTS

FAA's RE&D budget has grown steadily from fiscal year 1988 to fiscal year 1995 (from $150 million to $259 million). At the direction of this Subcommittee, FAA has shifted resources to research areas mandated by the Aviation Safety Research Act of 1988: human factors, simulation modeling, aircraft structures, and fire safety. Figure 1 shows that these four categories have grown from accounting for about 8 percent of the RE&D budget in fiscal 1988 to accounting for almost 30 percent of the RE&D budget in fiscal year 1995.

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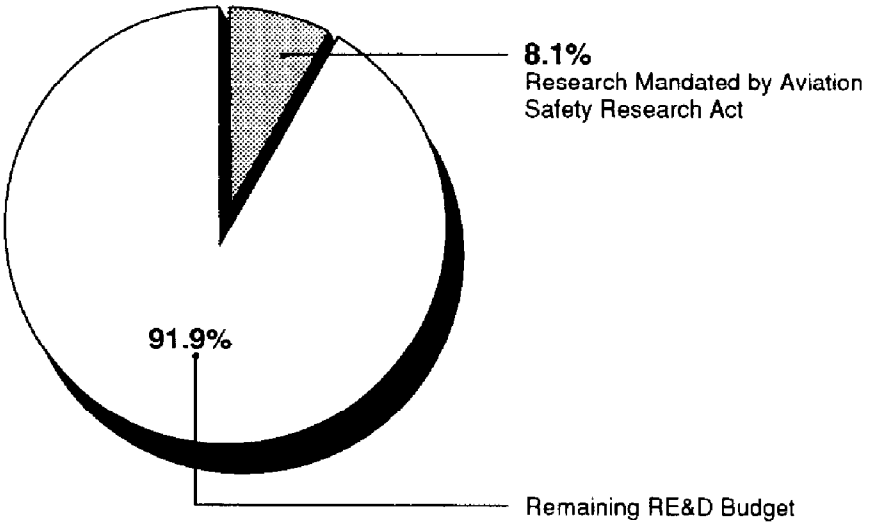
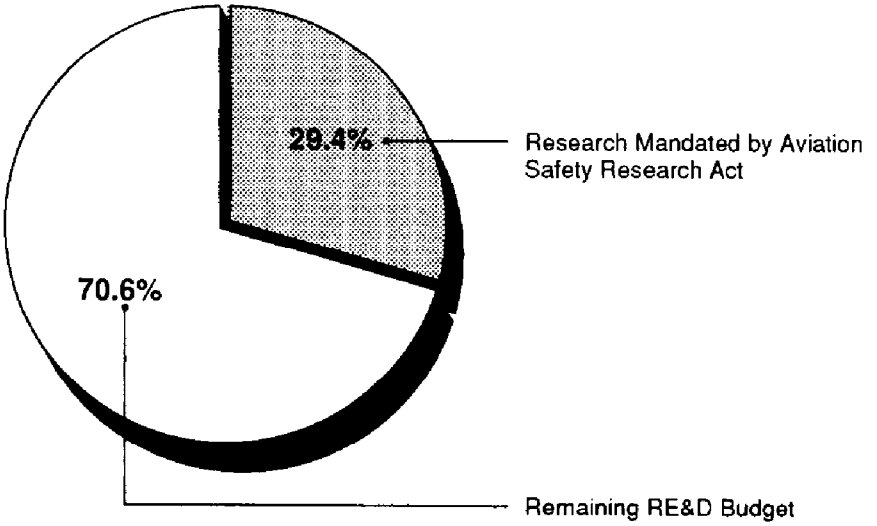
communications networks--to enhance the safety and efficiency of air travel and the productivity of FAA's work force. In 1990, the modernization program was redefined and expanded as the Capital Investment Plan (CIP). Currently, the CIP has 158 active projects estimated to cost $37.3 billion from 1982 through 2003. To date, FAA has completed 64 projects totaling $3.8 billion.

Figure 1: Comparison of Research Mandated by the Aviation Safety Research Act in Fiscal Years 1988 and 1995

1988



1995



In response to terrorism incidents such as the Pan Am 103 tragedy, FAA is spending more in its RE&D account on aircraft security research. Specifically, from fiscal year 1988 to fiscal year 1995, the budget share for security research grew from about 6 percent to 14 percent. In the same period, funding in the RE&D account for weather and communications, navigation, and surveillance declined in both dollars and budget share. However, some key research projects in these accounts, such as enhancing the Global Positioning System for satellite navigation, received additional funding.

CONSIDERABLE RESEARCH IS OUTSIDE OF THE RE&D PROGRAM

In addition to FAA's fiscal year 1995 RE&D budget of $259 million, over 1 billion dollars' worth of aviation research and development is conducted at FAA and other federal agencies.

First, FAA has historically conducted substantial research and development through its F&E account, but it did not delineate how much it was allocating for research activities in this account until 1993.[1] In fiscal year 1995, FAA allocated about $545 million for these activities. They include developmental work on the Voice Switching and Control System (VSCS) and the terminal and tower automation programs, which are key efforts in FAA's modernization program. FAA also funds most of its weather research from the F&E account.

Second, NASA budgeted about $1 billion for aeronautics research for fiscal year 1995, of which about $400 million is directly related to FAA's mission. For example, NASA has projects under way on air traffic control automation and on aging aircraft. Within the $400 million, NASA contributes about $30 million per year to specific joint projects with FAA on human factors and aircraft safety.

Third, FAA is benefiting from DOD's Technology Reinvestment Project (TRP). This effort, sponsored by DOD's Advanced Special Projects Agency, focuses on developing technology that has both military and commercial uses. FAA has access to research from joint government-industry projects on the detection of ice on wings and enhanced vision landing systems for aircraft. FAA estimates that over $155 million in TRP projects are under way that can or will benefit civil aviation. FAA is directly managing a $16

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[1] Aviation Acquisition: Further Changes Needed in FAA's Management and Budgeting Practices (GAO/RCED-91-159, July 29, 1991).

million TRP initiative to develop low-cost radar components to help track aircraft and weather that is co-funded by DOD and Martin Marietta. DOD also contributes about $90 million annually to FAA's research program in human factors.

ACQUISITION PROBLEMS OFTEN RELATED TO RESEARCH AND DEVELOPMENT PROBLEMS

Our work over the past several years shows that FAA has experienced significant and costly problems in moving from research to the application of technology. Some of these problems are the result of inadequate attention to issues, such as the definition of projects, technological complexity, and end-user involvement, during the research and development phase. Three projects--the Mode Select radar, the Advanced Automation System (AAS), and development of explosive detection equipment--illustrate the difficulties that FAA has experienced in developing and deploying new technology.

Consideration of Project's Purpose and Alternatives Has Been Insufficient to Ensure That Best Product Is Procured

In order to make good investment decisions, FAA needs to clearly define a project, including examining its purpose, its contributions to the agency's mission, and alternative ways of achieving the purpose. Needs assessment and alternatives analysis are functions most properly undertaken at the beginning of a research program's development of new technology. By not performing these analyses, FAA runs the risk of not choosing the most cost-effective alternative. We have found cases where FAA has not carefully considered needs and alternatives. For example, we found that FAA could have selected a more effective and less costly design for radar that would provide more accurate information on aircraft location and allow controllers and pilots to exchange data if the agency had considered a wider range of options for meeting its needs.[4] Although FAA initially considered five alternatives, combining surveillance and communications requirements had the effect of precluding all but one alternative--the Mode Select radar--from full consideration.

Underestimating Technology's Complexity and Maturity Leads to Major Delays and Cost Increases

Over the years, we have reported on the serious cost and schedule difficulties that have affected the Advanced Automation System (AAS). Conceived more than a decade ago, AAS was the centerpiece of FAA's modernization effort and the most expensive

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[4]Major Acquisitions: Top Management Attention Needed to Improve DOT's Acquisition Process (GAO/T-RCED-91-45, Apr. 24, 1991).

project.[5] After IBM won the design competition in 1988, design and development problems soon began to appear. A major reason for these problems was the underestimation by both FAA and IBM of the technological complexity of the system that was being developed and of the "off-the-shelf" availability of software components. Although FAA thought it was close to acquiring a new system, much more effort was required to complete research and development. Because FAA and IBM misjudged the technical effort required to complete AAS' software development, they agreed to schedules and cost estimates that were unrealistic. Total cost estimates for AAS rose from $2.5 billion in 1983 at the project's inception to $7.6 billion in 1994. The time for completion also slipped from 1994 to 2002.

Lack of Consultation With End-Users May Make Deployment More Difficult

FAA's efforts to develop new explosive detection equipment illustrate the importance of including end-users when developing new technology. Although FAA has developed a technology to detect explosives in checked baggage, it estimates that the cost to equip one screening station is about $1.7 million. Industry officials told us that a single airline at a busy airport, such as John F. Kennedy International, could require as many as 10 systems to meet the airport's high volume of traffic. The airline industry is concerned about how this equipment will affect the efficiency of airlines' operations and about its high cost. In addition, it is not clear who will have to pay for this new equipment--the airlines, the federal government, or a combination of both. Airline representatives have said that they are skeptical about FAA's ability to develop new security technology and believe that it is critically important for FAA to test this equipment at airports.

According to FAA officials, the agency will face similar problems in developing and refining future initiatives for aircraft safety, fire safety, and noise abatement because the cost impact on the airline industry may be significant. The inclusion of end-users earlier in the assessment of costs and implementation of new technologies will be important in these areas.

FAA IS EMBARKING ON A NEW MANAGEMENT APPROACH TO DEVELOP NEW TECHNOLOGY

FAA's RE&D and Acquisition programs are in transition. FAA is embarking on a new management approach that, for the first time, places RE&D and acquisition under one office headed by the Associate Administrator for Research and Acquisition. FAA's new

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[5]Advanced Automation System: Implications of Problems and Recent Changes (GAO/T-RCED-94-188, Apr. 13, 1994).

philosophy relies heavily on integrated product teams and a "cradle-to-grave" management approach whereby researchers, contract managers, maintenance personnel, and end-users are involved throughout the product's development, deployment, and life.

FAA recognizes that problems exist in the development and deployment of new technology. A March 1992 survey of FAA's research and acquisition staff found that a "stovepipe" approach existed when FAA researchers did not focus adequately on what end-users, such as controllers, need or on how the technology would be deployed and maintained. To overcome these problems and improve the development and acquisition of new technology, FAA has embraced integrated product development. Through the use of integrated product development teams, FAA hopes to resolve problems with defining requirements and ease the transition of new technology into day-to-day use, thereby speeding the introduction of the technology. FAA currently has 14 integrated product teams for, among other things, satellite navigation and aircraft/avionics.

While we are encouraged by the steps FAA is taking, it remains to be seen whether this approach will prevent past problems from recurring in developing new technology. According to FAA's top RE&D management, it may take 3 to 5 years for the new management philosophy to have an effect in the areas where it has integrated product teams. FAA has not established integrated product teams for aircraft safety and security, which account for about one-third of the RE&D budget. Without a similar mechanism for linking FAA's safety and security research with the agency's other functions as well as industry concerns about costs and implementation, important improvements could be delayed.

FAA managers believe that one of the most formidable challenges to meaningful change is FAA's culture. FAA officials describe the agency's culture as one that is averse to risk and that often pits one internal organization against another. Also, FAA officials told us that FAA's culture inhibits the effective flow of information. Such a culture is an important facet of FAA's difficulties in developing and ultimately deploying new technology, and later this year, we plan to report on FAA's culture as it relates to acquisitions.

CONCLUSIONS

FAA's research and development efforts--funded through the RE&D and F&E accounts--play an important role in developing new technology to enhance the efficiency and safety of the U.S. air traffic control system. But the agency continues to face challenges in developing new air traffic control and security technologies. Its overall program to develop new technology is in

transition, and while we are encouraged by the reforms and initiatives under way at FAA, it remains to be seen if they improve the agency's ability to develop and ultimately deploy new technology.

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Chairwoman Morella, this concludes our prepared statement. We would be glad to respond to any questions that you or any Member of the Subcommittee might have.

RELATED GAO PRODUCTS

FAA Budget: Issues Related to the Fiscal Year 1996 Request (GAO/T-RCED/AIMD-95-131, Mar. 13, 1995).

Air Traffic Control: Status of FAA's Modernization Program (GAO/RCED-94-167FS, Apr. 15, 1994).

Aviation Security: Development of New Security Technology Has Not Met Expectations (GAO/RCED-94-142, May 19, 1994).

Air Traffic Control: Status of FAA's Modernization Program (GAO/RCED-93-121FS, Apr. 16, 1993).

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

Aviation Research: Actions to Enhance the Effectiveness of FAA's Research Activities (GAO/T-RCED-93-40, May 20, 1993).

Air Traffic Control: Improvements Needed in FAA's Management of Acquisitions (GAO/T-RCED-93-36, May 5, 1993).

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

Air Traffic Control: Uncertainties and Challenges Face FAA's Advanced Automation System (GAO/T-RCED-93-30, Apr. 19, 1993).

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

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

Aviation Research: FAA Could Enhance Its Program to Meet Current and Future Challenges (GAO/RCED-92-180, June 3, 1992).

New Denver Airport: Safety, Construction, Capacity, and Financing Considerations (GAO/RCED-91-240, Sept. 17, 1991).

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