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AVIATION RESEARCH

Issues Related to FAA's Research Activities

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GAO/T-RCED-93-68

Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to discuss the Federal Aviation Administration's (FAA) Research, Engineering, and Development (RE&D) Program. FAA is requesting $250 million for RE&D activities in fiscal year 1994. The RE&D Program plays an important role in ensuring the safety, security, and efficiency of the U.S. air transport system. Several systems developed and tested through the program, such as the Traffic Alert/Collision Avoidance System, are finding their way into day-to-day use.

Today, a sense of urgency faces the program. The financial health of the airline industry, growing international competition for aerospace products, and the administration's focus on research and development to enhance our competitive position are converging to make increasing demands on FAA's RE&D Program. Although the program alone cannot solve the financial troubles of the airline industry, it can provide critical technologies, such as satellite and data link technologies, that can reduce delays and increase airspace capacity. Today, we will discuss FAA's progress in responding to the Aviation Safety Research Act of 1988, factors that will affect the success of the RE&D Program, the relationship between FAA and the National Aeronautics and Space Administration's (NASA) research programs, and four key challenges facing FAA's security efforts. This statement is based on prior reports and a recent testimony given before the Subcommittee on Transportation and Related Agencies, Senate Committee on Appropriations.[1] In summary:

-- FAA continues to make progress in responding to the Aviation Safety Research Act of 1988. FAA has expanded research in areas directed by the act--such as simulation modeling of the air traffic control system. Similarly, FAA is taking steps to respond to a recommendation we made last year to track long-term research[2]. In addition, FAA has developed an RE&D Plan. However, FAA has not included resource estimates in the plan as mandated by the act. Such information is important because FAA and industry officials estimate that FAA would need a significant funding increase--a 100 percent by fiscal year 1995--to implement the plan. Given the budget deficit, it is not prudent to think that such increases will be forthcoming. Therefore, FAA will have to make careful trade-offs among diverse projects to ensure that important research is funded and completed in a timely manner. This is

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

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

particularly important in view of the administration's emphasis on enhancing global competitiveness.

-- In June 1992, we also reported that the success of FAA's RE&D Program rested on several interrelated factors. We believe that these factors are still important, and careful attention to them is still needed. The factors include FAA's success in (1) incorporating RE&D goals into other programs, such as the Capital Investment Plan, to modernize the air traffic control system; (2) utilizing research conducted by other federal agencies; (3) integrating various technologies to address existing and future capacity, security, and safety concerns; and (4) incorporating human factors into all research. FAA has started to incorporate goals into other programs, but it faces system integration challenges and has yet to determine how to fully utilize other federal research efforts.

-- At the request of the Subcommittee on Transportation and Related Agencies, Senate Committee on Appropriations, we initiated a limited examination of the cooperation between FAA and NASA research activities. Given the challenges facing the aviation community today and current budget realities, FAA must take full advantage of NASA's expertise and resources. NASA makes a substantial investment, about $1 billion, in aeronautical research upon which FAA could draw to stretch its research funds to achieve greater returns on its research investments. NASA can complement FAA's RE&D Program by helping to provide the technological building blocks for future aviation systems. Such a partnership would be particularly useful in the development and deployment of satellite technology that could help maintain U.S. leadership in aviation. The current partnership has led to some joint programs, but we have identified several factors that inhibit greater cooperation between the two agencies. For example, NASA is generally excluded from participating in FAA's planning for future systems. Closer cooperation could ensure that the two agencies' resources are fully utilized and help speed the development of new technologies.

-- At recent hearings, we identified several security research issues that FAA must resolve to meet the high expectations of the Congress and the traveling public.[3] These issues include (1) technical problems, such as high false alarm rates; (2) the cost of new devices; (3) the cost, weight, and durability of blast-resistant containers carried in

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[3]FAA Budget: Important Challenges Affecting Aviation Safety, Capacity, and Efficiency (GAO/T-RCED-93-33, Apr. 26, 1993).

aircraft cargo bays; and (4) the relationship between efforts to improve aircraft survivability and improve detection of explosive devices.

BACKGROUND

FAA conducts a wide range of research to ensure the safety, security, and efficiency of the U.S. aviation system. The results of FAA's research programs include prototypes of systems, new procedures, rules, regulations, and certification criteria. Most, if not all, of FAA's research focuses on refining existing technology and equipment. To assist FAA in meeting its long-term challenges, the Congress enacted the Aviation Safety Research Act of 1988. The act directs FAA to (1) submit to the Congress an annual aviation research plan with detailed cost, schedule, and staffing data for each project and a report of accomplishments for the preceding year; (2) undertake research on aircraft structures, fire safety, human factors, aeromedical research, and computer simulation models of the air traffic control system; and (3) establish a research advisory committee. In addition, the act required FAA to allocate not less than 15 percent of its fiscal year 1989 and 1990 budget to long-term research.[4]

In response to the act, FAA is spending more RE&D funds on aircraft structures, simulation modeling, and human factors. (App. I compares funding levels for fiscal years 1988--before the passage of the Aviation Safety Research Act--and proposed funding levels for fiscal years 1994 by major research area.) Nevertheless, FAA faces many long-term challenges that will require sustained research over the next few years. These challenges include:

-- Alleviating capacity and congestion problems. In 1992 alone, over 280,000 flights experienced delays in excess of 15 minutes.

-- Developing systems that can detect a wide range of explosives with a high degree of reliability at an affordable cost.

-- Developing tools to detect cracks and corrosion in the nation's aging fleet without grounding aircraft for extended periods of time.

-- Ensuring that the next generation of air traffic control systems, which rely heavily on automation, are engineered so that controllers and pilots can effectively operate and work with the systems.

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[4]The act defined a long-term research project as a discrete project that was unlikely to result in a final rulemaking within 5 years or in initial installation of operational equipment within 10 years after the project began.

FAA HAS MADE PROGRESS IN RESPONDING TO THE AVIATION SAFETY RESEARCH ACT

In response to the act, FAA has expanded research in aircraft structures, human factors, and simulation modeling; established an advisory committee; and developed an RE&D Plan. The RE&D Plan enjoys industry support and provides information on, among other things, aircraft safety, security, and weather research. However, FAA has not included resource estimates--either staff or dollars--for research efforts as required by the act and as we recommended.[5] Such information is important for several reasons.

First, according to FAA and industry officials, FAA would need $500 million annually--a 100-percent increase over current funding levels--by fiscal year 1995 to implement the plan. Second, some research areas, especially human factors and airport technology, could cost significantly more in the next several years. Third, FAA will be making difficult decisions regarding allocation of scarce RE&D resources to many competing areas in the next decade, such as aircraft safety and air traffic control. Without cost and staffing information, neither the Congress nor FAA can adequately oversee decisions to ensure that resources are being used most effectively and that trade-offs have been made properly.

FAA is Instituting New Controls to Set Priorities and Funding Levels for Its Research Activities

FAA is taking steps to help set priorities and establish funding levels. For the past several years, FAA has been struggling to define a process to set research priorities, determine the correct balance of long- and short-term research, and establish funding levels for its research program. In March 1993, FAA issued a new acquisition policy that, among other things, requires priorities to be based on an analysis of mission need statements beginning in fiscal year 1995.[6]

These statements are intended to justify the need for an investment, clearly state the investment's purpose, relate the project to FAA's overall needs, and highlight the risks involved. Although not guaranteeing a successful acquisition, mission need statements are intended to provide a sound basis for investment decisions. Earlier this year, we reported on the importance of

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

[6]Office of Management and Budget Circular A-109 establishes guidelines for top-level agency management to review acquisitions at four key decision points. Approval of a mission need statement is the first decision point.

mission need statements and the steps that FAA needs to take in the management of the Capital Investment Program.[7] For the RE&D Program, FAA officials are optimistic that mission need statements will help them identify, fund, and deploy promising technologies.

Efforts to Track Long-Term Research are Underway

For many years, the Congress has been concerned that FAA's RE&D Program is not sufficiently future-oriented. According to FAA officials, about 20 percent of the fiscal year 1994 budget is allocated to long-term or future-oriented research. Such research is important because it can identify potential safety problems before they result in catastrophic accidents or incidents and enhance the industry's competitiveness. We previously reported that many projects FAA had classified as long-term were actually short-term or a combination of short- and long-term efforts. We also found that FAA does not track information on the amount of long-term research conducted. Consequently, budget and planning documents do not indicate the level of funds for short- or long-term efforts. Tracking such research would allow FAA to make judgements on the overall direction of the RE&D program, identify trends, and make the necessary adjustments. Therefore, we recommended that FAA develop a mechanism to track long-term research. FAA is exploring ways, including modifying the RE&D information system, to implement this recommendation and expects to have procedures in fiscal year 1995.

FAA's RE&D Efforts are Difficult to Estimate

FAA's total RE&D efforts are difficult to estimate because some research is funded from other sources, including other federal agencies and the facilities and equipment (F&E) account for modernizing the air traffic control system. For example, several important RE&D projects that utilize emerging technologies--such as Terminal Air Traffic Control Automation--receive both RE&D and F&E funds.[8] We previously reported that FAA needed to link its process for acquiring major projects with its budget to enhance project management and reduce the potential for cost growth and schedule delays.[9]

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

[8]For additional information on emerging technologies, see Air Traffic Control: Status of FAA's Modernization Program (GAO/RCED-93-121FS, Apr. 16, 1993).

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

On the basis of our recommendations, FAA now delineates F&E funds for engineering, development, test, and evaluation in its budget. FAA is requesting about $549 million in its fiscal year 1994 F&E budget to research and test specific problems associated with, for example, the Advanced Automation System and Voice Switching and Control System. Therefore, if F&E funds are considered, FAA expects to spend almost $800 million on research, engineering, and test-related activities in fiscal year 1994.

SEVERAL INTERRELATED FACTORS WILL AFFECT THE SUCCESS OF FAA'S RE&D PROGRAM

In June 1992, we reported that several interrelated factors will affect FAA's ability to meet current and future challenges. These factors are (1) incorporating RE&D goals into other FAA programs; (2) utilizing research conducted by other federal agencies; (3) integrating various technologies to address existing capacity, safety, and security concerns; and (4) incorporating human factors into all research. These factors are important today and will ultimately shape FAA's ability to meet its RE&D goals.

FAA's RE&D Plan includes nine ambitious but, in FAA's view, attainable goals. For example, the plan shows that FAA expects to increase airspace and airport capacity by at least 20 percent in 1999 and an additional 20 percent by 2005 and reduce runway incursions by 80 percent by the year 2000. Goals are important elements of a good plan because they set expectations and establish a basis to measure performance.

In our opinion, four interrelated and cross-cutting factors will shape FAA's ability to meet the safety, security, and capacity demands of the next decade and beyond. First, the RE&D goals must be incorporated into other program areas. This is important because the RE&D program must rely heavily on other programs, such as the Capital Investment Program. We recommended that FAA integrate RE&D goals into other programs or develop goals that are directly achievable by the RE&D Program. In response, FAA has included one goal (increase capacity by at least 20 percent in 1999) in the draft 1992 Capital Investment Plan. However, FAA still needs to integrate RE&D goals into other agency-wide efforts, such as the need to significantly reduce the number of accidents on crowded runways. FAA officials told us that they plan to integrate RE&D goals into other programs within the next year.

Second, FAA must utilize research conducted by other federal agencies and private organizations. As discussed later, FAA can make better use of NASA to bring about major improvements in safety and capacity. In addition, this fall FAA expects to complete an assessment begun late last year on increasing its use of Department of Defense (DOD) laboratories. Although the extent and type of technologies that could be transferred is unknown, DOD and FAA officials believe that they can contribute to FAA's research

efforts. Key areas that might benefit FAA include phased array radar technology, sensor fusion, and software testing. The National Aviation Research and Competitiveness Act of 1993 (H.R. 1229) has been introduced in the House and would require the establishment of a joint program for conducting research on aviation related-technologies.

Third, in such areas as air traffic control and security, an important relationship exists between developing technologies and how the technologies work together (system engineering and integration). For example, in the air traffic control area FAA must ensure the integration of ground-based systems and satellites for communications, navigation, and surveillance functions. Also, as discussed later, FAA must ensure that future security devices can successfully blend several technologies to detect a wide range of explosives. In the past, integration problems and issues have contributed to cost increases. For example, costs increased for the Terminal Doppler Weather Radar System because FAA did not fully consider the need to integrate that system with the Low-Level Windshear Alert System.

Finally, for more than 30 years, human error has contributed to over 65 percent of aviation accidents. As a result, FAA has developed a multi-year plan with NASA that focuses on many aspects of human factors in aviation. By December 1993, FAA expects to complete an evaluation of the plan's priorities and determine the correct balance of short- and long-term human factors research. This work will help identify potential safety issues and maximize efficiency in air traffic control and the operation and maintenance of aircraft.

FAA AND NASA COOPERATION

At the request of the Subcommittee on Transportation and Related Agencies, Senate Committee on Appropriations, we initiated a limited examination of the cooperation between FAA and NASA in conducting research activities. With research needs far exceeding what can reasonably be funded, it is paramount that FAA closely cooperate with other federal agencies. NASA makes a substantial investment in aeronautical research upon which FAA could leverage its research dollar and potentially achieve greater research investment returns. For fiscal year 1994, NASA is planning to spend over $1 billion for aeronautics research. Although some joint projects have had positive results in several areas, NASA research activities can further benefit FAA.

NASA and FAA Work Through Cooperative Agreements

FAA and NASA work closely on a wide range of projects, including aging aircraft, noise, and human factors research through cooperative agreements. According to FAA and NASA officials,

aviation research conducted by NASA is generally more long-term in nature. In 1993, FAA had seven major efforts with NASA, totalling almost $50 million. NASA contributed almost $26 million. The joint efforts include projects to (1) develop technical data and automation aids for overcoming air traffic delays and avoiding collisions; (2) investigate methods to protect passengers and crew during accidents; and (3) explore new aircraft technologies and communication, navigation, and surveillance systems for advanced air traffic control systems. However, the $26 million does not take into account the resources and research conducted outside of formal joint agreements, such as human factors and aircraft safety research.

Obstacles to Effective Cooperation/Partnership

FAA and NASA have established a formal coordinating committee and undertaken many cooperative efforts. However, the work we conducted shows that both agencies need to develop a much closer partnership if FAA is to take full advantage of NASA's expertise and resources. Moreover, top FAA officials told us that they are not sure whether the two agencies are cooperating on all of the research that can benefit FAA. FAA and NASA officials identified several factors that impact the effectiveness of their partnership:

-- First, the current process for formalizing cooperative agreements between the two agencies relies heavily on a "bottoms-up" approach for identifying joint research projects. For example, the NASA researcher and FAA program manager generally are responsible for identifying joint projects and sharing information. Although such discussions should be encouraged, this approach does not ensure that both agencies' resources are fully utilized. A "top down" approach would help focus and provide more direction for the long-term aviation research efforts of both agencies.

-- Second, some FAA and NASA officials believe that the "not-invented-here" syndrome has limited the cooperation between the two agencies. Although both agencies recognize that this attitude has improved over the past several years, it remains an underlying current in the FAA/NASA relationship.

-- Third, NASA is generally excluded from participating in FAA's planning for future systems, and some FAA officials told us that they view NASA as only one of many contractors. FAA officials believe that they are in the best position to decide which research contractor or laboratory is best suited for their needs. Regardless of which contractor FAA selects, NASA officials told us that the lack of participation inhibits their ability to guide research to meet future aviation needs.

The Terminal Air Traffic Control Automation (TATCA) program illustrates an opportunity that FAA almost lost because of poor coordination. According to FAA and NASA officials, in the early 1980s, NASA suggested that both agencies develop TATCA--a software enhancement to assist air traffic controllers in routing aircraft more efficiently. Although FAA decided not to fund the project, NASA did. FAA now anticipates that TATCA will provide significant capacity improvements and has incorporated it in its modernization plans. At the end of fiscal year 1992, major components of the TATCA program were delivered to air traffic control facilities for testing.

NASA Can Play a Key Role In Meeting Future Challenges

As discussed above, NASA plays an important role in FAA's research efforts and may be able to play a much larger role in the future. For example, NASA officials told us that they could contribute more research resources to develop satellite technology for the next generation air traffic control system. In addition, FAA's Advisory Committee for RE&D noted that considerable opportunity exists for FAA to harvest prior achievements from the technological investments made by NASA, particularly in the space arena. Moreover, a recent examination by the National Research Council found that NASA could play a key role in helping FAA to significantly increase the capacity of the nation's air traffic control system.[10] To do so, the Council recommended, in part, that FAA, NASA, and industry work together to expedite the development of satellite communications.

FAA has not actively sought NASA's input to help shape the vision of the future national airspace system. Although FAA has developed RE&D Plans, it has not yet developed a transition plan to integrate satellite technology into the future air traffic control system. FAA expects to have a transition plan by December 1994. Since the two agencies coordinate only after a specific problem has been identified, NASA is not involved with FAA's planning effort. Without closer cooperation, FAA will not be able to fully utilize NASA's substantial technology base. FAA and NASA are drafting a satellite navigation memorandum of understanding, but until FAA completes its transition plan, neither FAA nor NASA will be able to maximize the government's investment in aviation research.

SECURITY RE&D PROGRAM FACES SEVERAL CHALLENGES

After the Pan Am Flight 103 tragedy, the Congress directed FAA to, among other things, accelerate its research efforts for bomb

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[10]Aeronautical Technologies for the Twenty-First Century, National Research Council (1992).

detection, and explore ways to enhance aircraft survivability. The Congress' goal was to have new detection systems in place by November 1993. Accordingly, FAA's RE&D funding for security has grown from $16.9 million in fiscal year 1990 to about $36 million in fiscal year 1993--a 113-percent increase. FAA has requested $36 million for security research for fiscal year 1994. FAA expects to obligate all its fiscal year 1993 funds and has 40 projects to research detection devices.

At the request of the Subcommittee on Transportation and Related Agencies, House Committee on Appropriations, we are assessing FAA's security research program, particularly the development of new explosive detection devices and methods to improve aircraft blast resistance (aircraft hardening). The following four issues illustrate the challenges that FAA should address to meet the high expectations of the Congress and the traveling public. These issues also illustrate the challenges FAA faces in developing new technology for the aviation industry.

First, technical problems will prevent FAA from having new detection equipment--the centerpiece of its security research--at airports in the near future. For example, some advanced x-ray devices show promise in detecting explosives but are either too slow or have high false alarm rates. Also, FAA plans to spend about 23 percent of its security RE&D budget on vapor technology but has not determined how to ensure that the technology can reliably detect small amounts of explosives. Such devices "sniff" baggage and people for explosives and must discriminate between very small traces of explosives and much larger quantities of other materials. FAA expects to test several devices at selected airports later this year.

Second, FAA has not determined how much the new devices will cost the airlines. Industry estimates that the cost of a single device could range from $250,000 to well over a $1 million. Because no single device can meet the existing threat, airlines will have to use devices in combination to detect a small amount of explosives, which could have a significant financial impact on the industry. According to FAA officials, they will conduct an economic analysis after they approve devices for airlines' use.

Third, industry has raised issues related to the cost, weight, and durability of blast-resistant luggage containers carried in aircraft cargo bays. According to an FAA official, the containers that FAA is testing would add an average of about 3,200 pounds to an aircraft's weight, thereby increasing fuel use and operating costs. Also, because of their size, the new containers can be used on about 25 percent of the fleet--wide-body aircraft that typically fly international routes. According to these officials, FAA is working with the industry to resolve these issues.

Finally, FAA needs to determine the relationship between explosives detection and aircraft survivability. Last year the Congress directed FAA to conduct a detailed analysis of the trade-offs between survivability and detection. Defining this relationship is important because if FAA finds that an aircraft could be made to withstand an explosion, then devices would not have to be as sensitive as FAA currently requires. Conversely, if an aircraft cannot be made to withstand an explosion, then the devices will have to be as or more sensitive. FAA expects to complete its analysis in 1995.

CONCLUSIONS

FAA is taking some important steps to improve its RE&D Program and respond to our prior recommendations. FAA's plan to use mission need statements in fiscal year 1995 to prioritize research efforts and guide funding decisions is a positive step. However, FAA has not implemented our recommendation to include the requisite budget and staffing information in the RE&D Plan. This information is critically important in today's budgetary environment where FAA will have to be make difficult trade-offs between diverse research areas.

The success of FAA's RE&D Program in meeting current and future challenges rests on integrating RE&D goals into other program areas, leveraging research conducted by other federal agencies, integrating various technologies to meet specific safety and capacity problems, and incorporating human factors into all research. As our limited work on the relationship between FAA and NASA research activities shows, the solution to some of today's most pressing problems may call for greater cooperation between the two agencies.

RESEARCH UNDERWAY MANDATED BY THE AVIATION SAFETY RESEARCH ACT, FISCAL YEARS 1988 AND 1994

Dollars in thousands

Mandated Area	1988[a]	1994[b]
Human factors and medicine	$6,186	$27,256
Simulation modeling	764	11,814
Aircraft structures[c]	1,680	26,767
Fire safety	3,544	5,697
Total	$12,174	$71,534

[a]Obligations
[b]Requested funding for fiscal year 1994.
[c]Includes aging aircraft research.

Source: GAO analysis of FAA data.

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