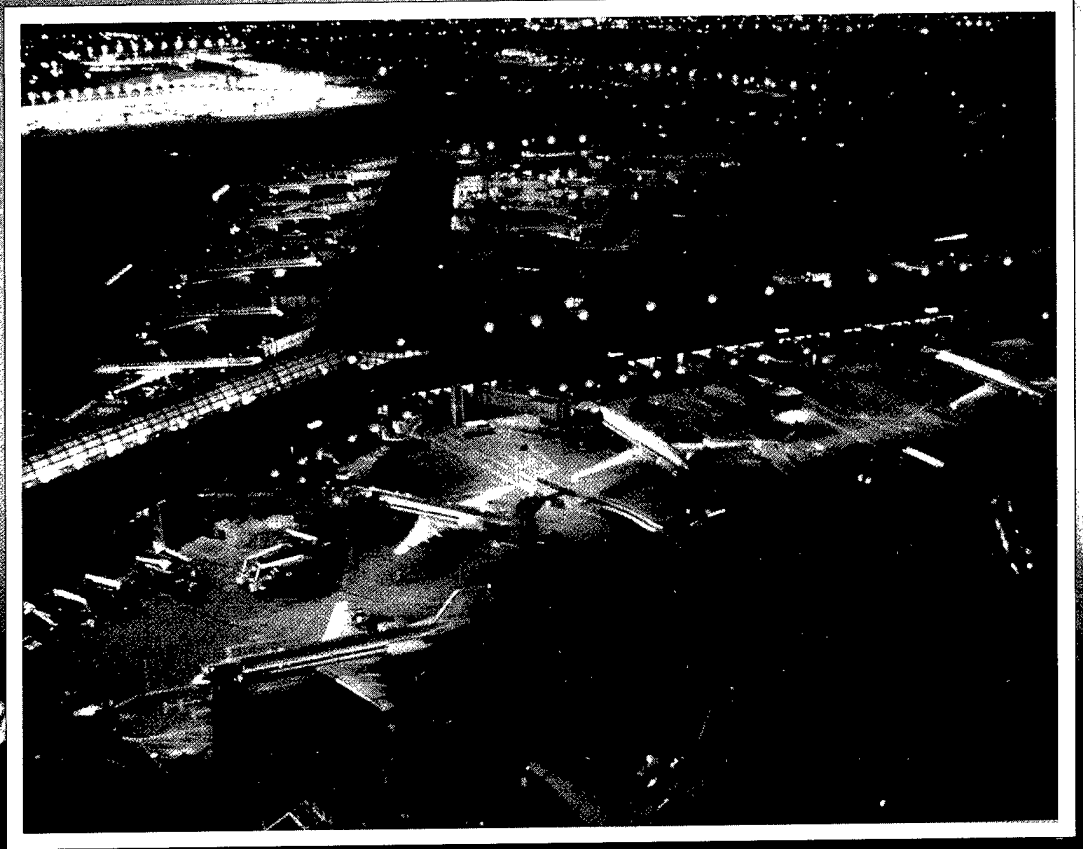
1998

Federal Aviation Administration Plan for Research, Engineering, & Development



U.S. Department of Transportation
Federal Aviation Administration

February 1998

Report of the Federal Aviation Administration to the United States Congress pursuant to 49 United States Code 44501(c).

Front Cover:

- World's Busiest Airport — Chicago O'Hare International Airport. Inset photo: American Airlines ramp.

Back Cover:

- The new Chicago O'Hare ATCT.

Photos courtesy of the Department of Aviation, City of Chicago.

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For further information or questions concerning the
1998 Federal Aviation Administration Plan for Research, Engineering, & Development
write to:

Federal Aviation Administration
Office of Aviation Research
AAR-200
800 Independence Avenue, S.W.
Washington, D.C. 20591

Or

Call an AAR Representative
at
(202) 267-9840

The Plan is available on the Internet at:
http://www.nasi.hq.faa.gov/nasipubs.htm

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1.0 Overview

1.1 Research, Engineering & Development Program Objectives

The Federal Aviation Administration's (FAA) mission is to provide the safe, secure, and efficient movement of air traffic consistent with national security concerns. The FAA Research, Engineering and Development (R,E&D) Program develops and validates the technologies, systems, designs, and procedures required for the full range of the agency's operational and regulatory activities to succeed. These activities include acquisition; air traffic services; certification of aircraft and aviation personnel; certification of airports; civil aviation security; and the development and publication of environmental standards for civil aviation.

The FAA is the nation's premier research organization for aviation technology. Its R,E&D program has made significant contributions to ensure the safety, efficiency, capacity, and cost effectiveness of the national aviation system. Today, that system is under heavy pressure to keep pace with rising traffic demand, needs for essential safety and security improvements, airspace user requirements for more flexible and efficient air traffic management operations, and demands for further mitigation of the environmental impacts of aircraft operations. As air travel increases, the agency's research and development work will take on added significance. To meet these future challenges, the FAA employs a comprehensive, agency-wide R,E&D investment analysis process to ensure that available resources remain customer focused in terms of "outcomes" and "outputs," as mandated by the Government Performance and Results Act (GPRA) of 1993, and that these resources be targeted on the highest priority activities.

Ensuring the safety of air travelers and the general public is the agency's first priority. Technologies introduced over the past 20 years have dramatically lowered the accident rate. A large number of these innovations have resulted from FAA research. The agency has frequently cooperated with the National Aeronautical and Space Administration (NASA) to find solutions to safety problems. The FAA has also teamed with the Department of Defense (DOD) to leverage research dollars in the search for common solutions to problems affecting aviation. The improved safety of aircraft and their operations are the major emphases of FAA/DOD cooperation in programs such as Aging Aircraft, Aircraft Hardening, Fire Research, and Aviation Safety Risk Analysis. The agencies also work together to identify and refine communications technologies capable of supporting new concepts in air traffic management.

In January 1995, the FAA met with airspace users and representatives of industry. The participants shared an ambitious vision. Despite projections that air traffic would double over the next 15 to 20 years, the group held only a zero-accident goal to be acceptable. The resulting "Aviation Safety Plan" was updated in February 1996.

In addition, the R,E&D program supports the goals and objectives of the agency's strategic plan as well as the requirements associated with the evolving air traffic system architecture. A major challenge facing the FAA today is the modernization of an aging infrastructure of air navigation facilities. A large infusion of new technology and procedures is essential if air traffic services are to continue to support safe and efficient flight operations at the budget levels expected in the future. The National Airspace System (NAS) Architecture provides the road map for this continuing modernization process, and the R,E&D program provides the necessary system development initiatives.

The FAA R,E&D program is divided functionally into seven areas. These areas are: Air Traffic Services, Airport Technology, Aircraft Safety, Aviation Security, Human Factors and Aviation Medicine, Environment and Energy, and R,E&D Program Management.

1.2 Forecasted Needs of Civil Aviation

Increasing Demand

The FAA's mission is to provide support and guidance to the aviation industry to ensure responsiveness to the needs of the aviation community. The nation's defense and economic prosperity rely heavily on the stability of the aviation industry. Aviation and related industries contribute almost $700 billion to the U.S. economy (6 percent of our gross domestic product) while they provide over 8 million jobs (See Figure 1-1). With a

$425 billion trade surplus in 1994, aviation remains the largest export sector of our economy. U.S. aviation industries hope to deliver over 14,000 transport aircraft valued at $1 trillion over the next 20 years. Aviation-related research and development is, however, accelerating in other nations, and increased foreign competition is showing some signs of eroding our international position. A strong FAA R,E&D program is critical not only to our national interests in improving the safety and efficiency of air travel systems, but to safeguarding U.S. interests through the adoption of our own technologies and products.

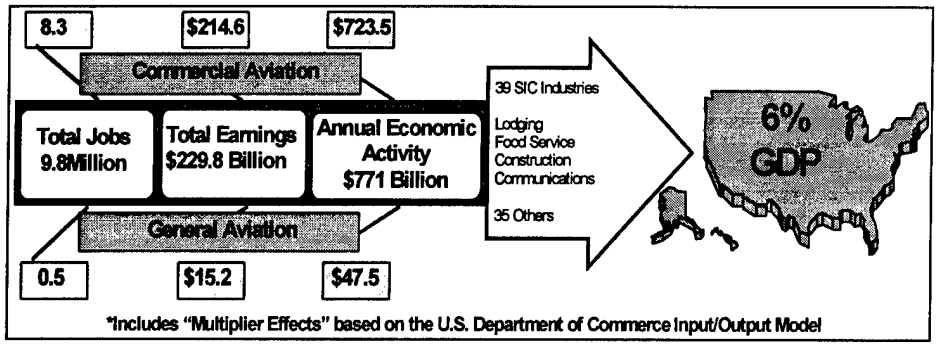

Figure 1-1 Aviation Impact on the Economy
(Source: The Economic Impact of Civil Aviation on the U.S. Economy, Update 1993, Wilbur Smith Associates, April 1996)

According to FAA Aviation Forecasts, between fiscal years 1997-2008, the demand for commercial air services is expected to escalate. (See Figure 1-2.) Domestic air carrier revenue passenger miles are expected to increase at an annual rate of 3.8 percent in these same years. Projections assume that domestic passenger yields will increase at an annual rate of 1.7 percent over the forecast period, and international air carrier revenue passenger miles and enplanements will increase at annual rates of 5.3 percent. Air transportation is expected to continue to dominate all other transportation modes in both long distance domestic inter-city and international passenger markets. Growth in commuter/air taxi aircraft activity should be somewhat larger than forecasted for the larger commercial air carriers. This projected growth will place additional strain on the air transportation system's capacity, safety, and security.

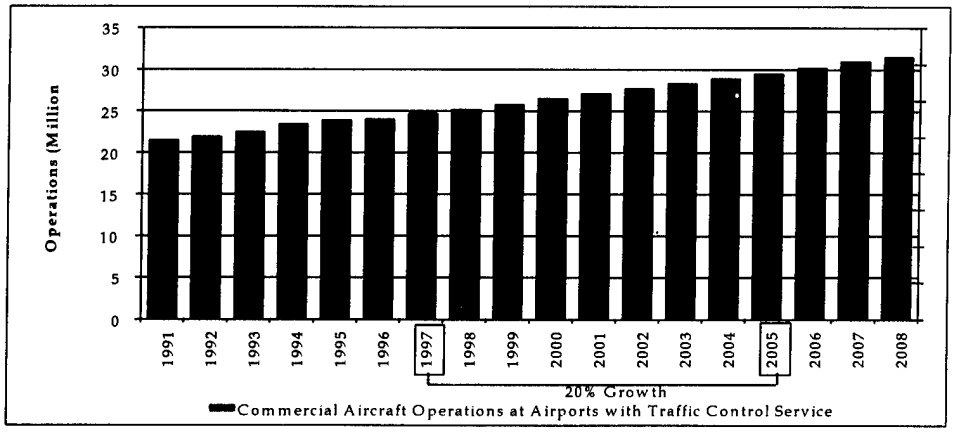

Figure 1-2 Commercial Aircraft Operations
(Source: FAA Aviation Forecasts: Fiscal Years 1997-2008)

Security

The increased sophistication of terrorist activity, and recent aircraft disasters have heightened public awareness and demand for better security systems and improved procedures affecting both security and safety. The public must feel secure in using the air transportation system. The Gulf War has shown that, without a sense of security, air travelers will change their mode of transportation or dramatically decrease their travel. Statistics may not bear out the flying public's fears and concerns, but these perceptions must be addressed. The FAA R,E&D program is being driven to develop methods and innovations that will produce the assurances which the public demands.

Navigation/Surveillance

The Global Positioning System (GPS), a satellite-based positioning system, is revolutionizing the FAA's current and future infrastructure plans. Its successful incorporation into air traffic services, however, requires technical answers to such questions as: What redundancy is needed for a space-based system; what information security measures are required; what certification is required for GPS-derived services such as the Wide Area Augmentation System; and how present air traffic management procedures and air traffic services systems can best be modified to take full advantage of the GPS information. The R,E&D program must address these and other questions immediately to avoid delaying GPS's application and expected economic and safety benefits.

Changing world economic, technical, and social environments result in new challenges to the FAA and recent initiatives have focused the R,E&D program on future enterprises discussed in the following paragraphs.

1.3 Recent Aviation Community Initiatives

1.3.1 NAS Architecture

The FAA, through the Office of System Architecture and Investment Analysis, has defined a comprehensive and realistic system architecture for the air transportation system infrastructure. The proposed architecture is the culmination of an intense effort undertaken by the FAA, industry representatives, pilot and owners' organizations, and DOD. Version 3.0 of the NAS Architecture, to be published in early 1998, responds to the requirements specified in *The Joint Government/ Industry Operational Concept for the Evolution of Free Flight* (Joint CONOPS).

The Joint CONOPS provides an evolutionary concept of operations from the perspective of NAS users. This concept covers the transition from the current NAS through three distinct timeframes: the year 2000; the year 2005; and the time when mature Free Flight occurs. It incorporates the needs and requirements of NAS users and serves as the basis for an incremental, benefits-driven approach towards free flight. The concept also forms the basis for FAA and user community plans calling for procedural, investment, and architectural decisions in support of operational capabilities needed to achieve free flight. A thorough review of all current and proposed R,E&D initiatives in the Air Traffic Services (ATS) area was conducted in support of the NAS Architecture. This effort validated R,E&D ATS research efforts with the NAS modernization model provided by the NAS Architecture. As a result, some ongoing research activities were restructured and new requirements were identified. Details of how ATS R,E&D research activities map to NAS modernization can be found in the NAS Architecture, Version 3.0.

1.3.2 Flight 2000

Flight 2000 is a major research activity that will significantly affect the pace and ultimate success of NAS modernization. Flight 2000 is an aggressive initiative to demonstrate and validate integrated flight system capabilities in a real operational environment. It brings together the systems, procedures, and training necessary to provide improved NAS safety, productivity, and efficiency at affordable operations and maintenance costs.

The Flight 2000 Steering Group, composed of representatives from FAA, NASA, and the U.S. aviation industry, provides high-level guidance. The RTCA Free Flight Select Committee advances industry

recommendations on candidate Flight 2000 operational improvements leading to free flight. A Flight 2000 Coordination Team has been formed to ensure commitment and participation from the many functional organizations.

Flight 2000 will provide an end-to-end integrated demonstration in which all participating users will realize benefits. Resulting improvements will be applied to the rest of the NAS.

Many of the technologies that foster free flight have been demonstrated in the laboratory or on a limited scale. These demonstrations, however, have not been sufficiently compelling to encourage NAS users to adopt the requisite systems. Flight 2000 will provide the opportunity for full operational demonstration and validation. It will set the stage for national deployment of the next generation air traffic management system, and will demonstrate new capabilities for better air traffic control (ATC) with reduced controller workload.

The objectives of the Flight 2000 program are to:

- Demonstrate safety and efficiency benefits of new technology and improved procedures.
- Evaluate communication, navigation, and surveillance transition issues.
- Streamline avionics development, certification, and installation, thereby driving down costs and reducing risks for accelerated NAS modernization.
- Develop controller and pilot tools for transition.

Flight 2000 operational capabilities, scheduled to begin in 2002 in Alaska, Hawaii, and selected Oakland Center oceanic airspace, will involve all classes of airspace users operating in all phases of flight operations and surface movement. Aircraft participating in Flight 2000 will be equipped with a new generation of advanced avionics.

1.4 Motivation for Modernization

1.4.1 The White House Commission on Aviation Safety and Security (Gore Commission)

In August 1996 the White House issued Executive Order 13015 establishing a commission on Aviation Safety and Security. Chaired by Vice President Al Gore, the commission is often referred to informally in the aviation community as the Gore Commission. Included in its initial mandate was the requirement to review the current status of NAS modernization efforts and recommend changes if required. As noted in the commission's final report, dramatic changes loom on the horizon for the aviation industry. Information technology presents opportunities that will again revolutionize aviation in ways as significant as the introduction of the jet engine forty years ago. Air traffic today is still controlled through ground-based radar, and on a point-to-point basis. Satellite-based navigation will bring a fundamental change in the way air traffic is directed, and may make the notion of "highway lanes in the sky" as obsolete as the bonfires that used to guide early fliers. Digital technology will replace analog systems, making communications with and among aircraft dramatically faster, more efficient, and effective.[1] Among its key recommendations on new initiatives and funding to improve safety and security, the commission also included the following: "In the area of air traffic control, the commission believes that the safety and efficiency improvements that will come with a modernized system should not be delayed, and recommends that the program be accelerated to achieve full operational capability by 2005".[2] This recommendation represents a significant challenge and opportunity for R,E&D, one that can be met only with a renewed sense of dedication and expanded partnerships with industry and academia.

1.4.2 Challenge 2000

Challenge 2000, a study initiated by the FAA Administrator, explored how best to cope with the changing and ever increasing responsibilities of the Associate Administrator for Regulation and Certification. Two overriding themes emerged from the study:

[1] White House Commission on Aviation Safety and Security, Final Report, dtd February 12, 1997, p-1
[2] White House Commission on Aviation Safety and Security, Final Report, dtd February 12, 1997, p-3

- There must be an aggressive, consistent, and enlightened scientific approach to certification.
- Introduction of new technologies is vital to both the economic future of U.S. aviation and the ability of the FAA to meet the challenge of significantly lowering future accident rates to near zero levels.

R,E&D program support has been, and will continue to be, instrumental in providing the new techniques, technology assessments, and process modifications necessary for the FAA to fulfill its regulatory mission along with assisting the growth of the aviation industry.

1.5 FAA/NASA/DOD Cooperation

The FAA has long recognized the value of leveraging scarce R,E&D resources. Recent efforts have strengthened FAA partnerships with other federal agencies. The result, greatly expanded cooperation with NASA and DOD, has significantly added to NAS modernization efforts.

The FAA has historically been able to adapt many technologies and products originally developed by NASA to improve the safety and efficiency of NAS operations. Both agencies have come to see the value of combining more of their long-term and applied aviation research and have increased their cooperative support to FAA/NASA joint programs.

Safety improvements to aircraft and their use pose as great a concern to military as to commercial aviation. Realizing the advantages of cooperation, the FAA and major DOD components have combined their strengths to make aging aircraft safer, and all aircraft more resistant to threats from terrorists and natural forces such as fire. The agencies also have worked together to improve levels of human performance in aeromedical and training programs and to find new applications of emerging technologies.

1.5.1 Integrated Plan for Air Traffic Management Research and Technology Development

On September 11, 1995, the FAA and NASA Administrators signed a memorandum of understanding (MOU) on Airspace System User Operational Flexibility and Productivity. In this document, the two agencies commit to an integrated effort to provide an air transportation system that facilitates user operational flexibility and productivity throughout the airspace while maintaining or enhancing safety.

The MOU established an FAA/NASA Inter-Agency Air Traffic Management Integrated Product Team (IAIPT) responsible for planning, oversight, and management of joint efforts. The principal defining documents for the IAIPT are the *Integrated Plan for ATM Research and Technology Development* and the *IAIPT Management Plan.*

The mission of the IAIPT is to plan and facilitate the integrated FAA/NASA Air Traffic Management (ATM) research and development into operational concepts and associated decision-support tools which, when implemented, will maximize the safety, efficiency, and flexibility of the operations for the current and future NAS. Efforts will encompass air-based and ground-based air traffic control and traffic flow management decision-support tools and procedures.

The IAIPT manages, advises, directs, decides, advocates and influences, but does not perform, ATM-related research and development (R&D).

At present, the IAIPT is focused on integrating ATM R&D within the FAA and NASA. Recognizing that the military and the FAA have common R&D needs and interests, the IAIPT co-leads have taken an action to ensure an active role for DOD in the planning and integration work of the IAIPT.

As illustrated in Figure 1-3, the IAIPT is organized under joint FAA/NASA leadership into an Inter-Agency Integrated Management Team (IAIMT), six Area Work Teams, and related staff. The composition and role of the various IAIPT elements are described below.

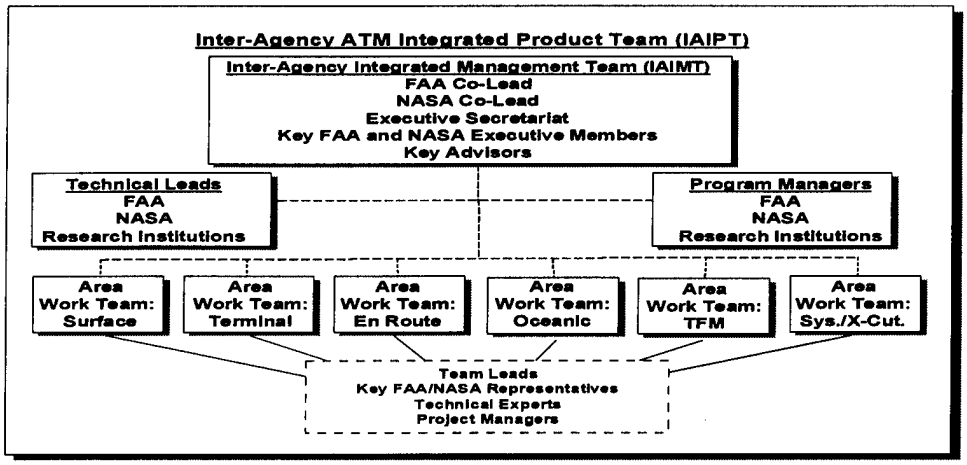

Figure 1-3 IAIPT Organization

The IAIMT, the senior management advisory body for the IAIPT, draws its co-leads from the FAA and NASA. A careful balance of other participants represent major organizations within these agencies. Key FAA and NASA contractors are represented on the team. These private-sector interests include MITRE/CAASD, Volpe National Transportation System Center, and the Massachusetts Institute of Technology Lincoln Laboratory.

The role of the IAIMT is to:

- Provide high-level vision and direction.
- Establish strategic outcomes consistent with FAA, NASA, and industry strategic goals (i.e., GPRA outcomes, etc.).
- Provide integrated strategic planning for ATM R&D, and communicate the plan in an *Integrated Plan for ATM Research and Technology Development.*
- Periodically review the status of ATM R&D, integration and report to the FAA-NASA Coordinating Committee.
- Make decisions and set priorities for over-arching issues, especially those affecting R&D technical and resource needs.
- Be the focal point for related program, policy, and budget issues internal and external to the FAA and NASA.
- Initiate and explore research and technology options.

Collectively, the Area Work Teams (AWT) form the operational body of the IAIPT. Individually, AWT representation reflects the same concern for balance as shown in overall IAIPT membership. The FAA lead of each team is the same person who is designated lead of the corresponding FAA Traffic Flow Management (TFM) Integrated Product Team (IPT), and members from NASA and the private sector are similarly designated by their organizations based on a combination of their relevant experience and their currently assigned duties.

The current IAIPT has six AWTs, one for each technical domain of ATM R&D, namely: Surface, Terminal, En-route, Oceanic, TFM, and System/ Cross-Cutting. The individual AWTs may augment their basic membership with other program participants, as required, to support the mission of the AWT.

Within their designated areas of responsibility, the role of the individual AWTs is to:

- Integrate FAA and NASA ATM R&D planning and project execution, including budgets, work, and priorities.
- Be responsible to the Co-Leads and the IAIMT for performance against key project milestones and program outcomes, (i.e., GPRA), including making recommendations to the IAIMT regarding scope, direction, and content of integrated ATM R&D.
- Foster technical exchange, alignment, and integration of ATM R&D programs among participating organizations and the ATM R&D community.

The IAIPT has active management interfaces at the FAA/NASA senior management level, as well as at

the program management level. As shown in Figure 1-4, there is a formal, management interface (vertical) between the IAIPT Co-Leads and the FAA and NASA Associate Administrators, primarily involving the FAA-NASA Coordinating Committee. Established by the MOU, this interface is a traditional management vehicle through which formal reports, requests for action, management direction, and technical and policy direction may pass along established lines of management control.

As illustrated in Figure 1-4, there are working-level interfaces (horizontal) between the AWTs and the program managers of the various agency ATM R&D programs. These interfaces were established by a consensus of the IAIMT members and have been accepted by the FAA-NASA Coordinating Committee. A key aspect of these interfaces is that they occur between organizations, not in an established project/line management chain of either the FAA or NASA. Operationally, decisions regarding R&D requirements definition, strategic program planning, oversight, and user communications are made within the IAIPT (i.e., the IAIMT or AWTs) and are implemented collaboratively by the cognizant agency program. This interface is effective because all affected parties are included in a formal IAIPT decisionmaking process which places a premium on cooperation and coordination.

The FAA partners with the U.S. Military and NASA as well as industry, other government agencies, and international agencies in research and development efforts. With research requirements expanding and costs accelerating, costs must be shared (and duplication of effort avoided) as advanced technology takes the aviation industry into the 21st century.

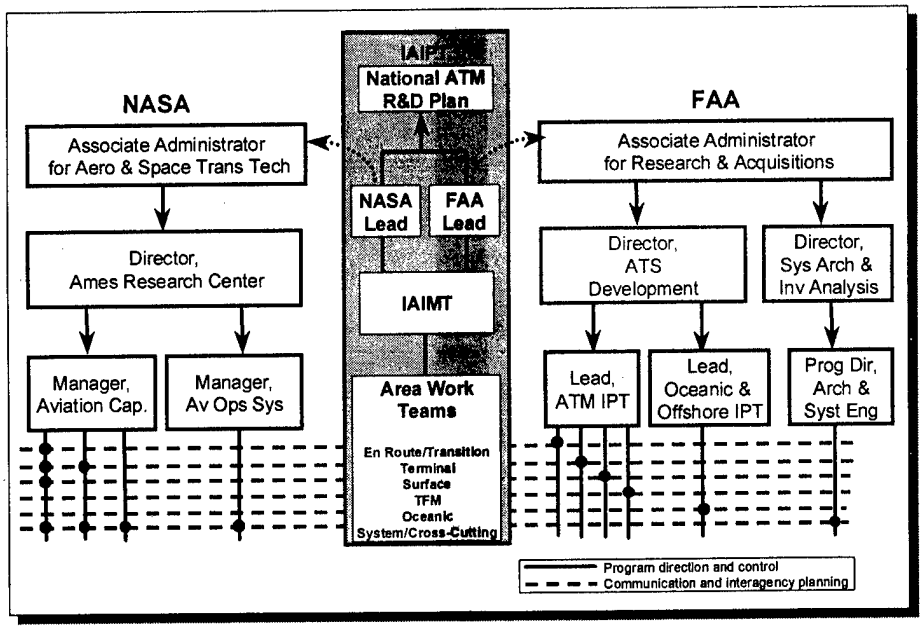

Figure 1-4 IAIPT Interfaces

1.5.2 Cooperative Results

The work described below is representative of cooperation between the FAA, NASA, and primary DOD components.

Traffic Management Advisor (TMA). As part of the Center Terminal Radar Approach Control (TRACON) Automation System (CTAS), TMA Single Center Metering provides en-route/terminal controllers with automation tools to meter aircraft flow rates in the terminal environment. Specific TMA controller tools include an automated miles-in-trail-based scheduling capability, a time-based scheduling capability, and the display of meter lists derived from these functions on en-route ATC displays. Development of the TMA functions for airport arrival flows are planned for and controlled

by en-route sectors in more than one Air Route Traffic Control Center (ARTCC). Scheduled activities include: (1) continued operation of existing prototype systems, (2) deployment of additional prototype systems that can be used in ATM operations, and (3) full-scale development and implementation of functionality for arrival traffic at up to 24 TRACONs/20 ARTCCs. TMA is in the prototype development phase. Prototypes are deployed at the ARTCCs/TRACONs located at Dallas-Fort Worth, Denver, Atlanta, Los Angeles, and Miami.

Passive Final Approach Spacing Tool (FAST). As part of the CTAS, FAST provides the runway assignment and sequence numbers which TRACON air traffic controllers need to maximize airport arrival capacity. Schedule activities include: (1) functional system testing for passive FAST prototype deployment at sites with complex airspace; (2) initiation of prototype deployment activities for sites with complex airspace; (3) operation of existing and new prototype systems; and (4) full-scale development and implementation of the functionality at up to 24 TRACONs. Passive FAST is in the prototype development phase, with a prototype deployed at the ARTCC/TRACON at Dallas-Fort Worth.

Conflict Detection and Resolution. Automatic Conflict Detection (ACD), formerly known as AERA build 1, will provide ATC specialists tools to automatically detect potential future aircraft/airspace conflicts through use of a continuous conflict probe feature and a trial planning capability. ACD enables a controller to determine whether a requested or changed altitude, speed, or route is conflict-free. The system's functionality provides the controller tools which assist in the implementation of free flight in the en-route environment. It will also be integrated with CTAS descent advisor functionality to provide a tool that extends across the en-route domain and into the descent phase of flight. CTAS and ACD are essential to increasing capacity and efficiency of the NAS and satisfying many RTCA recommendations for transition to free flight.

Operations Concept Development and Validation. The FAA will provide a detailed validated operational concept and an integrated system specification encompassing the roles of both the FAA and the users. The development of validated operational concepts is being undertaken in cooperation with the RTCA Select Committee for Free Flight implementation. Validation analysis will include both FAA and NASA simulation capabilities with a great likelihood of user and DOD participation as part of the free flight joint implementation.

Aircraft Modification and Improvement Research. FAA programs to improve the initial and continuing airworthiness and survivability of aircraft have benefited from the interest and support of the branches of service within DOD. The Aging Aircraft program develops information and procedures for the use of technologies which can predict the onset of failures of aircraft structures under a range of representative operating conditions. In addition to FAA and NASA sponsorship, this program receives significant U.S. Air Force funding. The Air Force and FAA are co-participants in funding the Fire Research and Safety program and its efforts to standardize and improve the testing of fire-resistant materials for use in the interior spaces of aircraft. Similarly, the Aircraft Hardening program relies upon significant U.S. Navy participation to develop protection for aircraft against catastrophic structural or critical system failures resulting from in-flight explosions or the effects of electronic interference. DOD also is vitally interested in the development of flight standards underlying the Safety Performance Analysis System (SPAS), which provides critical safety-related data to FAA shareholders regarding the design, maintenance, and operation of their aircraft.

Human Factors Research. Along with FAA and NASA, DOD is a primary participant in the publication of the *National Plan for Civil Aviation Human Factors - An initiative for Research and Application.* This document outlines a coherent national agenda for human factors research and application leading to significant improvements in NAS safety and efficiency. Programs stemming from this and similar research plans have developed and provided useful information to FAA shareholders regarding the effects of human performance on successful navigation, aircraft maintenance, and other matters of importance to commercial and military aviation.

1.6 Government Performance and Results Act of 1993

The R,E&D program development fully supports the concepts and recommendations set forth in the Government Performance and Results Act (GPRA) of 1993. This year the FAA is emphasizing GPRA concepts (outcomes and outputs) in descriptions of the R,E&D program. Explaining the research program in GPRA terms ensures the use of simple and measurable concepts. Figure 1-5 below illustrates how FAA outputs (R,E&D products) are directed towards specific customers. The FAA R,E&D program, explained in detail in Section 2 of this report, is described in GPRA terminology. Each program area is described in terms of outputs that will be used to achieve the desired outcomes.

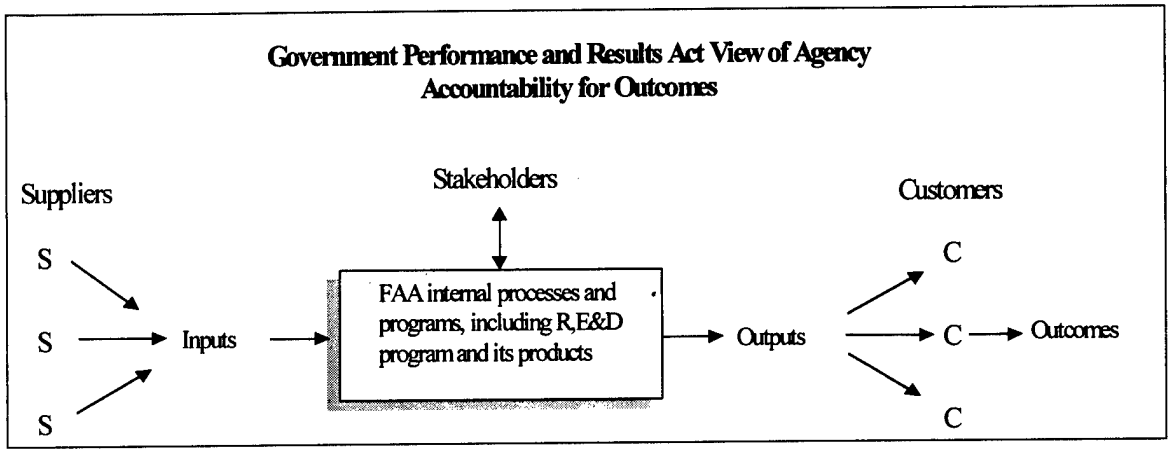

Figure 1-5

The primary challenge in the FAA R,E&D process is understanding how to package emerging technology into R&D outputs (products) that provide value to internal FAA users (Air Traffic Services, Aircraft Safety, etc.), as well as external customers (Air Transport Association, NASA, Air Line Pilots Association, etc.). The secondary challenge is to understand the impact and influence of emerging technologies on the present R,E&D program and to adapt the program to meet future needs.

1.7 Overview of the R,E&D Program

The FAA R,E&D program is divided functionally into seven areas: Air Traffic Services, Airport Technology, Aircraft Safety, Aviation Security, Human Factors and Aviation Medicine, Environment and Energy, and R,E&D Program Management.

Air Traffic Services R,E&D is focused on increasing system safety and capacity and enhancing the flexibility and efficiency of air traffic management operations. A key element in achieving these objectives is the development of decision support tools that will enable FAA air traffic specialists to manage traffic flows more efficiently while collaborating with the user community in making decisions affecting their operations. The R,E&D program is also working to reduce the risks of runway incursions, midair collisions, and aircraft encounters caused by the effects of wake vortices and hazardous weather. Research is developing new technologies that will improve navigational accuracy and provide improved landing guidance. Communication research develops technologies that improve the reliability of pilot-controller communications and permit the exchange of large data files, such as weather data, to pilots. The agency also is working to introduce new technologies in support of a free flight system, whereby aircraft operators would be able to vary their speed and flight path to increase operational efficiency while air traffic controllers ensure that safety is maintained.

Airport Technology R,E&D develops and evaluates technologies designed to ensure and improve safe and efficient operations on the airport surface and in the immediate vicinity of an airport. This research focuses on the development and evaluation of advanced, innovative technologies involving pavement design, construction, and maintenance; airport

visual and navigation aids; rescue and firefighting equipment and procedures; runway friction; and wildlife control techniques. Results of this research are used to update FAA standards for the design, construction, and operation of airports and airport equipment, and are incorporated into guidance material used by airport operators, consultants, and equipment manufacturers.

Aircraft Safety R,E&D is focused on ensuring the safe operation of in-service aircraft. It addresses the hazards that face all aircraft in service, as well as the special hazards endemic to select portions of the civil aircraft fleet. Older aircraft are more susceptible to structural problems associated with fatigue and corrosion. New aircraft, with their digital flight control and avionics systems and associated imbedded software, are more susceptible to disruption from external electromagnetic interference. This research focuses on the development of technologies and standards for the maintenance and modification of in-service aircraft to ensure continued airworthiness. It includes research in structural integrity of airframes and engines, maintenance and repair of composites, atmospheric hazards, crash worthiness, fire safety, and forensics capabilities to support accident investigations.

Aviation Security R,E&D develops technologies and standards that counter the threat of terrorism and criminal acts targeted at aviation. The research focuses on the development and evaluation of passenger, baggage, mail, and cargo screening devices to detect concealed explosives and weapons; aircraft hardening techniques to increase aircraft survivability in the event of an in-flight explosion; human factors aspect of detection and alarm resolution; and integration of airport security technologies and procedures. An important consideration in this research is to develop effective, reliable technologies and procedures which have minimal impact on airport and airline operations.

Human Factors and Aviation Medicine R,E&D directly supports the National Plan for Civil Aviation Human Factors and the validated needs of the agency's lines of business and NAS users. The program addresses major human factors priority areas related to flight deck, ATC, flight deck/ATC system integration, airway facilities, aircraft maintenance, and aeromedical aircraft cabin environments.

Environment and Energy R,E&D develops technical information, standards, and procedures to mitigate the environmental impact of aircraft operations (in particular, noise and air pollution emissions), and to better understand and manage the impact of FAA operations on the environment.

R,E&D Program Management includes the management, planning, control, and support activities associated with formulating the FAA R,E&D program. These efforts ensure that the program is a cohesive and integrated effort, consistent with the FAA strategic goals and objectives, and fully coordinated with stakeholders and customers. It also ensures outside assessment of the FAA R,E&D investments through the active participation of the FAA R,E&D Advisory Committee. The members of the committee represent industry, academia, and other government agencies. R,E&D Program Management also facilitates research partnerships with industry, universities, and other government agencies that enable the FAA to leverage its research dollars.

1.8 Long-Term Research

The Research, Engineering, and Development Management Reform Act of 1996 directed the FAA to identify the allocation of resources among long-term research, near-term research, and development activities.

Long-term research, as defined in the Aviation Safety Research Act of 1988, is a research project which is "unlikely to result in a final rule-making action within five years, or in the initial installation of operational equipment within ten years after the date of the commencement of such project." In accordance with congressional direction, not less than 15 percent of amounts appropriated is to be allocated for long-term research projects. Figure 1-6 shows that 18 percent of the R,E&D appropriation is currently allocated for long-term research projects.

The FAA's R,E&D appropriation is principally associated with applied research. More developmental activities beyond this stage, such as prototype or full scale development, can be found in the Engineering, Development, Test, and Evaluation activity of the FAA's Facilities and Equipment (F&E) appropriation.

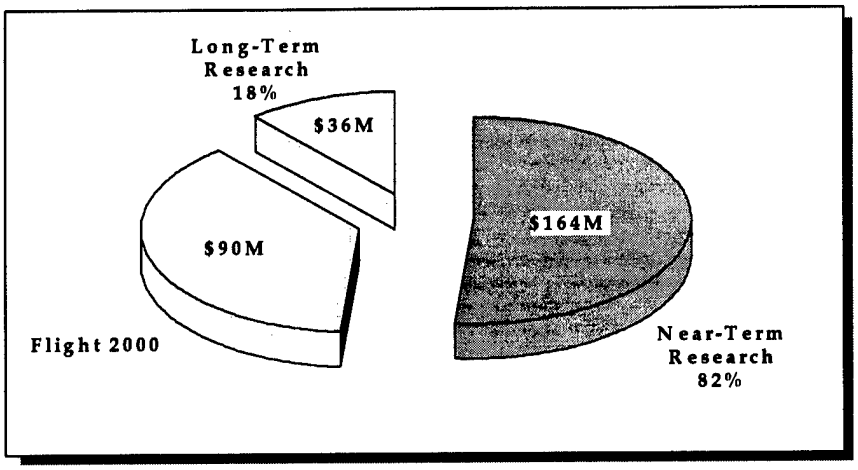

Figure 1-6 Fiscal Year 1999 Long-Term Research

1.9 Document Organization

Unlike previous versions, this plan now lists individual research projects under their respective budget line item program numbers. The six-digit tracking numbers previously used to identify projects can be found on the schedules attached to each program write-up. An alphabetical listing and index is available in Appendix A. The program write-ups are grouped by program area. Preceding each group of write-ups is a detailed description of the program area including mission, outcomes and outputs, structure, customer/stakeholder involvement, and accomplishments.

2.0 Program Information

2.1 Air Traffic Services Program Area Description

Introduction

In addition to large facilities and equipment (F&E) investments in the aviation infrastructure, the Federal Aviation Administration (FAA) makes modest investments in research, engineering and development (R,E&D) to improve the value of services provided in the National Airspace System (NAS). Although demand for system services is expected to rise dramatically over the next 20 years, the current system is already experiencing constraints. As a part of its mission, the Air Traffic Services (ATS) line of business must plan for and be able to respond to changing customer demands in the areas of safety, capacity, productivity, and economy. Pressure is building for the FAA to change quickly from a ground-based to a space-based NAS within a more collaborative and flexible environment. Focused investment in R,E&D is the way to meet these challenges before they become critical and while a smooth transition in services is possible.

Mission

ATS maximizes the use of existing airspace resources to ensure the safe and efficient movement of aircraft. Continuous improvement of the NAS and related services provided to system users is at the heart of the process. The ATS R,E&D program links these services to the future. Listed below are the key services ATS delivers today which must be adapted to the future environment:

- Providing separation assurance so that aircraft can maintain a safe distance from other aircraft, terrain, obstructions, and atmospheric disturbances while they avoid airspace that is unsafe for travel.
- Managing the use of the system to ensure that traffic flows in an orderly and efficient manner under varying weather and equipment conditions.
- Managing and classifying various volumes of airspace to balance the conflicting demands of potential users while maintaining a high level of safety and maximizing the value of the airspace.
- Gathering and disseminating aeronautical information such as weather, traffic congestion, availability of airspace, and aeronautical publications.
- Operating a system of navigational aids allowing pilots to navigate point-to-point without visual reference to the ground.
- Operating a support system to ensure safe and precise landings and take-offs in varying weather conditions.
- Assisting local, state, other federal agencies and private entities in support of their aviation activities. (This assistance sustains the federal mandate for safety and standardization of procedures.)
- Initiating search and rescue activities after determining an aircraft is lost, overdue, or downed, and assisting in the search and rescue process by providing information and direction regarding the missing aircraft.

Intended Outcomes

The ATS R,E&D program is part of an integrated strategy intended to increase the scope and effectiveness of air traffic services while reducing costs. Operations and maintenance (O&M) initiatives, as well F&E investments, are vital to this strategy. Research initiatives allow the FAA to integrate its air traffic services into the global air transportation system. The R,E&D program is the agency's preferred means to leverage its ATS investments in improving services, procedures, and infrastructure. The program also integrates new concepts and technology, as required, to meet demands for improved safety, efficiency, and productivity. Central to the ATS research program outcomes, is an ATS workforce prepared to deliver the future services.

The R,E&D program contributes to the seven ATS programmatic outcomes described below and represents increased value to the users of the system and the American public.

Increase System Safety

Safety is the first priority of the FAA, and the R,E&D program plays a critical role in development of procedures and technologies that continuously improve

the level of safety in the air traffic system. The primary safety-related service of the ATS organization is aircraft separation. The R,E&D program conducts research to determine safe separation distances under varying weather conditions, and researches means to more accurately monitor/ predict aircraft positions. It also looks at ways to prevent runway incursions. Finally, the R,E&D program provides a safety net by forwarding traffic information directly to the pilot when traditional separation efforts fail.

Weather, including clear air turbulence, accounts for a large percentage of passenger injuries. The weather research program improves safety by developing timely forecasting and observation tools that can help pilots avoid encounters with microbursts, thunderstorms, icing, turbulence, and other dangerous weather conditions.

Decrease System Delays

Based on projected traffic increases, under the current system, 29 of the top 50 airports will experience more than 20,000 hours of delay by 2004. The R,E&D program is attacking this problem from three directions. First, it is developing procedures and systems to minimize ground delays and their economic impact. Second, it is developing procedures and systems to maximize the throughput of the airways and the existing airport infrastructure. And third, it is increasing the accuracy of information being exchanged between pilot, controller, air traffic manager, and the airline operations center to increase collaborative decisionmaking among these system elements.

Increase System Flexibility

Flight management and flight planning systems, enhanced by new technologies, will allow users to operate at their selected altitudes, speeds, and routes. These innovations will dramatically improve the efficiency of air transportation.

Increase System Predictability

One of the most effective ways to add value to the NAS is to improve the predictability of service. Weather is a significant contributor to flight delays (65%) and a major factor in aircraft accidents and incidents (30%). High-resolution weather forecasts, in space and time, are possible, but they require graphical display to become useful. Identification of specific aviation weather impacts (e.g., icing and turbulence) through manual analysis can neither provide the information quickly enough nor with sufficient clarity to significantly reduce related delays. Research in this area is intended to improve system responsiveness by providing weather observations, warnings, and forecasts that are more accurate and accessible than those currently in use. Any ability to reduce weather impact on operations fundamentally increases the predictability of the system. More predictable service equates to real savings for the industry and the public, with more flight segments being handled with the same number of aircraft because less time is lost through uncertainty. Less fuel is carried for contingencies and fewer capital resources are tied up to deal with the possibility of unforeseen delays.

Increase User Access

Navigation and landing assistance are core ATS services. Without them, the nation's airspace and airports become useless when weather prevents visual navigation. The R,E&D program contains several key initiatives that make access to navigation, airspace, airports, and landing services available to a wide variety of users under varying conditions.

Thousands of airports and runways, already financed with federal, state, and local funds, become useless when weather conditions prohibit visual navigation. The widespread availability of global positioning system (GPS) signals, along with published GPS instrument approach procedures, will enhance these capital assets and the communities they serve. Our research efforts will ensure that the GPS, Wide Area Augmentation System, and the Local Area Augmentation System services will be available with 100% reliability.

Surveillance research in the area of automatic dependent surveillance-broadcast and other similar technologies improves services for low altitude operations (medivac and offshore operations), coverage in shadow areas (mountains and valleys) and satellite airports surrounding the terminal area. The same technologies provide higher airport throughput by allowing more closely spaced landings and surface movements during inclement weather.

Maintain Infrastructure Service/Equipment Availability Rates

Traditionally, ATS has used an overall equipment availability rate to indicate the basic trends

associated with whether essential NAS subsystems and equipment are available. This overall availability indicator consistently runs over 99%. While the overall equipment availability rate offers some insight into the quality of operational services, a more detailed look at service availability is being taken to assess the impact of subsystem performance, service delivery, the effect of the existing backups, and the most cost-effective way to increase service quality. Even small changes in availability might significantly impact air traffic management and system users.

The ATS performance target is to maintain operational availability of equipment and services, at current high levels, while minimizing impact on the quality and efficiency of the system during service interruptions.

Increase Productivity

It is imperative that the cost of air traffic services be held constant even as the demand for these services increases. R,E&D investments allow the ATS organization to make better use of its 36,000 personnel. R,E&D programs support the consolidation and centralization of maintenance control which will ultimately reduce the escalating cost of equipment maintenance. Other R,E&D programs provide air traffic operations personnel with support tools to enhance their level of control and reduce their workloads. Without programs such as these, the increasing demands of users, despite a dwindling workforce and infrastructure, soon might force the agency to choose between paying higher personnel costs or curtailing services.

Program Area Outputs

ATS R,E&D programs yield operational concepts, simulation results, standards for application of new technologies, prototype developments and evaluations, and software products for integration into operational systems.

Listed below are specific examples of expected outputs of the ATS research program:

- Selection criteria and training methods for operators and maintainers reflecting changes to the operational environment and automation.
- Design guidelines for new systems including the computer human interface and allocation of functions between the operator and hardware.
- Methods to predict outcome performance for future systems and/or procedures in support of the operational concept development and investment decisions.
- Airspace design models to display and modify boundaries and routings.
- Analysis and requirements for separation reductions in a free flight environment.
- Safety models that include new enabling technologies and results of flight tests.
- Hazard avoidance capability.
- Real-time surveillance and identification data provided to controllers and operators of surface aircraft and maintenance vehicles. This will lead to safe, orderly, and expeditious movement of traffic on the airport surface.
- High-resolution and timely provision of information for icing, winds, temperature, and turbulence to improve aviation advisories and forecasts issued by the National Weather Service (NWS).

Program Area Structure

The ATS R,E&D program is structured to support six ATS R,E&D program objectives:

1. Develop and validate new operating paradigms for ATS.
2. Develop tools and techniques to model and measure NAS performance.
3. Reduce weather and atmospheric related incidents, accidents, and capacity constraints.
4. Improve system performance without compromising safety.
5. Reduce ATM/pilot information processing and communication errors and increase data transfer capacity.
6. Improve service availability, reliability, and efficiency.

Customer/Stakeholder Involvement

The ATS R,E&D program actively engages all facets of the aviation community. It directly supports goals and programs delineated in Challenge 2000, the Aviation Safety Plan, RTCA Free Flight Action Plan, and NAS Architecture development. Examples of customer and stakeholder involvement include:

- The R,E&D Advisory Committee (REDAC) provides guidance on FAA's ATS investments. Recently, the REDAC NAS Panel reviewed the ATS research and development (R&D) program and provided draft recommendations on FAA R&D ATS investments in January 1997. In February, the ATS Subcommittee of the REDAC reviewed our proposed FY99-03 investment plan and provided advice. This program has considered the Subcommittee's recommendations and adopted much of their advice.

- The Center of Excellence for Operations Research is an FAA-industry initiative that includes four main universities, nine affiliated universities, and 20 industry partners.

- The National Aviation Users' Forum develops a federal/industry consensus on the needs and priorities for aviation weather information. Participants include the Airline Pilots Association, United, American, and Delta Airlines and other industries.

- The National Plan for Human Factors represents a cooperative effort between the FAA, NASA, and DOD to outline a coherent national agenda for human factors research and development designed to improve NAS safety and efficiency.

Accomplishments

The following accomplishments represent a few of the successes of ATS R,E&D program efforts:

- Over the past year, the Traffic Flow Management Research and Development Program has rapidly developed and demonstrated numerous tools and information exchange mechanisms. These resources facilitate dissemination of NAS information to industry and help to establish collaborative decisionmaking processes.

- The Oceanic Automation Program delivered the first operational prototype Oceanic Data Link System at Oakland Air Route Traffic Control Center (ARTCC), and established requirements, cost, schedule, and technical baselines for the Advanced Oceanic Automation System. A conflict probe decision support tool and satellite voice communications link began operational use at Oakland ARTCC.

- The Surface Movement Advisor (SMA) Program now conducts a successful preproduction prototype operational evaluation of SMA Build 1 at Atlanta Hartsfield International Airport.

- A rapid update cycle analysis and forecast capability is being developed and implemented at the NWS. This provides more accurate and higher-resolution upper winds, temperature, and precipitation data (leveraged with NWS development efforts). Use of more accurate data on hazardous weather and jet streams has resulted in reduced flight times and decreased flight delays.

- Issuance of first-ever forecast of freezing precipitation aloft at the Aviation Weather Center in Kansas City responds to regulatory activities regarding turboprop commuter aircraft. Especially for commuter aircraft, these forecasts increase airspace efficiency, aircraft utilization, and safety.

- The Operation Heli-STAR demonstration in Atlanta permitted the first use of a complete low-altitude surveillance system (without radar services) to provide safer, more efficient traffic advisories.

R&D Partnerships

The Air Traffic Services research program area has been supported and will continue to be supported by partnerships with academic institutions, other government agencies (both U.S. and international), corporations, industry groups, and most recently the Center of Excellence for Aviation Transportation, which is a consortium of universities.

Included below is a partial listing of the partners with which we currently are working to implement our research program:

U.S. Government Agencies:

- Department of Commerce
- Department of Defense
- National Aeronautics and Space Administration
- National Science Foundation
- National Weather Service

International Organizations:

- British Civil Aviation Authority
- EUROCONTROL

- French DGAC
- International Civil Aviation Organization

Academic Institutions:

- Embry Riddle Aeronautical University
- Massachusetts Institute of Technology
- Ohio State University
- Purdue University
- University of Maryland

Non-Profit Organizations:

- AGATE Consortium
- RTCA

Airline Industry:

- America West
- American
- Continental
- Delta
- Northwest
- Southwest
- Trans States
- TWA
- United
- US Air

This listing is included to show not only how closely this research program is linked with the aviation community in terms of addressing their needs, but also to show how the aviation community is working as a team to accomplish vital air traffic services research.

Long-Range View

The ATS R,E&D program described above takes a long-range view of the NAS research operation and maintenance needs. There is no "end state," and "NAS modernization" is only accomplished in general time frames. Much of the work described is predicated on the capability to measure NAS and FAA performance and to model the impact of system upgrades on overall system performance and its effect on system users. Rapidly advancing technology is driving major improvements in how future air traffic services will be provided. Research in some subprogram areas can be reduced after the initial free flight investigations, evaluations and verifications. The analysis and absorption of new systems and procedures into the NAS, however, will always require some level of resources to evaluate and determine how these new elements will be integrated into the complex and highly effective nexus of NAS systems, people, and procedures. Similarly, improvements in ATM, communication, surveillance, and navigation will require R,E&D investments.

A02a Traffic Flow Management

GOALS:

Intended Outcomes: The FAA intends to improve flexibility and reduced delays, while maintaining or improving the level of safety, through new traffic flow management (TFM) capabilities. The following capabilities enable NAS users to optimize operational schedules and reduce operating costs associated with system constraints:

- FAA/industry data exchange capabilities enabling the implementation of collaborative TFM operational concepts.
- Collaborative decisionmaking (CDM) methods and procedures giving NAS users greater flexibility and control over operational decisions and improved flexibility for NAS users operating in the ground delay program.
- NAS flow analysis tools offering traffic managers expanded decisionmaking support, performance assessment, and compliance monitoring capabilities.

Each of the above contributes to cost reductions for NAS users, as follows:

- Reduced routine flying times, departure delays, and better responses to system disruptions; reduced scheduled block times; and saved airlines $360 million a year in operating costs (crew and equipment) for the scheduled domestic jet fleet (reference: RTCA Task Force 3 final report, page 92).
- Increased information flow and more collaborative decisionmaking; reduced delays during national ground delay programs; and saved airlines $221 million a year in crew costs (reference RTCA Task Force 3 final report, page 94, sum of "most likely" entries"). Savings realized from reduced missed connections/cancellations, and improved on-time performance, etc., further increases the savings.

Agency Outputs:

- FAA/industry data exchange. Requirements for users and service providers are identified and operational concepts are demonstrated for the incorporation of emerging technologies. These actions have resulted in improved, more timely electronic distribution and display of user and service provider operational data and better support for FAA/industry collaborative traffic flow planning and decisionmaking.
- CDM. Based on the new information exchange, TFM explores and identifies effective methods and procedures for FAA/industry collaborative decisionmaking. This results in automation applications, algorithms, and procedures to reach operational traffic flow planning decisions. These decisions respond to both user and service provider objectives.
- NAS flow analysis tools. TFM researches analytical tools and approaches used in analyzing historical flow patterns and NAS performance data. This provides real-time operational analyses to users and service providers. It also results in near real-time analyses for use in distributed environments for joint user and service provider traffic flow planning.

Customer/Stakeholder Involvement: The TFM R&D program directly supports the following community initiatives:

- Air Traffic Service Plan (ATSP). The ATSP was created with a five-year forward-looking window with participation from all entities of the aviation community. The need for better operational communications with the users is a prominent theme throughout the ATSP.
- Free Flight Action Plan. This Plan includes the following initiatives directly related to the research planned in this area:
  - Recommendation 6. Develop mechanisms to provide pre-departure feedback to flight planners on potential impacts of flight plan request changes and on system constraints causing those changes.
  - Recommendation 7. Implement rationing-by-schedule during ground delay programs.
  - Recommendation 8. Establish more flexible ground delay program procedures and decision support systems.
  - Recommendation 9. Coordinate military, FAA, and NAS users to define the information and capabilities needed to improve civil use of special use airspace (SUA) during periods when SUA is not used by the Department of Defense (DOD).

- Recommendation 10. Conduct operational trials in one or more SUAs to demonstrate how improved SUA status information exchange can improve civil use during periods when SUA is not used by DOD.
- Recommendation 11. Develop and implement real-time SUA notification between DOD and FAA and between FAA and flight planners.
- Recommendation 14. Improve telecommunication devices to enhance information flow between users and the TFM system on a machine-to-machine basis.
- Recommendation 15. Incorporate airline schedule information (e.g., company delays and cancellations) into FAA decision-support systems and decision processes.
- Recommendation 16. Enhance or replace the air traffic management monitor alert function, including, but not limited to, ways to measure controller workload and function complexity.
- Recommendation 24. Develop methodology and tools to measure and predict dynamic density.
- Recommendation 25. Develop and implement TFM capability for information exchange among users and the FAA. This enables users to be involved in the FAA's TFM decision-making process.

- NAS architecture development. The NAS architecture development effort has produced a target operational concept for the NAS. This concept supports the collaborative partnership philosophy between NAS users and service providers. In principle, the concept states that the responsibility for safe and efficient NAS management should be a collaborative effort between air traffic managers and flight operators.

Accomplishments: The TFM R&D effort accomplished the following during FY 1997:

- FAA/industry data exchange accomplishments included:
  - Initial Industry/Air Traffic Control System human-in-the-loop exercises, of initial CDM functions, were completed using the ARINC network.
  - Aeronautical operational control network (AOCnet) communication architecture was defined and a vendor was selected by the airlines.
  - The aircraft situation display (ASD) to industry (ASDI) Memorandum of Agreement between FAA and service providers was approved.
  - AOCnet became operational July 1997.
  - ASDI became operational August 1997.
- Collaborative decisionmaking accomplishments included:
  - Flight schedule monitor (FSM) beta software was delivered.
  - RTCA Special Committee 191 on collaborative ATM held the initial plenary session to foster CDM efforts.

R&D Partnerships:

- Airline industry. The airlines listed below are actively engaged in our TFM R&D program. They are full partners in determining new CDM functionality, priorities, design, testing, and evaluation.

America West	Southwest
American	Trans States
Continental	TWA
Delta	USAir
Kiwi	United
Northwest	

- Center of Excellence (COE) for Aviation Transportation. The COE, comprised of the University of Maryland, Massachusetts Institute of Technology, the University of California, Berkeley, and their industry partners are key players in collaborative decisionmaking technologies development and evaluation. In addition, the COE provides an opportunity to explore the potential application of game theory, decisionmaking under uncertainty, and artificial intelligence.
- Academia. The TFM R&D group has a long-standing relationship with aviation transportation, operations research, and human factors academic personnel from the following universities:
  - Embry Riddle Aeronautical University

- Ohio State University
- Massachusetts Institute of Technology
- University of Maryland

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

FAA/industry data exchange.

- Completed prototype development and evaluation for ASDI.
- Completed prototype development and evaluation of initial data exchange for Ground Delay Program enhancements.
- Completed concept development and evaluation of both data exchange for NAS status information, and dynamic SUA information capabilities.

Collaborative decisionmaking.

- Completed the prototype development and evaluation of FSM, ration-by-schedule, and schedule compression capabilities (CDM Package #1) and made investment decision.
- Completed concept development and evaluation of Initial Severe WX avoidance, Simplified Flight Plan Substitutions, and Control Time of Arrival capabilities (CDM Package #2).
- Completed Concept Exploration for Collaborative Routing, System Impact Assessment, and Automated Problem Recognition capabilities.

NAS flow analysis tools.

- Completed the initial analysis of the performance assessment and compliance monitoring capabilities.

KEY FY 1999 PRODUCTS AND MILESTONES:

FAA/industry data exchange.

- Complete prototype development and evaluation of the data exchange for NAS status information and dynamic SUA information capabilities.

Collaborative decisionmaking.

- Complete prototype development and evaluation of Initial Severe WX avoidance, Simplified Flight Plan Substitutions, and Control Time of Arrival capabilities (CDM Package #2).
- Complete Concept Development and evaluation for Collaborative Routing, System Impact Assessment, and Automated Problem Recognition capabilities.
- Complete Concept Exploration phase of the Dynamic Density analysis function.

NAS flow analysis tools.

- Complete Concept Exploration for the performance assessment and Compliance Monitoring capabilities.

FY 1999 PROGRAM REQUEST:

In FY 1999, the TFM R&D program will be completing the foundation portion of its research as the FAA/industry data exchange and the near-term (i.e., "low hanging fruit") CDM capabilities transition to the operational TFM system. Concurrently, concept and prototype development and operational evaluations will begin for: (1) the advanced data exchange, (2) automated dialogue and FAA/industry collaborative decisionmaking, and (3) near real-time NAS analysis capabilities.

A02a Traffic Flow Management Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
021-110 Advanced Traffic Management System						
FAA/Industry Data Exchange						
Completed Aircraft Situation Display to Industry Prototype Development	♦					
Completed Data Exchange Prototype Development (PD) for GDP Enhancements	♦					
Complete Data Exchange Concept Development for NAS Status Information	♦					
Complete Data Exchange Prototype Development for NAS Status Information		◇				
Complete Dynamic Special User Airspace Information Concept and Prototype Development	♦					
Complete Dynamic Special User Airspace Information Prototype Development		◇				
Collaborative Decisionmaking (CDM)						
Completed CDM Package #1 PD	♦					
Completed CDM Package #2 CD	♦					
Completed CDM Package #2 PD		◇				
Completed Collaborative Routing CE	♦					
Complete Collaborative Routing CD		◇				
Complete Collaborative Routing PD			◇			
Completed System Impact Assessment CE	♦					
Completed System Impact Assessment CD		◇				
Completed System Impact Assessment PD			◇			
Completed Automated Problem Recognition CE	♦					
Complete Automated Problem Recognition CD		◇				
Complete Automated Problem Recognition PD				◇		
Completed Dynamic Density Analysis CE	♦					
Complete Dynamic Density Analysis CD			◇			
Complete Dynamic Density Analysis PD					◇	
NAS Flow Analysis Tools						
Complete System Performance Analysis CE		◇				
Complete System Performance Analysis CD			◇			
Complete System Performance Analysis PD					◇	
Complete Compliance Monitoring CE		◇				
Complete Compliance Monitoring CD			◇			
Complete Compliance Monitoring PD				◇		

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	8,119	962	1,355	2,986	2,332
Personnel Costs	876	2,107	2,195	0	916
Other Costs	179	431	450	0	39
Total	**9,174**	**3,500**	**4,000**	**2,986**	**3,287**

A02b Oceanic Automation Program

GOALS:

Intended Outcomes: The oceanic air traffic automation program is aimed at: (1) increasing oceanic air traffic capacity and efficiency without degradation to safety; (2) maintaining the U.S. status as the leader in international air traffic control, which will benefit U.S. aircraft and avionics manufacturers; and (3) improving operator fuel efficiency by allowing more aircraft to fly more optimum flight profiles. This will be accomplished through development of new oceanic capabilities that enable user-preferred trajectories and reduced separation standards in the face of increasing traffic, as follows:

- Advanced oceanic automation system (AOAS) development: Increase the capacity of the oceanic air traffic system to accommodate an estimated traffic growth of over 30 percent over the next five years; increase controller productivity; increase the efficiency and cost-effectiveness of flight operations for users; provide new automation infrastructure, including software system and common network interface for domestic and oceanic air traffic control (ATC) systems; and provide conflict probe and other automation support to assist the controller in maintaining safe separation in oceanic airspace.
- Oceanic separation standards: Reduce horizontal separation standards so that users can fly more fuel-efficient routes, taking advantage of winds aloft and using more efficient weather-avoidance routes. The reduction in separation standards will significantly increase capacity in oceanic airspace, resulting in fewer delays for airspace users, increased granting of user preferences, and significant economic benefits to airspace users.

Agency Outputs:

- AOAS development: ATC equipment and procedures that support pilot-controller and ground-ground data communication and automatic dependent surveillance (ADS); common oceanic ground infrastructure that includes a modern flight data processor and improved controller tools; and operational concepts will be developed that will increase controller ability to handle more aircraft and more complex situations and move oceanic operations closer to free flight.
- Oceanic separation standards: Reports on reduced horizontal separation minims, minimum performance standards, data analysis, operational test and evaluation reports, rulemaking to enable reduced separation standards, modified collision risk models, and other data packages required to coordinate changes to international separation standards.

Customer/Stakeholder Involvement:

- Supports the RTCA Free Flight Action Plan by providing elements of the automation foundation needed to support free flight.

Accomplishments: The following R&D projects were accomplished in FY 1996 and early 1997:

- Prototype oceanic data link operational at Oakland Center (9/95).
- Last operational readiness demonstration for the telecommunications processor (3/96).
- AOAS build 1 operational requirements document signed (3/96).
- Cost, schedule, and technical baselines for AOAS build 0 and build 1 approved by the Joint Resource Committee (7/96).
- ISD hardware installation completed at Oakland Center (8/96).
- Conflict probe and satellite voice operational at Oakland Center (10/96).

R&D Partnerships:

- Oceanic separation standards: In January 1994, the FAA made an international commitment to fund a fair share portion of this research to ensure benefits to U.S. customers.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

- Monitored development and operational evaluation of system infrastructure replacement prototype.
- Monitored engineering trials to support ADS capabilities.

KEY FY 1999 PRODUCTS AND MILESTONES:

- Monitor development and evaluate prototype capabilities for advanced controller productivity tools.
- Continue to coordinate international and industry standards.
- Continue developing requirements definition and coordination for system enhancements.
- Continue to conduct benefits and metrics analysis.

FY 1999 PROGRAM REQUEST:

Ongoing research projects will:

A02b - Oceanic Automation Program Product and Activities	Program Schedule FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
021-140 Oceanic Air Traffic Automation						
Oceanic Data Link (ODL) Enhancements						
Complete ADS engineering trials			◇			
Continue To Monitor ADS Development				◇	◇	◇
Traffic Flow Management and Air Traffic Control (ATC) Applications						
Developed Prototype Capabilities for Advanced Controller Productivity Tool	♦					
Coordination of International and Industry Standards						
Final International Agreement			◇			
Benefits & Metrics Analysis of Oceanic Program						
Final Report			◇			

Budget Authority ($ In Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	9,479	6,480	3,346	0	0
Personnel Costs	971	1,262	2,650	3,488	3,006
Other Costs	199	258	543	714	231
Total	10,649	8,000	6,539	4,202	3,237

A02c Runway Incursion Reduction

Runway Incursion Reduction

GOALS:

Intended Outcomes: Develop technologies that minimize the chance of injury, death and damage, or loss of property due to runway accidents/incidents within the civil aviation system. Minimize the risk of runway incursions and increase the efficiency of aircraft movement on the airport surface.

Agency Outputs:

- Develop low-cost airport surface detection equipment (ASDE).
- Develop secondary surveillance capabilities for the airport surface.
- Develop target extractor and data fusion platforms.
- Investigate alternative options such as visual aids (lights, signs), training, and advisory circulars.

Customer/Stakeholder Involvement: The office of Air Traffic Requirements has been actively involved in the development of requirements to meet objectives of reducing runway incursions. Also, language in the FAA's FY 1997 appropriation encourages the FAA to continue research with the objective of reducing incursions. Reducing runway incursions is a very high priority of the National Transportation Safety Board.

Accomplishments: The following R&D projects were accomplished in FY 1996 and early 1997:

- Installed low-cost ASDE at Milwaukee Airport.
- Installed low-cost ASDE at Salt Lake City Airport.
- Installed low-cost ASDE at Norfolk, Virginia Airport.
- Memorandum of Agreement (MOA) with NASA.
- Cost-benefit analysis updated.
- Published Runway Incursion Systems Engineering Management Plan.
- Prototype testing of two industry developed low-cost radars.
- Surveyed secondary surveillance technologies.
- Completed initial study of target extractor and data fusion platform.

R&D Partnerships:

- MOA with NASA. Research on airport surface operations in reduced visibility, contract with Raytheon (s-band radar), Dassault (phased-array radar), ELAR frequency modulated continuous wave (FMCW) radars, and Hughes (secondary sensors). Also, receiving technical support from Volpe National Transportation Systems Center (target extractor).
- Technology transfer. Currently researching runway incursion reduction systems with various contractors. Upon completion of evaluation of systems, specifications will be developed for solicitation of competitive bids for production of successfully demonstrated systems. Periodic briefings to industry during the R,E&D phase will also be conducted to inform industry of FAA's requirements for runway incursion reduction solutions. A Cooperative Research and Development Agreement (CRDA) is in negotiation with Raytheon. In addition, CRDAs and interagency agreements will be considered.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Low-cost ASDE.

- Complete test and final evaluation report of pulse raytheon radar at Houston Hobby and S-band radar at Milwaukee Airport.
- Complete test and final evaluation report of dassault phased array radar.

Low-cost airport movement area safety system.

- Complete test and final evaluation of the target extractor at Dallas/Ft. Worth Airport.

KEY FY 1999 PRODUCTS AND MILESTONES:

Complete prototype testing of technologies including low-cost radars, secondary surveillance systems, target extraction, and other runway incursion reduction alternatives.

FY 1999 PROGRAM REQUEST:

- In FY 1999, funding will provide for full-scale development of three low-cost ASDE systems.

No funding was requested for FY 1998, therefore funding in FY 1999 is necessary to maintain schedule and begin acquisition activities in FY 2000.

Surface Automation Research and Development

GOALS:

Intended Outcomes: The FAA intends to improve the level of safety, increase airport capacity, and reduce costs and delays for aircraft operating on the airport surface through the development of new automation, communications and information distribution capabilities. These capabilities augment operational decisionmaking processes and improve situational awareness of surface operations under all visibility and weather conditions.

Surface movement advisor (SMA) will enhance the national airspace system (NAS) air traffic management systems by providing controllers, airline ramp managers, and airfield operators with unprecedented advisory and information sharing to help minimize congestion and reduce delays on the airport surface. Recipients of this information-sharing initiative will be able to make informed decisions in managing airport surface resources. Specific SMA goals include:

- Facilitate an electronic exchange of flight critical information among airlines, air traffic control (ATC), and airport operators.
- Provide dynamic real-time data to help users increase efficiency of ground movement operations.
- Predict surface events that impact users operational decision process.
- Help users achieve at least 10 percent decrease in taxi-out delays.

This coordination will improve safety by minimizing the risk of collisions and increasing the efficiency of aircraft movements on airport runways and taxiways. It will help meet system capacity needs by reducing constraints/limitations at the top level V delay/operationally-impacted airports while improving the automated infrastructure to provide capacity-enhancing technologies and procedures. It will also create capabilities that ensure safe separation while imposing minimum constraints on system users.

Surface Development and Testing Facility (SDTF) will simulate major level V airport and tower operations. The SDTF will facilitate FAA capital investment decisions by enabling quantitative validation, demonstration, and test of the performance/benefits of new functional capabilities and enhancements prior to developing a field prototype and deploying at national sites. The SDTF will mitigate risks associated with deployment of new capabilities by enabling testing in a pre-deployment environment and will reduce costs associated with pre-deployment site adaptation, functional testing and benefits validation.

Low/zero visibility tower environment R,E&D will develop augmentations to the air traffic tower environment that can provide an operationally useful enhanced or synthetic view of the airport surface during periods of low or zero visibility. This will lead to improved safety and increased use of airport surface capacity under low or zero visibility conditions, and ensure that the use of airport surface capacity is adequate to manage the increased aircraft landing rates expected in the future.

Agency Outputs: The surface automation research & development (R&D) program will produce new tower surface management functions and technologies, which will be validated in pre-production prototype systems in an operational tower/airfield environment. Included will be assessments of airport operational effectiveness, performance, and benefits to assist in investment decisionmaking process. These activities will result in functional packages and specifications that can be transferred for implementation on the appropriate tower automation platform. This program will also result in new air traffic control, airline, and airport operating procedures for the management of aircraft on the airport surface.

The low/zero visibility tower environment R,E&D program initiatives will develop prototype systems that provide synthetic views of the airport surface under all restricted visibility conditions. This will lead to the definition of operational requirements, procedures, emerging technologies, and system requirements for continuous operations under all visual conditions.

Customer/Stakeholder Involvement:

- This R,E&D program directly supports a congressional mandate RTCA task force 3 and resulting FAA commitment to increase airfield safety and reduce runway incursions.

- The surface automation R&D involves the airlines and airport operators through an unprecedented sharing of dynamic, operationally critical information.
- This R,E&D program has involved the customers and stakeholders from concept exploration through the development process of an operational pre-production prototype system. The Air Traffic Services airport and aircraft operators have contributed to the definition of the functional performance of surface automation tools and participated on the program design and management teams.

Accomplishments: SMA concept evaluation and development were completed. SMA (full prototype) installed at Hartsfield-Atlanta International Airport (2/96); airport/ramp towers brought on-line (7/96); completed SUPCOM/NATCA testing (9/96); began operational assessment (10/96); and completed operational assessment (05/97).

R&D Partnerships: This R,E&D program is being conducted in close partnership with NASA through the inter-agency ATM integrated product team, a joint research and technology development program managed cooperatively by the FAA and NASA. The NASA Ames Research Center is a key participant in the R,E&D activities of the program.

Qualifiable benefits to air traffic operators include an increase in terminal area situational awareness reduced radio frequency congestion.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

- Completed construction of the SDTF tower/ airfield simulator.
- Completed SMA enhancements.
- Sustained operation/assessment of the SMA prototype in Atlanta International Airport.

KEY FY 1999 PRODUCTS AND MILESTONES:

- Finalize SMA specification.
- Initiate concept exploration.
- Complete Collaborative Departure Schedule concept exploration.

FY 1999 PROGRAM REQUEST:

- Initial concept development of the user-driven collaborative departure scheduling tool.
- Initiate concept exploration for low visibility tower environment.

A02c - Runway Incursion Reduction Product and Activities	Program Schedule FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
021-200 Surface Automation Research and Development						
Surface Movement Automation Research and Development						
SMA Investment Decisions		◇				
Completed Surface Development Test Facility	◆					
Completed SMA Enhancements	◆					
User-Driven Collaborative Departure Scheduling Concept Development Start		◇				
User-Driven Collaborative Departure Scheduling Prototype Testing Start			◇			
Integration of SMA With Other ATM Functionalities Concept Exploration Start			◇			
Integration of SMA With Other ATM Functionalities Concept Development Start					◇	
Integration of SMA With Other ATM Functionalities Prototype Development Start						◇
Low Visibility Concept Exploration Start						◇
Low Visibility Concept Development Start			◇			
Zero Visibility Concept Exploration Start			◇			
Zero Visibility Concept Development Start					◇	
021-250 Runway Incursion Reduction						
Runway Incursion Plan						
Update Project Plan		◇	◇	◇		
Complete Prototype Testing of Technologies						
Completed FMCW Radar (Salt Lake City)	◆					
Completed S-Band Radar (Milwaukee)	◆					
Phased Array Radar (Norfolk)		◇				
Select System(s) for full-scale validation testing						
FMCW Radar			◇			
S-Band Radar			◇			
Phased Array Radar				◇		
Secondary Sensors				◇		
Target Extractor/Data Fusion				◇		
Complete Full-Scale Validation Testing						
Select System(s) for Acquisition					◇	
Develop the Final R,E&D Project Report					◇	
Complete Acquisition Specification						◇
Contract Award						◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Request	FY 1999 Request
Contracts	7,214	2,457	4,950	5,696	2,269
Personnel Costs	735	1,281	872	252	870
Other Costs	150	262	178	52	29
Total	**8,099**	**4,000**	**6,000**	**6,000**	**3,168**

A02d System Capacity, Planning and Improvements

GOALS:

Intended Outcomes: The FAA intends to develop an overall strategy to enhance capacity. This includes both terminal and en-route airport and airspace assessment of procedures and capacity related technologies. It also includes developing a performance measurement system for the air traffic system to measure FAA progress against customer expectations. This strategy allows programs and projects, coordinating across budgetary lines, to improve investment decisionmaking to achieve optimal strategic and operational results.

Initiatives are implemented in aviation system capacity planning to increase the number of aircraft operations per hour, reduce both en-route and terminal airspace delays, reduce controller work-load, and increase savings. As a result, the FAA, and the overall aviation community, will experience lower maintenance/operating costs. This program: (1) complies with the congressional mandate to produce airport improvement plans; (2) responds to the aviation industry's high priority initiatives for increased capacity; (3) responds to the Presidential Commission on Improved Airline Competitiveness recommendations; and (4) complies with the Government Performance and Results Act (GPRA) of 1993 and Executive Order on Infrastructure Investment requirements.

Agency Outputs: To comply with GPRA, Air Traffic Services (ATS) has developed four areas of capacity-related outcomes: flexibility, predict-ability, access, and delay. These outcomes provide guidance and a framework to enable any ATS R,E&D program to successfully increase the value of services and in parallel, reduce the cost of these services to the public. The capacity program strictly adheres to the guidelines of the following four areas:

Flexibility: The FAA estimates that operators experience $558 million in inefficiencies in the terminal and en-route airspace each year. The capacity program provides models and simulations that assess present shortfalls within the subject airspace. These models and simulations determine the delay, travel time, sector loading, and operating cost effects of all suggested redesign alternatives. Results include:

- The redesign of Chicago O'Hare and Dallas/Fort Worth terminal airspace.
- New arrival routes to Los Angeles and Las Vegas International Airports.
- Airspace suggestion changes to Minneapolis/St. Paul, based on construction of a new runway, at the request of the Minnesota State Legislature.
- Annual savings to the aviation industry at airports and en-route facilities estimated between $450-$500 million annually.

Predictability: The most dominant influence on air transportation is the ability of weather to impose capacity restrictions at major airports. Although many airports are equipped with multiple runways (many converging), resources become extremely restricted due to associated weather minima. The capacity program establishes criteria to develop and improve simultaneous converging instrument approaches with the following results:

- Reductions in approach minimums, ensuring an average capacity gain of 30 arrivals per hour.
- Fundamental increases in the predictability of the system.
- Testing and acceptance for implementation down to a 650-foot ceiling at Chicago O'Hare and Dallas/Fort Worth Airports. Continued testing is expected to decrease the minimum ceiling even lower.
- Anticipated use of the global positioning system.
- Combined savings (both airports) to the air carriers $40 million (estimated) annually.

Access: In the capacity program, the outcomes of predictability (the ability to land at a particular airport) and having access to that airport, are often considered the same thing. Work required to accomplish these outcomes, however, is different. Predictability establishes approaches to increase capacity under certain weather conditions. Access models simulate new technologies and procedures to ensure that these technologies are compatible for the airport in question. Examples follow:

- Precision Runway Monitor - for closely spaced parallel runways with centerlines separated by 3,000 feet (reduced from 4,300 feet).
- Reduced separation of 2.5NM on final approach (reduced from 3.0NM).

- Dependent staggered approaches to closely spaced parallel runways; stagger angle 1.5NM.

Delay: The major capacity program emphasis is to minimize the impact of airport and airspace delay on the overall NAS. One primary program focus is responding to near-term airport-driven capacity issues. It is projected that by 2004, 29 of the top 50 airports will experience 20,000 hours or more of annual delay. This is cause for concern within the aviation industry. Delay reduction initiatives undertaken to date include:

- The capacity program has completed more than 50 airport enhancement projects.
- The program supports the development of an overall capacity strategy that considers: airport and technology conduct, measurement, and assessment; and electronic tools development and application to aid in forming that strategy.
- Investigation of airfield improvements such as new runways and runway extensions, improved approach procedures, and new facilities and equipment such as the precision runway monitor.
- The improvements producing the greatest capacity increases, estimated delay reductions, and cost savings, are described and recommended for implementation in the final design plans.
- The top recommendations at any one airport are estimated to save the aviation industry $75-$100 million annually.
- Since 1994, based on recommendations, 18 new runways have been constructed at major airports.

The FAA's airport and airspace design programs have the dual objectives of (1) addressing tactical improvements, which respond to industry requirement shifts and (2) large-scale investment analysis and optimization planning. The process problem is identification at the local (regional) level with a high degree of coordination among affected facilities and user groups. Various proposed solutions to the problems are simulated, and the results are then compared in order to make intelligent investment decisions.

Example: At the Dallas/Fort Worth (DFW) Metroplex project, which involved substantial Airport Improvement Program, facilities and equipment, and operational investment, we compared the effect on the system of several airspace structures including a "do nothing" scenario. Given the industry's plan to expand operations at DFW, the FAA concluded it was best to expand the airport. This meant designing new airspace, supported by upgraded navigation and communications capabilities along with entirely new arrival and departure procedures. This approach enabled the community to construct a new runway and ground infrastructure. It also enabled the industry to schedule growth and capital investment. This plan instilled confidence that there would be a return on investment since the revised system could support anticipated demand. The industry and local community, therefore, could commit this expanded service to the public. Estimated savings to the aviation industry for the next 20 years is $10 billion.

Customer/Stakeholder Involvement: While the entire capacity program is under the direction of the FAA, customers and stakeholders play active roles in its success. Airport authorities from all concerned airports, air carrier representatives, aviation interest groups, and FAA regional and local air traffic control personnel are an integral part of every airspace and airport capacity task force/project. Joint American/European airspace study through EUROCONTROL - Maastricht Center.

The capacity program annually publishes the Aviation Capacity Enhancement Plan to keep the aviation world well informed of progress and advancements in the capacity arena. Both the national and international aviation community regularly request this document. Scholars in academia also request the document for their aviation studies.

As previously stated in GOALS, the overall capacity program is in line with the Congressional mandates concerning airport improvement plans and agency performance and results.

Accomplishments: Airport and airspace recommendations and redesign studies have produced a conservatively estimated $1.2 billion in savings to the aviation industry. (An accurate estimate is difficult due to the fact that the improvements, either combined or treated individually, are a direct cause of the constant increase in traffic.)

- Prototyped and tested the initial system performance measures.
- More than 50 major airport studies have been completed. Some studies were done more than

once due to growth. Estimated annual savings will be $75-$100 million per airport.

- Three major terminal/en route airspace redesigns were completed: (1) Chicago terminal and 5 adjoining Air Route Traffic Control Centers (ARTCC), (2) Atlanta terminal and 3 adjoining ARTCC, and (3) Jacksonville ARTCC.

The program's achievements reach beyond the borders of U.S. airspace. Inquiries about our modeling and design methods and requests for assistance, have been received from countries in Asia and Europe, i.e., Schipol International Airport, Netherlands, and the new International airport in Seoul, South Korea.

R&D Partnerships:

- In accordance with the annex of the memorandum of understanding between the FAA and EUROCONTROL, the capacity program has established a joint airspace technologies and initiatives group to modernize international aviation. The intended outcome is to meet compatibility requirements between the United States and the rest of the aviation world in such areas as free flight, global positioning system, flight management system, precision runway monitor, and other emerging technologies.

- Partner with major air carriers and business aviation aircraft in the development of financial management systems approaches.

- Partner with NASA to utilize performance measures developed by the capacity program for ATS in compliance with the congressional mandate for GPRA. Participate in joint computer simulation modeling for terminal radar approach control (TRACON) systems including the Center TRACON Automation System (CTAS) and the Standard Terminal TRACON Automation Replacement System (STARS).

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

- Integrated measures into the budget process and GPRA performance reports for investment decisions.

- Completed redesign of Salt Lake City terminal and ARTCC airspace in preparation for the 2002 Winter Olympics.

- Redesigned routes to and from Grand Canyon National Park.

- Initiated Airport Design Studies at JFK and LaGuardia Airports.

- Initiated ground analysis at Salt Lake City and Phoenix Sky Harbor Airports; completed at Las Vegas Airport.

- Initiated redesign of Phoenix Sky Harbor terminal airspace, and Albuquerque and Seattle ARTCCs.

- Completed Newark, LaGuardia, Boston, Tampa, and San Diego Airport Design Studies.

KEY FY 1999 PRODUCTS AND MILESTONES:

- Complete analysis of new and/or additional performance measures for the national airspace system.

- Complete airport design studies at JFK and Anchorage and ground analysis at Salt Lake and Phoenix Sky Harbor Airports.

- Complete redesign/analysis of Phoenix terminal airspace and Albuquerque and Seattle ARTCCs.

FY 1999 PROGRAM REQUEST:

In FY 1999, the program focuses on the capacity enhancement at all major airports as well as on terminal and en-route airspace. Efforts primarily focus on: (1) airports where construction of suggested improvements can be completed within two to three years; and (2) air traffic radar facilities where airspace redesign reduces controller workload and provides the aviation industry with additional flexibility and predictability during flight.

In addition, the program continues to fine tune air traffic system performance measures. These efforts concentrate on reducing the cost of service delivery by targeting and coordinating investments across appropriations.

A02d - System Capacity, Planning and Improvements Product and Activities	Program Schedule FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
024-110 Aviation System Capacity Planning						
Enhance/Design Plans & Consolidated Ops & Analysis Systems						
Aviation Capacity Enhancement Plans (Annual)	♦	◇	◇	◇		
Regional/Airport Design Team Plans	♦	◇	◇	◇		
Performance Measurement/Government Performance Results Act	♦	◇	◇	◇		
Airspace Analysis						
Completed Airspace Redesign Las Vegas, Grand Canyon Area Salt Lake Terminal & ARTCC	♦			◇		
Redesign Phoenix, Seattle ARTCC & Albuquerque ARTCC	♦	◇		◇		
Integrated Measures into the Budget Process and GPRA	♦			◇		
Performance Reports for Investment Decisions	♦			◇		
Redesigned Salt Lake Terminal and En-Route	♦			◇		
Facilities Airspace in Preparation for 2002 Winter Olympics	♦					
Redesigned Routes Around Grand Canyon National Park				◇		
Completion of Newark, Las Vegas, Boston, and San Diego Airport Design Studies	♦			◇		
Analysis of New and/or Additional Performance for the National Airspace System	♦	◇		◇		
Ground Analysis of Phoenix Sky Harbor International Airport		◇		◇		
Anchorage Design Team Project		◇				
Analysis of Low Level Routes Between Northern and Southern California					◇	◇
Analysis of Houston ARTCC Airspace					◇	◇
Analysis of Detroit Terminal Airspace					◇	◇
Ground Analysis For Pittsburgh and Kansas City Airport					◇	◇
San Francisco Ground Task Force					◇	◇
023-120 Separation Standards						
Reduced Horizontal Separation Minimization						
Complete Annual Regional Traffic and Aircraft Performance Monitoring & Analysis	♦	◇	◇	◇	◇	◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	5,865	3,602	3,676	1,354	1,272
Personnel Costs	5,160	4,480	4,377	2,196	2,408
Other Costs	1,057	918	897	450	364
Total	**12,082**	**9,000**	**8,950**	**4,000**	**4,044**

A02e Cockpit Technology

GOALS:

Intended Outcomes: The FAA intends to improve system safety by implementing a viable airborne collision avoidance capability to mitigate the risk of mid-air collisions.

The traffic alert and collision avoidance system (TCAS) is an avionics capability to warn pilots of proximate aircraft and to provide information and guidance for collision avoidance. TCAS I provides traffic advisory information indicating the range, bearing, and altitude of intruding aircraft. Pilots use this information to visually acquire intruders and maintain separation. TCAS II provides traffic advisory information as well as resolution advisories in the vertical plane. Resolution advisories indicate maneuvers (e.g., CLIMB) for collision avoidance.

Agency Outputs: The FAA provides the technical characteristics (technical standard orders) for TCAS avionics and certification guidance (advisory circulars) for installation and operation of the system. The R,E&D program develops the technical and operational information to support these products and is working with the TCAS user community to collect and analyze data to maintain and enhance TCAS.

Currently, the principal focus of the TCAS program is completion of the design and implementation of Change 7 to TCAS II. This change incorporates more than 300 detailed modifications to the surveillance and collision avoidance algorithms and displays in TCAS II avionics equipment. These changes have been developed based on six years of TCAS II operation and have been developed in partnership with industry and users. Timely implementation of Change 7 is essential for the continued safe and effective employment of TCAS II.

The first annual report of TCAS activity will be provided to all interested organizations to review ongoing progress and update future activity. Plans for future applications of TCAS (e.g., free flight) will be developed and implemented in close collaboration with industry and governments.

Customer/Stakeholder Involvement: The FAA has developed TCAS in collaboration with the domestic and international aviation communities. In particular, the R,E&D effort supports RTCA Special Committee 147 and the International Civil Aviation Organization (ICAO) Secondary Improvements and Collision Avoidance System (SICAS) Panel in their efforts to finalize domestic and international standards for airborne collision avoidance systems. RTCA SC 147 provides the principal forum for collaboration among industry, aircraft operators (i.e., TCAS users), and FAA representatives in the development of technical standards for avionics. It also provides the principal means for transferring TCAS technology to industry.

The FAA TCAS program responds to the requirements of Public Laws 100-223 and 101-236, which establish the requirements and time frames for air carrier equipage with TCAS II. TCAS I also responds to CFR 135.180.

The TCAS program will directly support the RTCA Free Flight Action Plan, Future Air Navigation System (FANS) implementation, reduced aircraft spacing standards, oceanic operation, and in-trail climb.

ICAO has been closely monitoring and assisting in TCAS development for many years. Based on TCAS success in the U.S., EUROCONTROL is mandating the use of an airborne collision avoidance system (ACAS) in European airspace in the year 2000. Several Pacific Rim countries (e.g., Japan, Australia) will also mandate ACAS. The FAA has been asked to support these activities.

Accomplishments: TCAS II has been installed on all commercial aircraft operating in the U.S. airspace with more than 30 passenger seats. TCAS I or TCAS II is installed on all commercial aircraft with 10 to 30 passenger seats. More than 9,000 aircraft around the world have TCAS systems on board; approximately 90 million hours of system operations have been accumulated. TCAS has been credited with averting near mid-air collisions in a significant number of documented encounters.

The Air Force, Navy, and Coast Guard are in the process of acquiring TCAS equipment for many of their aircraft, fixed wing and helicopters. The FAA is working with these organizations in developing their requirements for procurement and implementation of these systems.

R&D Partnerships: The FAA is coordinating TCAS program activities with related international efforts

through ICAO and EUROCONTROL. A principal consequence is that technical standards finalized by RTCA SC 147 have been incorporated into ICAO standards and recommended practices which will be used worldwide. ICAO member states, primarily U.K. and Germany, have worked and are working with the FAA on a number of critical developments to ensure that TCAS operates properly in their airspace.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

TCAS I.

- Completed TCAS I transition program.
- Continued data collection and analysis to support the implementation of TCAS I.

TCAS II.

- Began implementation of Change 7 within the user community.
- Initiated data collection and analysis to support Change 7 implementation.
- Continued support to industry to resolve TCAS II implementation and user issues.

KEY FY 1999 PRODUCTS AND MILESTONES:

TCAS I.

- Continue support for implementation and use of TCAS I by industry.

TCAS II.

- Continue support to industry to resolve TCAS II implementation and user issues.
- Initial summary report on the operation and effectiveness of TCAS II Change 7.

FY 1999 PROGRAM REQUEST:

In FY 1999, the user community will continue its implementation of Change 7. This implementation activity is not funded by FAA; however, FAA resources are required to resolve issues associated with the Change 7 installations.

Data analysis efforts supporting TCAS I and TCAS II will continue. These efforts utilize information provided by industry, users, pilots, air traffic controllers, and FAA facilities describing technical and operational difficulties experienced during system implementation. A team of TCAS program experts follows up on every event reported to identify both the source of the difficulty and a remedy to prevent its occurrence. This analysis and follow-up activity has been essential to the successful introduction of TCAS into operational service.

A02e - Cockpit Technology Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
022-110 Traffic Alert & Collision Avoidance System (TCAS)						
TCAS I						
Completed TCAS I Transition Program	♦					
Continued Data Collection and Analysis to Support the Implementation of TCAS I	♦					
Continued Support for Implementation and Use of TCAS I by Industry	♦					
TCAS II						
Began Implementation of Change 7 Within the User Community	♦					
Initiated Data Collection and Analysis to Support Change 7 Implementation	♦					
Continued Support to Industry to Resolve TCAS II Implementation and Use Issues	♦					
Summary Reports on TCAS II Change 7	♦	◇				
Continued Support for Implementation and Use of TCAS II by Industry			◇	◇		

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	2,586	4,526	1,032	1,765	349
Personnel Costs	1,854	1,804	1,633	1,913	1,073
Other Costs	380	370	335	392	220
Total	**4,820**	**6,700**	**3,000**	**4,070**	**1,642**

A02f General Aviation & Vertical Flight Technology Program

GOALS:

Intended Outcomes: The General Aviation and Vertical Flight (GA&VF) technology program supports general aviation (GA) demands through applied research and development, which introduces certifiable and affordable advanced technologies. These technologies provide cost-effective air traffic services, improve safety, and expand the capacity and efficiency of the NAS, especially where communication, navigation and surveillance services are not currently available to GA users. The program office serves as an integral part of the Flight 2000 Program.

General aviation represents one of the most diverse and productive elements of aviation. In addition to the traditional single- and multi-engine airplanes, GA users fly experimental aircraft, helicopters and tiltrotors (known as "vertical flight aircraft"), business jets, and historic aircraft. The GA community includes lifesaving airborne emergency medical services (EMS) and law enforcement services, and is the first line of response in state and local disaster relief operations. The economic impacts of GA are global, but no other nation in the world produces more GA&VF aircraft and related goods and services than the United States. GA is a gross exporter of goods and services and provides the U.S. economy a positive balance of payments impact.

General aviation users currently rely upon existing procedures and air traffic services, but many cannot take full advantage due to technological and economic limitations. Helicopters, for example, must operate heliport-to-heliport to more efficiently support customers and the public. They need different instrument approaches that curve and support deceleration prior to landing.

Access to the excellent traffic advisory services, already available through air traffic management's radar-based technology, would benefit GA if complete surveillance at low altitudes and in built-up urban areas could be provided. Promising non-radar technology research, such as automatic dependence surveillance broadcast, could identify affordable, adaptable ways to meet this critical need. It is also critical to evaluate, through applied research, where technology allows for this increase in service without adversely impacting the already demanding workloads of air controllers and safety inspectors.

The FAA GA R,E&D program supports research and development across the full spectrum of GA operations. The five separate research areas within this program align with the most critical components for GA participation in the NAS-terminal operations: en-route communications and navigation, landing facilities, airmen and controller training, and low-cost avionics.

Vertical flight terminal instrument procedures (TERPS) efforts support the terminal flight arena. Low altitude communication, navigation, and surveillance (CNS) research provides critical data and evaluations for future low altitude en-route infrastructure to support free flight. The marking and lighting area supports the transition from instrument flight to visual approach. The training system area evaluates and recommends optimum uses of technology. TERPS capabilities facilitate implementation and use of advanced technology in the cockpit and at the controllers workstation for GA needs. These efforts are inter-related and support mutual requirements without duplication or added costs (example: ensuring lighting and marking integration with steep angle instrument flight rules approaches and heliport design criteria).

Intended Outcomes: The goal of the GA R,E&D program focuses on the outputs and products of the larger research efforts on specific GA user needs and requirements. These efforts are not duplicated in other FAA R,E&D programs. The GA program area is a collaborative and complementary effort, tailoring the successes and achievements of other, broader scope, efforts into affordable products and tangible benefits for GA. Outcomes of this program support the following strategic goals of the Government Performance and Results Act:

- Improved level of safety. Air Traffic Services (ATS) R,E&D mitigates the risk of low-altitude airborne collisions by adapting affordable global positioning system (GPS)-based surveillance technology at GA airports, heliports, popular resorts and national parks, and in congested terminal areas. This is done by providing traffic information directly to the GA pilot via cockpit displays of traffic information (CDTI).

- Improved flexibility. The goals of the ATS R,E&D program ensure a collaborative and fully integrated air traffic control system. Free flight technologies and procedures are ideally suited to allow GA users to operate at altitudes, speeds, and routes more supportive of their missions and recreational uses. The GA R,E&D program identifies, develops, and evaluates technology to satisfy user needs and support the overall goals to maintain a fully integrated air traffic control system focusing on GA use of free flight procedures.

- Improved predictability. With more access to weather services via data link and short term weather information to GA users, ATS R,E&D allows more aircraft to operate safely in close proximity during periods of reduced visibility and adverse weather conditions.

- Reduced delays. This program researches and develops technology and procedures enhancing the utility of GA facilities. It complements the goals of the air traffic management program and traffic throughput automation systems. Affordable and effective non-radar navigation and communication systems (installed at the more than 17,000 GA airports) will attract more GA users to these facilities and away from the busier hub airports. Also, providing increased instrument flight rules (IFR) capabilities at these airports will reduce GA users' demands at major hub airports during periods of bad weather and poor visibility.

- Improved access. This program is a key element in the ATS R,E&D strategic goal to make access to navigation and landing services nearly universal. GPS makes accurate navigation and landing signals available in the large volume of low altitude airspace not currently provided for by land-based landing signals. Further, GPS permits the use of very low cost avionics, which in turn increases the number of pilots and operators who are able to utilize the safer and more efficient instrument approaches. Investing in the development of GPS instrument approaches planned for use at major medical trauma centers and hospitals nationwide will result in saving over 350 lives each year. This has an equivalent economic value of almost $5 billion over the next six years.

- Reduced costs. This major ATS GA R,E&D program goal contributes to overall goals of phasing out the expensive ground-based infrastructure, and helps realize an expected $3 to $4 billion cost savings during the next ten years. The application of low-cost CNS equipment contributes to this cost savings. This equipment also allows all GA aircraft to become airborne repeater stations, transmitting continuous weather observations, and become part of the NAS infrastructure as well.

Agency Outputs: Although the private sector is responsible for the design and development of specific technologies to accomplish these outcomes, the ATS R,E&D GA program helps generate design criteria, publish advisory circulars and training documents, and provide for collaborative technology integration with the current and future NAS. This program area also provides technical and management expertise to establish highly successful partnerships. The GA&VF program features two major research projects:

Rotorcraft IFR and infrastructure procedures. This research emphasizes the following efforts:

- The Vertical Flight Precision GPS TERPS project is the primary effort producing new precision instrument approaches at heliports and GA airports using GPS. Because existing IFR instrument approach criteria are based upon airplane performance characteristics, these existing IFR approaches do not support most of the missions demanded by IFR helicopters. This project develops criteria and design parameters that provide more effective and affordable instrument approaches to hospitals and corporate and urban business district heliports. Outputs include vertical flight TERPS criteria; certification procedures for potential supplemental type certificates (which permit existing aircraft to add new technologies safely); EMS procedures; IFR EMS training guidelines and design standards such as minimum operational performance standards, minimum aviation system performance standards and technical standard orders. These standards, advisory circulars, and guidelines support planned implementation over the five-year (98-02) schedule for ten medical trauma centers, 150 commercial heliports, five Department of Defense (DOD) aviation facilities, and three vertiports (slightly larger heliports designed to accommodate the new civil tiltrotor aircraft). This program area supports joint DOD and manufacturers' research. This research evaluates cockpit displays design standards and

symbology, air traffic procedures, and airspace requirements for new vertical flight aircraft (i.e., the BB-609 civilian tiltrotor, as well as the military V-22 osprey tiltrotor).

- The low altitude CNS infrastructure projects produce route system guidelines, cockpit display guidelines, noise abatement procedures, terminal and en-route system integration plans for low altitude CNS operations, and cost benefit analyses to improve efficiency and safety within the NAS. The FAA has proposed two test locations, as part of the Flight 2000 project, to test and evaluate these technologies, proposed route design, and procedures. These two locations provide diverse operating environments to expedite necessary technical data collection to support the following development of guidelines, procedures, and plans:
  - Hawaii - This effort adapts technologies such as position and traffic information CDTI, along with map features and data link. This assists in providing safer aircraft separation and helps mitigate flight noise problems in noise sensitive areas.
  - Alaska - As the state with the largest concentration of GA users, Alaska is a prime candidate for enhanced air traffic services using the GPS and CDTI. The adverse environment of Alaska claims many victims each year because radar-equipped aviation services are not available.
- The marking and lighting technology project (which is currently unfunded for FY 1999) produces technical data, specifications, design guidelines, and certification criteria that permit users to provide safer, affordable, and more effective lighting at airports and heliports. This effort, however, is limited in FY 1999 to infrastructure assessments; not low-cost or affordability requirements. Current lighting and marking systems are expensive to operate and maintain. They also require large amounts of real estate. New advances in marking and lighting promise to drastically reduce power and maintenance requirements. Advances in approach guidance systems, specifically GPS and differential GPS, open many GA airports that previously were unsuited for IFR approaches. The outputs of this project produce affordable lighting system standards and criteria to equip these airports for full IFR operations.

Low cost integrated cockpit information system (CIS).

- This avionics project integrates a CIS, intended to provide the pilot essential flight information. The CIS concept focuses on currently obtainable technology and the development of a generic software avionics suite that includes CDTI. This low-cost avionics system is designed to control specific avionics software applications which support individual user requirements. The hardware acts as an electrical interface while the avionics functions are largely in software modules. The plan reduces certification time and improves or streamlines the current certification process while developing a low-cost avionics system responsive to user needs and anticipated future NAS enhancements.

Customer/Stakeholder Involvement: The GA program directly supports goals and programs delineated in Challenge 2000, the Aviation Safety Plan, the RTCA Free Flight Action Plan, and NAS architecture development. The program emphasizes GA&VF community's direct needs (helicopters and tiltrotors). In setting a "zero accidents" goal, Challenge 2000 found that between 1986 and 1994, GA operations accounted for the greatest number of accidents in the NAS. 44,102 of 48,164 accidents recorded by the National Transportation Safety Board were attributed to GA. Because flight crew problems accounted for 19,388 GA accidents, the GA program targets flight crew training as a key research element. Other important causal factors were environment (7,146) and facilities (4,867). The general aviation program accomplishes major research and implementation work in these areas: The Aviation Safety Plan calls for "implementation of a GPS-based ADS capability. . .that the FAA deems appropriate." It sets goals for training airmen and operational personnel in the use of new technology and for upgrading practical testing standards. The plan identifies goals for GPS-based Category (CAT) I, II, and III landing capability. Work is underway to research rotorcraft GPS CAT I procedures. Specific stakeholders include:

- Helicopter Association International
- American Helicopter Society
- National Business Aircraft Association
- Experimental Aircraft Association

- General Aviation Manufacturers Association
- National Association of State Aviation Officials
- National Emergency Medical Services Pilots Association
- Advanced General Aviation Transport Experiment (AGATE)
- Small Aircraft Manufacturers Association
- Association of Aero Medical Services
- Airborne Law Enforcement Association

Accomplishments: The recent success of the applied technology demonstration in Atlanta (Operation Heli-STAR) validated ATS GA R,E&D program technical approach and management concepts. This permitted the first complete low-altitude surveillance system with the ability to provide traffic advisories more safely and efficiently than ever before possible. The R,E&D non-precision GPS approach project has resulted in the saving of over 70 lives. These lives would otherwise have been lost had not the aircraft been able to land directly at the hospital during bad weather and poor visibility. The program has produced design guidelines to more effectively integrate GA aircraft into disaster relief operations. It has also produced a series of pilot training documents to enhance GA crew resource management and decisionmaking. The program recently concluded support of the congressionally mandated Civil Tiltrotor Development Advisory Committee. The program produced a series of documents laying out a logical plan to develop and implement this exciting new technology into the NAS. In the past two years, GA&VF program FAA teams have received over 40 individual and organizational awards from various stakeholders recognizing excellence, customer focus, and program-generated products.

R&D Partnerships: The GA R,E&D program has unique R&D partnerships with industry. A partnership of 12 private sector companies and corporations, working together with GA&VF program teams, develops GPS precision approaches for rotorcraft. The successes of Operation Heli-STAR were due to the effective teamwork of over 230 individuals from over 30 public and private organizations. General aviation infrastructure and air crew training work is accomplished under the FAA/NASA AGATE program, a structured partnership between government and industry, in which industrial contributions make up 50 percent of the needed resources.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Air and ground infrastructure development.

- Completed required research to support non-precision GPS approaches for emergency medical facilities.**
- Completed initial flight testing for CAT I GPS precision approach TERPS criteria.**
- Completed initial planning for the Alaska low altitude demonstration project.**
- Completed obstacle-rich environment report (September 1998).**
- Developed CAT II rotorcraft TERPS criteria (September 1998).**
- Developed advisory circular - Integrating Rotorcraft Assets into Disaster Relief Planning.*

Aircraft/aircrew systems enhancements.

- Developed an enhanced decisionmaking helicopter pilot training manual; expert decisionmaking (EDM) manual and safety and audio visual training aids.**

Civil tiltrotor technology analyses.

- Initiated action to introduce tiltrotor technology into the NAS.**
- Supported state and local government analysis on establishing a vertiport network in the Northeast transportation corridor.**
- Developed the Civil Tiltrotor Infrastructure Development Plan and established roles/responsibilities for joint government/industry team.**
- Established regional test site connecting several communities in a civil tiltrotor regional transportation system demonstration project.**

KEY FY 1999 PRODUCTS AND MILESTONES:

- Design, develop, and implement advanced aeronautical decisionmaking training for pilots.*
- Publish revised vertiport design advisory circular.*

- Publish CAT I GPS precision approach TERPS criteria.
- Establish joint FAA/DOD low altitude routes system test bed at Quantico, Virginia.

FY 1999 PROGRAM REQUEST:

- Initiate FAA research to safely and effectively introduce tiltrotor technology into the NAS.**
- Complete CAT II criteria and continue researching CAT III GPS precision approach TERPS criteria for vertical flight aircraft .
- Develop rotorcraft low noise conversion corridor criteria.**

* Denotes efforts performed with in-house resources only (as they become available).

** Denotes efforts performed with in-house resources and anticipated financial partnership with industry, DOD and NASA, or additional FAA R,E&D contract dollars.

A02f - General Aviation & Vertical Flight Technology Program Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
022-141 Low-Cost Avionics						
Cockpit Display of Traffic Information (CDTI)						
Complete CDTI-1 Field Trials			◇			
Complete Cost Benefit Analysis			◇			
Publish Final ADS-B Avionics Standards				◇		
Complete CDTI-1 Operational Testing & Evaluation				◇		
Complete CDTI-2 Field Trials					◇	
Complete CDTI-2 Operational Testing & Evaluation						◇
Publish Final CDTI-2 Standards						◇
022-142 Rotorcraft Instrument Flight Rules (IFR) Procedures						
Air and Ground Infrastructure Development						
Completed Flight Testing for Category (CAT) I GPS TERPS Criteria	♦					
Completed Obstacle-Rich Environment (ORE) Report	♦					
Developed CAT II Rotorcraft TERPS Criteria		◇				
Complete CAT II & Continue CAT III GPS TERPS Research		◇				
Avionics Prototype Complete				◇		
Ground Station Prototype Complete					◇	
Civil Tiltrotor Technology Analyses						
Developed Civil Tiltrotor Infrastructure Development Plan		◇				
Initiate FAA Research to Safely and Effectively Introduce Tiltrotor Technology into the NAS		◇				

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	4,475	2,085	1,486	0	1,462
Personnel Costs	300	427	925	0	1,240
Other Costs	62	88	189	0	200
Total	**4,837**	**2,600**	**2,600**	**0**	**2,902**

A02g Flight 2000

GOALS:

Intended Outcomes: With the Flight 2000 program, the FAA intends to accelerate the implementation of free flight concepts and harmonize the global air transportation system, providing increased safety for the flying public and efficiency benefits for system users. Flight 2000 validates the new air transportation system operational concepts in a small portion of the entire air transportation system. This allows implementation processes to be perfected prior to transitioning the entire national airspace system to a free flight infrastructure. Specifically, Flight 2000 provides the following:

- Accelerated achievement of free flight safety and increased economic efficiencies in air traffic management and control operations.
- Increased air traffic services to Hawaii and Alaska general aviation, air taxi, and regional carriers.
- Increased air carrier operational efficiency in the Pacific Oceanic environment and associated Continental U.S. (CONUS) transition airspace.
- Increased air transportation system safety in the Hawaii and Alaska Airspace.
- Reduced costs for avionics and ground-based systems through resolution of design and operational use issues prior to full-scale production of systems and equipment.

Agency Outputs: Flight 2000 delivers vital services and products that pace the implementation of the free flight era; and it accelerates modernization of the national airspace system. Key to achieving Flight 2000 outputs, system integration merges the program engineering, avionics, ground system development and evaluation pieces of the program to provide the following services and products:

- New global positioning system (GPS) based navigation and landing services for Alaska and Hawaii.
- Situational displays for pilots.
- Operational procedures that take advantage of the avionics suite situation display.
- Graphical weather information displayed in the cockpit.
- Surveillance service for air routes where none existed before.
- Validated air traffic management operational concepts.
- Validated air traffic control operational concepts.
- First implementation of ground-side automatic dependent surveillance - broadcast (ADS-B) surveillance systems.
- Incorporation of ADS-B surveillance data FAA aircraft tracking systems into the micro En-route Automated Radar Terminal System (EARTS), and the Standard Terminal Automation Replacement System.
- Controller to pilot data link service.
- Improved oceanic conflict probe.
- Concurrent development of airborne and ground system procedures and training.
- Quantified cost/benefit data for the free flight concept of operation.
- General aviation, regional, air carrier, DOD and U.S. Coast Guard (USCG) aircraft equipped with free flight era avionics.
- Streamlined certification process for new avionics or modifications of present avionics.

Customer/Stakeholder Involvement: A report issued by the White House Commission on Aviation Safety and Security (February 1997) challenged the FAA "to develop a NAS modernization plan ... that will set a goal of the modernized system being fully operational nationwide by the year 2005." The FAA is answering this challenge with the Flight 2000 program as an initial step toward achieving this goal. This program has been planned using input from the RTCA Government/Industry Free Flight Steering Committee, including representation from the Aircraft Owners and Pilots Association, Regional Airline Association, Air Transport Association, and other national/international aviation community representatives. The successful accomplishment of Flight 2000 is a performance goal of the FAA and of the Department of Transportation.

Accomplishments: FY 1999 is the first year that Flight 2000 could be included in the FAA R,E&D

budget process. During FY 1998, the FAA is accomplishing planning tasks that must be completed prior to the start of Flight 2000 implementation in FY 1999. The initial program planning activities are as follows:

- Definition of a Flight 2000 operational concept and evaluation.
- Canvassing of avionics manufacturers to stimulate early competition for low-cost avionics.
- Development of a system-level plan to implement Flight 2000 capabilities in Alaska, Hawaii, and Oakland Air Route Traffic Control Center (ARTCC) oceanic and domestic airspace.
- Development of a Flight 2000 integrated program plan.
- Incorporation of Flight 2000 as one of the National Science and Technology Council Committee on Transportation research and development goals (next generation air transportation system).

R&D Partnerships: Flight 2000 is based on the principle that government, unions, and industry must share in the development of the free flight era global air transportation system.

The principal Government partners in this process are DOD, NASA, and the USCG. Satellite-based global positioning system (GPS), multiband-multimode software programmable radios, information distribution systems and other important Flight 2000 technology stems from DOD development programs. As participants in the Flight 2000 operational evaluation, DOD and USCG will install Flight 2000 avionics suites, provide training for their air crews, and fly their aircraft as part of the program. NASA's ongoing advanced general aviation technology experiments (AGATE) program will be a major contributor to the development of the Flight 2000 avionics suite.

Unions representing pilots, controllers, and technical support personnel along with associations representing the private pilot are included in Flight 2000 planning, the actual conduct of Flight 2000 operations, and the operational benefits evaluation. The implementation of Flight 2000 operational capabilities is estimated to give pilots, controllers, and technicians the information needed to increase safety and efficiently accomplish their tasks. Controllers, pilots, and technicians provide operational assessments of new capabilities and associated operating and certification procedures.

The aviation industry (including general aviation, avionics manufacturers, aircraft manufacturers, air carriers, & regional airlines) contributes expertise in defining the Flight 2000 avionics suite and eventual installation of the avionics on aircraft participating in the program. These participants also develop procedures and training packages for the pilots and technicians.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Flight 2000 will accomplish the following during FY 1999:

- Awarded the avionics acquisition contract - this achievement allows completion of avionics installation by March 2002.
- Award development and acquisition contracts for ground systems such as GPS reference stations, micro-EARTS modifications, ADS-B ground stations, and flight information broadcast services to include graphical weather.
- Simulate the Flight 2000 operational environment including extensive human-in-the-loop experiments.
- Develop performance measurements for air traffic management and air traffic control processes used in Hawaii, Alaska, and Oakland airspace.

KEY FY 1999 PRODUCTS AND MILESTONES:

Engineering and evaluation.

- Complete preliminary analysis of Flight 2000 baseline data.
- Complete preliminary design of the Flight 2000 operational evaluations in Alaska, Hawaii, and Oakland ARTCC.
- Complete preliminary assessment of proposed Flight 2000 operating procedures (using modeling and simulation techniques).

Avionics.

- Complete preliminary installation engineering and develop certification procedures.

Ground systems development/deployment.

- Install the first GPS reference station in Alaska.

- Begin the final test and evaluation for 7 of the 14 systems under development and acquisition.

FY 1999 PROGRAM REQUEST:

FY 1999 funding completes preliminary engineering, certification, and evaluation tasks. Funding also completes the development and acquisition phase for most of the ground systems necessary for the Flight 2000 operational evaluation. Acquisition, testing, and installation activities requiring additional funding will be requested as part of the FY 2000 budget.

A02g - Flight 2000 Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
025-150 Flight 2000 Operational Evaluation						
Program Engineering & Evaluation						
Flight 2000 Operational Environment Simulations Completed		◇				
Development of Performance Measures Completed		◇				
Flight 2000 Implementation Plan Completed		◇				
Complete Analysis of Flight 2000 Baseline Performance Data			◇			
Complete Design of Flight 2000 Operational Evaluations			◇			
Complete Assessment of Proposed Operating Procedures			◇			
Avionics						
Avionics Acquisition Contract Awarded		◇				
Acquire 1000 Avionics Suites			◇			
Complete Installation Engineering and Develop Cert. Procedures			◇			
All Avionics Acquired and Installed					◇	
Ground System Development/Deployment (HI/AK/OAK)						
Dev. and Acquisition Contracts Awarded (11 of 14) Req. Sys.		◇				
Install First WAAS Reference Station in Alaska		◇				
Begin Final Test and Evaluation for 7 of 14 Systems Under Development and Acquisition		◇				
Install Digital AATIS in Hawaii and Alaska			◇			
SATCOM (LEO/MEO) - Testbed IOC				◇		
ADS-B - Non Mode-S Requirements Complete				◇		
HF Data Link Testbed IOC				◇		
Flight Information Services (Including Graphical Weather) Available					◇	
ADS-B Surveillance and Separation Services Available					◇	
Improve Controller to Pilot Datalink Service Available					◇	
Micro-EARTS/ADS-B Modification Completed					◇	
STARS/ADS-B Modification Complete (Anchorage)						◇
Oceanic Conflict Probe Upgrade Completed					◇	
Operational Evaluation						
Begin Evaluation					◇	
Testbed Evaluations Begin					◇	
Analysis of Evaluation Data						◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	0	0	0	0	86,000
Personnel Costs	0	0	0	0	3,800
Other Costs	0	0	0	0	200
Total	**0**	**0**	**0**	**0**	**90,000**

A02h Operations Concept Validation

GOALS:

Intended Outcomes: Integrated guidance to the aviation community for the development and transition to a modern national airspace system (NAS). This guidance includes system specification, roles and responsibilities, and procedures, training, and certification requirements.

The RTCA Free Flight Steering Committee, the FAA's RE&D Advisory Committee, The White House Commission on Aviation Safety and Security, and numerous other members of the aviation community have called for the development and validation of a Concept of Operations for Modernization. This concept is to be used as the driver and the integration guidance for the transition from the current rigid procedures and outdated, failing infrastructure to a free flight environment. The RTCA Task Force 3 provided the modernized NAS capability descriptions sought by the user community. The validated operational concept describes how each part of the NAS, both ground and air, interacts to provide the capabilities while transitioning to a new infrastructure involving planners, pilots, service providers, and systems.

Agency Outputs: The agency provides:

- A well defined and well understood ("validated") operational concept to guide aviation community NAS modernization efforts wherein the technical, operational and economic (cost-benefit) performance of the target new system has been thoroughly described based on system modeling and simulation.
- Validated, integrated, configuration-managed requirements for the subsystems of the target new system to provide a coherent, comprehensive framework to guide the associated research and development activities (e.g., specific requirements for surveillance system capabilities, Surface Management capabilities, Advanced Concept Probe, etc.)
- Top-level designs for the major new ATM capabilities and subsystems associated with the operational concept (e.g., the ground-based and airborne information infrastructures required for modernization and the design of a capability to dynamically tailor an air traffic controller's airspace responsibility to more efficiently accommodate traffic demand).
- A system-level safety assessment of the operational concept and associated new capabilities.
- A risk mitigation plan to guide the development activities for new capabilities.
- A human factors validation plan that provides a comprehensive roadmap of activities to ensure that new functionality will be operationally acceptable to flight crews and controllers.

Customer/Stakeholder Involvement: The RTCA Select Committee for Free Flight Implementation cooperates in operational concept development and validation. Its ATM Operational Concept Subcommittee participates to provide the user perspective and detail into both the initial narrative as well as each additional layer of detail. The participation ensures that the concept reflects the requirements of the user community and is essential for validation of a concept for a modern NAS based on a shared, integrated infrastructure.

Accomplishments: The vision for the modern NAS has been developed and published in the *Government/Industry Operational Concept for Free Flight* (RTCA, August 1997) and *A Concept of Operations for the NAS Airspace System in 2005* (Air Traffic Services, September 1997). These documents have provided guidance to the development of the NAS Architecture Version 3.0. Additional detail has been provided through appendices in FY 1998.

The validation of the concepts, the associated top-level designs, risk mitigation planning, and the coordination of a validation plan with the human factors activity, the end-to-end certification are activities to be initiated with this start in FY 1999.

R&D Partnerships: This work directly relates to the FAA/NASA Memorandum of Understanding ATM research and development. The work under this program is coordinated through the joint Integrated Product Team Plan to ensure NASA's efforts are a complement to and integrated into the NAS Operational Concept. NASA contributes in the development and validation of flight deck concepts and in the far-term ATM system development.

The Concept Development and Concept Validation work is also coordinated with the European community via agreements with EUROCONTROL. This effort ensures that unique solutions/transitions

are not developed in different quadrants of the globe imposing an undue burden on U.S. carriers, manufacturers, and others that participate in the global airspace system.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Operational concept development.

- Developed, in conjunction with the Free Flight Select Committee, the projected 2005 operational needs and requirements concept documents for the modernized NAS.
- Developed roles and responsibilities based on the operational needs and requirements concept document for 2005 "mid-term."
- Developed distributed simulation standards to support concept validation activities.
- Development of the concept validation schedule and test plan.

KEY FY 1999 PRODUCTS AND MILESTONES:

Operational concept development.

- Develop task assignment information and information performance requirements based on the operational needs and requirements concept document for 2005.
- Perform engineering technical task analysis and develop related concept documents for the 2005 "mid-term."
- Develop scenario descriptions based on engineering technical task analysis concept document for the 2005 "mid-term."

Concept validation.

- Develop executable information flow tool.
- Perform operational analysis, including fast-time simulation.
- Conduct joint FAA/NASA/user concept validation activities including human-in-the-loop simulations.

Concept system design.

- Conduct dynamic resectorization infrastructure impact analysis.
- Develop reliability standards for modernized NAS.
- Develop end-to-end certification methods

FY 1999 PROGRAM REQUEST:

The FY 1999 request expands the initial operational concept narrative into a detailed description of the NAS. This includes roles and responsibilities, task taxonomy, and information flows and scenarios (by domain). An executable information flow tool capability is developed to begin the validation process. This capability analyzes and conducts information flow analysis and begins both operational analysis and human-in-the loop simulations. The expected operational analyses for FY 1999 include a comprehensive analytic look at sector sizing and shape. This effort looks at how to identify flow and density in a non-route environment, how to size and shape the sectors to meet the flow, and how resectorization is to be utilized in the future.

An expanded test-bed for modernization is being developed to support the integrated FAA/NASA/user concept simulation. Prior work on distributed simulation standards and database for joint simulations is completed and supports these efforts.

Leveraging work being conducted at NASA Langley for safety assessments, a methodology for safety and reliability assessment for the joint air-ground infrastructure will be developed.

A02h - Operations Concept Validation Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
028-110 Operations Concept Validation						
Operational Concept Development						
Developed Operational Needs and Requirements Concept Documents for "2005"	♦					
Develop Roles and Responsible Based on the Operational Needs and Requirements Documents for "2005"	♦	◇				
Perform Engineering Technical Task Analysis and Develop Related Concept Documents for "2005"		◇				
Develop Scenario Descriptions Based on the Engineering Technical Task Analysis Documents for "2005"		◇		◇		
Develop Operational Needs and Requirements Concept 2015		◇				
Develop Roles and Responsibilities Based on the Operational Needs and Requirements Documents for "2015"			◇	◇		
Perform Engineering Technical Task Analysis and Develop Related Concept Documents for "2015"					◇	
Develop Scenario Descriptions Based on the Engineering "2015"					◇	◇
Technical Task Analysis Documents for "2015"				◇		
Concept Validation						
Develop Executable Information Flow Tool		◇				
Perform Operational Analysis, Including Simulation		◇	◇	◇	◇	◇
Conduct Information Flow Analysis			◇	◇		
Perform Human-in-the-Loop Simulation			◇	◇	◇	◇
Develop Test-bed for Modernization			◇	◇		
Develop Distributed Simulation Standards & Database	♦	◇				
Concept System Design						
Conduct analysis for End-to-End Certification for Mixed Ground and Air Infrastructure		◇	◇			

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	0	0	0	0	3,412
Personnel Costs	0	0	0	0	3,099
Other Costs	0	0	0	0	307
Total	**0**	**0**	**0**	**0**	**6,818**

A02i Software Engineering R&D

GOALS:

Intended Outcomes: The FAA intends to improve the National Airspace System (NAS) and avionics safety, and to reduce NAS and avionics acquisition, development, and maintenance costs by developing and implementing improved processes and procedures for the safe use of software within the NAS and avionics. These actions will directly benefit all elements of air transportation, including passengers.

The FAA has come under strong criticism by the GAO and the R,E&D Advisory Committee for its lack of software competency in the acquisition and maintenance of software-intensive systems. This lack has been judged to increase the costs of and decrease the quality of new software intensive systems. The large majority of NAS systems currently in operation and planned for the foreseeable future are software-intensive systems. Eight of the nine high drivers of change in the next eight years, as identified by the Office of the Associate Administrator for Research and Acquisitions, involve the addition or improvement of software-intensive systems.

The FAA Software Engineering Resource Center (the Center), to be established by the end of FY 1999, will be a focal point for research on FAA software-intensive systems. Through the use of interdisciplinary teams, which need not be collocated, the Center will leverage government, academic and industry resources. The Center will be a FAA-wide resource to address strategic software technology problems that impact mission performance. The primary facilities for the Center will be established at the FAA Hughes Technical Center and at FAA headquarters. Remote tie-ins with other facilities are also planned, e.g., at other research sites such as NASA and the EUROCONTROL Experimental Center.

Agency Outputs: The principal products of the efforts of the Software Engineering Resource Center will include a series of standards, guidelines, models, and evolvable prototypes which demonstrate, validate and verify the safety properties, performance and other critical attributes of new technologies that are to be used within the NAS. Also, the Center will evaluate and validate improved software processes, methods and engineering tools that enhance architecture, systems and software engineering, testing and certification functions over the lifecycle of NAS systems.

The specific focus and outcomes of the applied research work of the Software Engineering Resource Center are as follows:

NAS Architecture research:

- Evaluation and prototyping of high integrity, safety-critical architectures. The objectives of this research are to find better and cheaper ways of assuring integrity in safety-critical architecture design, that jointly addresses hardware and software. This may potentially eliminate a need for independent certification of the software.

- Architecture definition and description. This research will investigate unified approaches to formal architecture definition and description for cost-effective evaluation and comparison of competing candidate architectures.

- Analytical and simulation architecture models for the NAS. This research will investigate the effect of various constraints on NAS operational concepts, and optimization of constraints, including cost and performance, prior to committing resources to system implementation and deployment.

The specific outputs of the architecture research will be: guidelines and standards for the definition, representation and design of high integrity architectures for the NAS; and, executable and re-useable architecture models which can be extended or tailored to support domain specific engineering and product acquisitions for the NAS.

Research on Applying commercial-off-the-shelf (COTS)/non-developmental item (NDI) within the NAS ground systems and avionics.

- COTS/NDI software assurance research. This research will directly support the Flight Controls and Digital Avionics Systems RPD by investigating conditions under which a COTS software product can be certified to a given level of safety, as defined by current standards. It will help establish selection criteria and evaluation guidelines for ongoing work in Information Security Product Evaluation and a number of other related areas, such as NAS Infrastructure. It also will identify and evaluate techniques for reducing the cost and time needed to ensure that COTS/NDI

software, or systems containing COTS/NDI software, are safe and function as required.

- Evaluation and prototyping of systems and software engineering processes and methods for use in COTS intensive systems. This research will identify and evaluate more effective practices for use in software requirements definition, software/systems analysis and design, and testing that are appropriate for safety-related systems using COTS/NDI software. It will include investigatation of different methodologies to quantify, characterize, and guard against the risk of unexpected activation of unplanned for COTS functionality for a given system and environment.

- Software estimation models for COTS-intensive systems. There will be an investigation of better ways of estimating and predicting the lifecycle costs of COTS-intensive systems. This study will include consideration of the complex interactions of major cost and schedule drivers that relate to the evaluation, interfacing, integration, product refreshment, and maintenance of COTS.

This research will result in a set of evaluation criteria and guidelines for COTS software proposed for use in safety-related aviation systems.

Software certification research.

- Processes for certification of the software aspects of safety critical airborne and ground-based systems within the NAS. Current certification processes require a long lead-time, and are costly to perform. Resulting delays affect the equipage of aircraft with modern, affordable avionics, and are a significant contributor to the long lead-time required for NAS modernization. This research will explore promising techniques for streamlining the certification process without affecting levels of safety.

- Processes for ensuring end-to-end safety and certification of integrated air and ground systems within the NAS. The air and ground segments of the NAS are becoming more integrated through the introduction of new services such as data link. The current practice of separately certifying the airborne and ground components of the NAS can no longer ensure safety of the integrated air-ground system. This research will investigate and validate different approaches for performing end-to-end safety assessments and certification of integrated air-ground systems of the NAS.

This research will result in a series of guidelines and processes for improved certification of avionics and ground systems. Specific recommendations will also be provided to the appropriate RTCA committees which develop standards and guidelines for certification of avionics systems.

Customer/Stakeholder Involvement: : The goal of the streamlining software aspects of certification is to assess the cost and schedule drivers of the software aspects of certification for both avionics and ground systems, and to prototype solutions which show promise to reduce cost and schedules. This supports high-level FAA objectives.

Recommendation R-14 of the "Report of the Challenge 2000 Subcommittee of the FAA RE&D Advisory Committee for the Administrator" reads, in part: "The FAA should conduct an in-depth analysis of processes within the FAA which are affected by COTS/NDI technologies .... 5. Identify new methods to test and validate safety-critical systems that are not dependent on source code analysis. 6/7. Investigate ways to reduce cost and time to (re)establish high confidence in a system ... 18. Promote software technology and process improvement techniques . . . ." The COTS/NDI software assurance research work is directed towards answering the recommendations of this Subcommittee, and also addresses concerns and recommendations contained in the "COTS/NDI in Safety-Critical Systems" report. This research also supports *Action Plan 5: Validation and Certification Methodology* of the "FAA/EUROCONTROL R&D Committee" agreements.

The "Subcommittee Report of the NAS ATM R&D Panel to R,E&D Advisory Committee" addresses the entire contents of section 4.0 of the report to Software Engineering Research and Development. It concludes with a number of critical recommendations relating to the need to initiate research in (1) certification of ground as well as air systems involving critical software; (2) systems/software complexity; (3) various software architectural issues such as reuse and reliability; and (4) software/computer security. This is all captured within several sections beginning with the Major Recommendation 4.2.1.a #2, "The FAA should establish a Software Engineering Laboratory under the direction of the Chief Scientist for Software Engineering that performs as a center of excellence." A major purpose of this research initiative is

directed to addressing the concerns and identified weaknesses noted by the Subcommittee.

Accomplishments: N/A

R&D Partnerships: Partnership agreements are under discussion EUROCONTROL, NASA, DOD, NIST and others.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Establishment of the Center will be initiated by the end of FY 1998 using funding earmarked for operational planning. Some research activities will have already begun.

KEY FY 1999 PRODUCTS AND MILESTONES:

The FAA Software Engineering Resource Center (the Center) will be established by the end of FY 1999. Activity will take place at both FAA headquarters and the FAA Technical Center to determine the physical requirements of the Software Engineering Resource Center and to make the necessary arrangements. The Center will act as a virtual and physical facility to coordinate the software engineering research. The necessary physical infrastructure (COTS computers, communication links, audiovisual devices, etc.) will have been assessed, and purchase and installation will take place. Links will be established with remote researchers and research sites.

FY 1999 PROGRAM REQUEST:

The COTS/NDI Software Research program will be directed largely from FAA headquarters and will initially make use of prior, related activities conducted by the Office of Information Technology. It will subsequently make use of resources throughout the United States, particularly those of a Software Engineering Resource Center to be established both at FAA headquarters and at the FAA Technical Center, and aviation-related programs already underway at several universities. Support has been promised and is being negotiated with a number of FAA organizations.

A02i - Software Engineering R&D Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
028-130 Software Engineering R&D						
Software Engineering Resource Center (SERC)						
Establish/Maintain the infrastructure	♦	◇				
Develop/Implement Operational Plans and Methodology		◇				
Establish/Maintain Working Relations with Other Centers		◇	◇	◇	◇	◇
Establish/Maintain Working Relations with Contract Researchers		◇	◇	◇	◇	◇
NAS Architecture Research						
Develop an Architectural Decision Tree			◇	◇	◇	◇
Prototype the Architectural Decision Tree				◇	◇	◇
Develop Guidelines for a "Good" Definition			◇	◇	◇	◇
Develop Guidelines for a "Good" Representation			◇	◇	◇	◇
Develop Guidelines for Secure Software Systems					◇	◇
Develop, Test, and Evaluate Analytical Models					◇	◇
Develop, Test, and Evaluate NAS Simulations					◇	◇
Research on Safe and Effective Application of COTS/NDI in the NAS						
Develop Standards and Guidelines for COTS/NDI Software/ System Assurance					◇	◇
Develop Standards and Guidelines for COTS/NDI Software/ System Methods					◇	◇
Develop Standards and Guidelines for COTS/NDI Software/ System Cost Estimation					◇	◇
Software Certification Research						
Develop Standards and Guidelines for Certification of Safety Critical Software Intensive Systems					◇	◇
Develop Standards and Guidelines for End-to-End Test of Air/Ground Software Intensive Systems					◇	◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Request	FY 1999 Request
Contracts	0	0	0	0	1,067
Personnel Costs	0	0	0	0	474
Other Costs	0	0	0	0	64
Total	**0**	**0**	**0**	**0**	**1,605**

A03a Communications

GOALS:

Intended Outcomes: The FAA intends to improve safety, capacity, productivity, and economy of the national airspace system (NAS) by creating affordable, robust communications services. It intends to reduce weather and atmospheric related incidents, accidents, and capacity constraints by providing pilots direct access to flight information service (FIS) and weather products through data link. It intends to facilitate the transition from air traffic control to air traffic management through data link integration of air traffic and flight operations automation. These improvements reduce air traffic controller workload, increase situational awareness, and alleviate voice traffic congestion.

Providing data link services supports the evolution toward a free flight environment as envisioned in the RTCA task force 3 report and the Free Flight Action Plan. This also advances the concept of the self-reliant pilot described in the future architecture for automated flight service station support. Several government and industry initiatives have identified improved weather information in the cockpit (delivered by data link) as a key priority and mitigating strategy to reducing weather related accidents. Weather is the number one cause/factor cited in aviation accidents after pilot error. Over one-third of all fatal accidents in all sectors of aviation involve weather, and in general aviation, more than 200 fatalities per year are due to weather.

Agency Outputs: The FAA provides cost-benefit analyses for ground processing and uplink of FIS/weather products, software radio, domestic satellite, and decision support system (DSS) services.

Standards and guidance material for FIS/weather products, DSS services, software radios, and domestic satellite communications provides technical characteristics for cockpit presentations. RTCA minimum operations performance standards (MOPS) provide guidance for data link avionics. Advisory circulars, minimum aviation system performance standards (MASPS), and the Aeronautical Information Manual provide certification guidance for installation and operational use/application. This program develops technical and operational information, including human factors criteria, to support these products.

Specifications for FIS/weather products, DSS services, and domestic satellite communications provide/identify requirements for FAA automation and industry implementation.

Customer/Stakeholder Involvement:

Free Flight. The integration of air traffic management (ATM) DSS technologies with controller, pilot and airline operational control (AOC) facilities systems via digital data link provides enhanced capabilities for trajectory prediction, in-flight planning, and re-routing. ATM DSS alternatives include Center TRACON Automation System and automated en-route air traffic control technologies. Use of these alternatives will lead to a reduction in the number of current procedural restrictions present in the NAS. This is one of the primary goals of the free flight initiative. Development and implementation of FIS/weather products to the cockpit is also included in this goal.

RTCA. RTCA participates in many special committees (SC) including SC-169, which formulates a systems-oriented approach to aeronautical data link (ADL) applications and coordinates standards development to integrate data link functions for air traffic management; SC-182 develops standards for modular avionics concepts which affect cockpit avionics used by ADL. Others include SC-162, SC-165, SC-172, SC-181, SC-185, SC-186 and task force 3, Air Transport Association Flight Management System Task Force.

ICAO. The International Civil Aviation Organization leads and participates in several panels: the Automatic Dependent Surveillance Panel with a focus on automated air-ground data exchange; the Aeronautical Telecommunication Network Panel with a focus on requirements for a globally interoperable digital data communications network; and the Aeronautical Mobile Communications Panel with a focus on satellite-based safety services for data and voice, including standards development for high and very high frequency digital communications.

Aviation Safety Plan. ADL-related initiatives include: Initiative 2.10.2, that deploys data link capability to disseminate alphanumeric and graphical weather products, including weather, directly to the cockpit; Initiative 4.2.6, that completes definition of data link systems to support communications,

navigation, and surveillance operations; Initiative 4.2.7, that establishes two-way data link capability throughout domestic en-route and terminal airspace; and Initiative 4.3.4, that demonstrates/validates risk reduction benefits of weather and traffic products acquired by local surveillance systems delivered to aircraft, ATC facilities, air carriers, and any combination of these.

The FMS-ATM Next Generation (FANG) Team, chaired by the ADL product team, focuses on decision support system services through an FAA-industry cooperative research and development agreement (93-CRDA-0034). This effort defines an integrated flight management system/air traffic management/aeronautical operational control (FMS/ATM/AOC) system.

The FAA participates in and sponsors the communications and surveillance operational implementation team. This is an Administrator-chartered organization, established to coordinate the implementation of FAA modernization programs with the aviation industry.

The agency oversees and participates in Defense Advanced Research Project Agency initiatives (SPEAKeasy and ACE) to develop software configurable radio systems for digital communications. The agency leads in industry and international standards organizations, including Airlines Electronic Engineering Committee, International Telecommunications Union - Telecommunications Standards Sector, International Standards Organization, Internet Engineering Task Force, American National Standards Institute, and Modular Multifunction Information Transfer Systems Forum.

In addition, the general aviation community has participated in the FAA demonstration and operational suitability assessment of initial graphic and text data link products provided through the mode S-based Graphic Weather Service (GWS) at Dulles International Airport. GWS products, a graphic precipitation map and text airport observations and forecasts, provide a valuable safety service through enhanced situational awareness. The user community strongly advocates improved dissemination of FIS/weather, especially graphics, to the cockpit as demonstrated through the Free Flight Action Plan (1996); the National Research Council report, *Aviation Weather Services, A Call for Federal Leadership and Action* (1995); the National Aviation Weather Program Plan (1992); and the FAA Order 7032.15, Air Traffic Weather Needs and Requirements. Most recently, the NASA Aviation Safety Investment Strategy Team recognized cockpit dissemination of weather information as a key strategy for mitigating aviation fatalities in response to the Gore Safety Commission report.

Accomplishments: The FANG Operational Concept has been published. It identifies a preliminary set of services, associated potential benefits, and required functional capabilities of an integrated FMS/ATM/AOC system.

The basic requirements and operational concepts for FIS/weather data link applications were jointly developed by industry and government, and published (DO-232) through the RTCA Special Committee 169, Working Group 3. Operational FIS/weather data link products are available today through the ARINC ACARS vendor data link service.

Terminal weather information for pilots is currently available at all TDWR locations.

Pre-departure clearance and digital-air traffic information service is currently available through the tower data link system (TDLS) at 57 TDLS locations. Implemented data link Traffic Information Service, "see and avoid" assistance to pilots of intruders and potential threats.

R&D Partnerships: The FAA coordinates development of NAS improvements, including data link applications, with NASA. These activities include a Memorandum of Agreement and the development, evaluation, and implementation of the NASA Center TRACON Automation System (CTAS). In addition, a new inter-agency integrated product team, formed between the FAA and NASA, develops future ATM systems. Also the joint FAA-NASA Advanced General Aviation Transport Experiment (AGATE) development of advanced general aviation concepts, includes joint testing (ground and flight) with the AGATE partners. Finally, NASA plans to reprogram $500 million, over 5-years, in research related to aviation safety in response to the Gore Commission. Weather, including cockpit graphic products, is one of the major focus areas of this NASA initiative.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

- Published ICAO CNS/ATM-1 standards and recommended practices.

- Developed real-time simulation modules at existing simulation facilities for ATM/FMS data link integration.
- Completed fast-time model benefits analysis of advanced AOC/ATC data link integration.
- Developed AOC to ATM communications architecture for insertion into NAS architecture.
- Developed standards for additional FIS products.
- Completed identification, evaluation, and test of commercial off-the-shelf software radio systems.
- Began satellite communications.
- Achieved validation and approval of the HF data link standards and recommended practices.
- Completed viability analysis for WAAS reserve capacity for broadcast data link.

KEY FY 1999 PRODUCTS AND MILESTONES:

- Begin modeling and simulation of proposed DSS data link services.
- Complete comprehensive listing of data link DSS services.

FY 1999 PROGRAM REQUEST:

Aeronautical Data Link works collaboratively with FAA product teams including en-route, terminal, air traffic management, interfacility telecommunications, and weather to ensure the successful integration of data link services into the NAS.

Decision support system data link enhancement identification and development allows the benefits of advanced ATM automation tools to be fully realized.

Ground simulations and flight evaluations are conducted using the facilities and resources at the William J. Hughes Technical Center. These simulations and evaluations identify data link product and system architecture specifications and operational guidance issues. Based on these specifications and operational guidance issues, implementation standards (MOPS and MASPS), operational guidance documents (advisory circulars), and system architecture strategies are drafted.

A03a - Communications Product and Activities	Program Schedule FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
031-110 Aeronautical Data Link (ADL) Communications						
Communications Infrastructure						
Published CNS/ATM-1 Standards and Recommended Practices	♦					
Software Radio						
Identified, Evaluated and Tested COTS Software Radio Systems	♦					
Complete Cost Benefit Analysis (CBA)			◇			
Complete Minimum Operations Performance Standards (MOPS)				◇		
Complete Aircraft Certification Standards				◇		
Operations/Validation Complete						◇
Satellite Communications (SATCOM)						
Completed Analysis of Wide Area Augmentation System (WAAS) Reserve Capacity for Broadcast Data Link	♦					
Complete Functional Specifications for SKYLINKS			◇			
Complete/Publish SARPS				◇		
031-111 Aeronautical Data Link (ADL) Applications						
Decision Support System Services (DSSS)						
Completed Fast-time Model Benefits Analysis of Advanced AOC/ATC Data Link Integration	♦					
Begin Modeling/Simulation of Proposed DSS Data Link Services		◇				
Complete Comprehensive List of DSS Data Link Services		◇				
Complete Functional Capability Document for DSS			◇			
Complete CBA for DSSS			◇			
Complete ATN Specifications for DSSS					◇	
Flight Information Services (FIS)						
Developed Standards for Additional FIS Products			◇		◇	
Complete Flight Evaluation Study			◇		◇	
Complete CBA				◇		◇
Implementation Specification				◇		◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	13,556	5,412	1,054	4,706	1,174
Personnel Costs	3,755	3,808	4,105	0	4,129
Other Costs	769	780	841	0	566
Total	18,080	10,000	6,000	4,706	5,869

A03b Navigation

GOALS:

Intended Outcomes: The FAA intends to provide time efficiencies and cost savings through satellite-based navigation implementation. This technology allows direct point-to-point navigation, optimum routing, and other capacity improvements. Efficiencies and savings such as the following are realized by the airlines, the traveling public, and the FAA:

- Increased air traffic control efficiencies and NAS capacity through a restructured airway system to accommodate direct routings between airports as well as reduced separation standards.
- Reduced fuel cost to airlines and reduced travel time to the public due to more economical air routes.
- Reduced FAA operating costs due to decommissioning existing ground-based navigation equipment.
- Simplified global positioning system (GPS)-augmentation infrastructure through wide area and local area inter-operability to provide satellite navigation services at a reduced cost.

Agency Outputs: The FAA uses the national satellite test bed (NSTB) as the foundation for all research and development associated with implementing satellite-based navigation technology. The NSTB is essential to the wide area and local area augmentation development strategy needed to implement GPS-augmented navigation technology. Findings from the NSTB help the FAA to develop required user equipment by avionics manufacturers, continue development of GPS user procedures, and gain international acceptance of a seamless global navigation satellite system.

The program is developing and implementing satellite navigation center to centralize all research and development efforts for current and future satellite-based navigation technologies. This center will enable the FAA to monitor and evaluate system performance of GPS and GPS-augmented systems, such as NSTB and the wide area augmentation system (WAAS), as they are implemented by locating key system components in one location. During these evaluations, large quantities of complex, technical data will be collected, analyzed, archived, and made available to other government agencies. The data is used by industry, academia, and international entities to further research, facilitate information exchange, and foster cooperation around the world to achieve a seamless global navigation system. The results of this "live" data collection and analysis will assist the FAA in defining and analyzing air traffic and airway facility requirements for satellite-based navigation technology. The center will be instrumental in monitoring the WAAS system contractor performance during interim contractor maintenance and logistics.

The FAA will approve GPS as a primary means of navigation through category I precision approaches by 2001 in all weather conditions, by implementing WAAS. This will enable existing navigation equipment across the United States to be decommissioned.

The FAA will validate the capability to perform category II/III precision approaches through research and development efforts associated with local area augmentation system (LAAS). The FAA will provide a LAAS functional specification, architecture, and minimum operating performance standards (MOPS) to industry for the implementation of local area systems across the United States. LAAS prototypes will be developed and flight tests will be conducted to validate the specification and MOPS.

Customer/Stakeholder Involvement: The program pursues an implementation strategy which involves other government agencies, industry, and academia as follows:

- The FAA establishes and participates on various teams addressing immediate needs for operational implementation issues. These include the Satellite Operational Implementation Team (SOIT), Satellite Procedures Implementation Team, the Technological Requirements and Implementation Team, the Air Traffic SOIT, and other teams at FAA regional offices.
- The FAA participates on the RTCA working groups and subcommittees.
- The FAA has completed 16 bilateral agreements with several countries and participates in International Civil Aviation Organization (ICAO) panel sessions to further the acceptance of GPS augmentations as a seamless global navigation satellite system.

- The FAA supports the Positioning and Navigation Executive Committee, the Joint Precision Approach and Landing System Program and interacts with the Department of Defense to establish and promote a consensus on the management and operation of GPS.

Accomplishments: During FY 1998, the NSTB continued to provide a MOPS-compliant signal in space allowing development of WAAS aircraft avionics, terminal en-route procedures (TERPS) criteria, and user procedures. Research efforts included evaluation of new algorithms, hardware, and communication topologies to improve the integrity and availability of the WAAS. Enhancements to the NSTB were made to improve its use as a performance assessment tool for the WAAS. In addition, the NSTB conducted initial global navigation satellite system (GNSS) inter-operability studies.

The FAA completed development of the LAAS functional specification and the MOPS. Development efforts for LAAS prototypes were initiated to validate and verify the specification and MOPS.

The FAA initiated the requirements definition and analysis of system performance characteristics for the satellite navigation center as the first step toward developing a monitoring network to evaluate GPS and WAAS system performance.

R&D Partnerships: Approximately 20 grants, interagency agreements, and contracts are in place with industry, academia, and other government agencies to leverage their expertise and capabilities in satellite navigation R&D. Principal participants include Stanford University, Ohio University, the Naval Air Warfare Center Aircraft Division (NAWCAD), the Central Intelligence Agency, the Air Transport Association (ATA), and Massachusetts Institute of Technology Lincoln Laboratories. In addition, 16 cooperative bilateral agreements are in place, with additional agreements currently in work, to facilitate and promote the communication and information transfer for a seamless global navigation satellite system across the world. The program also maintains a government industry partnership with the ATA for the continued development of performance operating standards for GPS-based navigation with emphasis on local area applications.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

- Completed initial GNSS inter-operability studies.
- Provided a WAAS broadcast signal in space to support avionics development, generation of TERPS criteria, and user procedures.
- Evaluated WAAS algorithms that improved system integrity and availability in order to increase user confidence.
- Initiated WAAS software prototyping on the NSTB.
- Developed a WAAS MOPS for a Beta WAAS receiver.
- Developed specific requirements for WAAS satellite navigation using FAA dedicated satellites.
- Analyzed FAA alternative terrestrial methods.
- Developed augmentation performance alternatives.
- Completed the development of a functional specification with the participation of NAWCAD, university researchers, independent researchers, and the William J. Hughes Technical Center (WJHTC).
- Continued development of the LAAS test prototype at the WJHTC for data collection supporting verification of key algorithms and associated hardware for the ground system specification, the RTCA MOPS, minimum aviation system performance standards (MASPS), and the ICAO standards and recommended practices (SARP).
- Continued the coordination process with ICAO to produce SARPs that will define the basis for the LAAS in the international community.

KEY FY 1999 PRODUCTS AND MILESTONES:

- Perform data collection and analysis using the NSTB to further develop WAAS performance assessment capabilities.
- Develop a prototype integrity monitor for the WAAS.
- Conduct WAAS/LAAS integration studies.
- Develop operations and maintenance connectivities.

- Prototype international connectivity.
- Develop WAAS performance monitoring network.
- Establish research database and analysis capability.
- Develop real-time simulation methodologies for WAAS components.
- Conduct ionospheric data collection and analyses.
- Continue research into signal quality monitoring, operations and maintenance, flight control monitoring, and automatic dependent surveillance with participation from Stanford and Ohio Universities.
- Initiate investigation studies analysis for surface movement guidance, helicopter operations, and advanced LAAS augmentations using pseudolites, instrument landing system glideslope, low-earth-orbit satellites, etc., which will be conducted through university research grants.
- Begin installation and testing of LAAS prototype systems at several sites to insure that the systems will validate the functional specification in particularly difficult sites.

FY 1999 PROGRAM REQUEST:

In FY 1999, the program continues to focus on development and implementation of GPS augmentations to further the transition to satellite-based navigation technology. Efforts focus on research and analysis for issues associated with accuracy, integrity, and availability to the users, with specific emphasis on interference to ensure continuity of service. Efforts also focus on gaining continued acceptance and support by the international community for a seamless GNSS.

A03b - Navigation Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
032-110 Satellite Navigation Program						
National Satellite Test Bed (NSTB)						
Initiate/Continue Data Collection for WAAS P3I Definition	♦	◇	◇	◇		
Avionics, TERPS Criteria and User Procedure Development/Test	♦	◇	◇	◇		
WAAS Integrity Monitor Development	♦	◇	◇	◇		
WAAS Performance Assessments		◇	◇	◇		
Wide Area Advanced Research						
Interference Mitigation Analysis	♦	◇	◇	◇		
International Flight Test Demonstrations	♦	◇	◇	◇	◇	◇
Conduct ICAO/Global Navigation Satellite System (GNSS Evaluations)	♦	◇	◇	◇	◇	◇
Initiated WAAS Software Prototyping	♦					
Completed Alternative Analysis for End-state WAAS	♦					
Developed Requirements for FAA Dedicated Satellites	♦					
Develop Operations/Maintenance Connectivity Concepts		◇				
Initiate Prototype for WAAS International Connectivity		◇				
Develop Simulation Methodologies for WAAS Components		◇	◇	◇		
Establish Central Database		◇				
Data Collection Analysis		◇	◇	◇	◇	◇
Local Area Concepts						
Completed MOPS Development	♦					
Completed Functional Specification Development	♦					
Initiate Installation/Test of LAAS Prototypes			◇	◇		
Begin Surface Movement, Helicopter & Advanced Research		◇	◇	◇		
Complete Validation of LAAS Specification/MOPS		◇		◇		
WAAS/LAAS Inter-operability						
Conduct WAAS/LAAS Inter-operability studies		◇	◇	◇		
Develop Interface Control Requirements					◇	
Finalize Architecture Study					◇	
Conduct Prototype Tests					◇	◇
NAS Integration Plan					◇	◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	13,139	10,334	10,772	10,426	6,718
Personnel Costs	1,480	2,213	1,849	2,466	1,844
Other Costs	303	453	379	505	433
Total	**14,922**	**13,000**	**13,000**	**13,397**	**8,995**

A03c Surveillance

GOALS:

Intended Outcomes: The FAA intends to improve system efficiency and safety by implementing a low-cost surveillance system that enables free flight capabilities, minimizes runway incursions, and provides coverage in existing non-radar areas.

Automatic dependent surveillance-broadcast (ADS-B) is a technique to derive aircraft position by an onboard global navigation satellite system (GNSS) receiver. Aircraft identity, altitude, and position are broadcast directly to ground receivers and nearby aircraft. Squittered ADS-B messages, received by nearby aircraft, are processed and displayed on an airborne cockpit display of traffic information (CDTI) used for situational awareness and free flight capabilities. Accurate and timely updated reports from ADS-B minimizes runway incursions and improve efficiency and airspace capacity by potentially reducing current separation standards. The modular design offers a low cost alternative for surveillance coverage in existing non-radar areas.

Agency Outputs: Current efforts focus on developing standards for ADS-B avionics, CDTI, and transponders. The standardization efforts include minimum aviation system performance standards, minimum operational performance standards, technical standard orders, and design criteria. Future outputs will include procurement specifications for ground systems, deployment of system prototypes, and revised operational procedures.

Customer/Stakeholder Involvement: Air carrier and general aviation user communities have asked for FAA leadership in developing ADS-B technology. The FAA and the user community are actively involved in the standards development activity at RTCA Special Committee (SC) 186. Other stakeholders include ATN Systems Inc., Air Freight Association, Experimental Aircraft Association, and the International Civil Aviation Authority study group on simultaneous operations for instrumented parallel or near-parallel runways.

Accomplishments: Draft ADS-B avionic standards development has been initiated at RTCA. Additional engineering prototype and certification work, including development and test/validation, is required to complete these standards.

R&D Partnerships: The joint government/industry committees, RTCA SC-186 and SC-159, are tasked with achieving R&D consensus on system standards for ADS-B. Massachusetts Institute of Technology Lincoln Laboratory and MITRE are also jointly involved in the technical development and integration of ADS-B technology into the NAS.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

ADS-B avionics.

- Efforts to develop draft ADS-B avionic standards have been initiated at RTCA.

KEY FY 1999 PRODUCTS AND MILESTONES:

ADS-B avionics.

- Develop/publish project plan for ADS-B avionics.
- Complete operational concept and alternative analysis including cost benefit studies.
- Complete CDTI field trials.
- Develop/publish draft CDTI standards.
- Conduct/complete analysis of integrating ground initiated communications B (GICB) enhancement into Mode S transponders.

ADS-B ground systems.

- Develop/publish project plan for ADS-B ground systems.
- Conduct/complete analysis of integrating ADS-B with existing radars and automation systems.

FY 1999 PROGRAM REQUEST:

The FAA and RTCA continue to complete the ADS-B avionic standards for CDTI displays as well as standards to modify Mode S transponders with GICB software enhancement. Field tests validate CDTI standards. Operational concept analysis describes proposed features and benefits obtained by implementing and deploying ADS-B. The analysis includes cost benefit studies. An analysis of ADS-B integration with existing radars and automation systems will be performed. A project plan will be published outlining the tasks required to implement and transition to ADS-B.

A03c - Surveillance Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
033-140 Automatic Surveillance-Broadcast (ADS-B)						
Plans, Standards, and Analysis						
Development of Draft ADS-B Avionics Standards by RTCA	♦					
Publish ADS-B Avionics Management Plan	♦					
Publish ADS-B Implementation Plan	♦					
Complete Operational Concept Analysis		◇				
Perform/Complete CDTI-1 Field Trials and Analysis		◇				
Publish ADS-B Project Plan		◇				
Publish Avionics Standards for CDTI		◇				
Ground Initiated Comm B (GICB) Analysis for Mode S Transponders		◇				
Conduct/Complete CDTI Operational Test & Evaluation (OT&E) for Visual Flight Rules			◇			
Update CDTI Standards			◇			
Publish Analysis Report Describing Integration of ADS-B with Existing Radars and Automation Systems		◇				
Procure, Install and Demonstrate ADS-B Ground-Based Engineering Prototypes			◇			
Conduct/Complete CDTI OT&E for General Aviation Instrument Flight Rules Applications				◇		
Update CDTI Standards				◇		
Complete Demonstrates/Publish Ground-Based Systems Demonstration Report				◇		
Publish Operational Requirements Document for Ground- Based Systems				◇		
Develop Specification for ADS-B Ground Systems					◇	
Develop Specifications for ADS-B Automation/Integration						◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	3,618	0	0	0	3,506
Personnel Costs	286	0	0	0	701
Other Costs	58	0	0	0	83
Total	**3,962**	**0**	**0**	**0**	**4,290**

A04a Weather Program

GOALS:

Intended Outcomes: The FAA intends to provide the capability to generate weather observations, warnings, and forecasts that are more accurate and accessible than existing weather services. These upgrades enhance flight safety, increase system capacity, improve flight efficiency, reduce air traffic controller and pilot workload, improve flight planning, increase productivity, and enhance situational awareness.

In accordance with the Federal Aviation Act of 1958 as amended, the FAA is responsible, in cooperation with the Department of Commerce, to promote and develop meteorological science, and to foster support of research projects through the use of private and governmental research facilities. These duties are further amplified by recommendations contained in an Aviation Weather Services report issued by the National Research Council (1995) and the final report of the Aviation Weather Subcommittee issued by the FAA's Research, Engineering and Development Subcommittee (October 1995).

The weather program directly supports FAA Strategic Goal #1: "Eliminate accidents and incidents in the aviation and space systems with a strategy that targets the most critical areas." It specifically supports objective 1H: "Reduce the likelihood of weather-related accidents by improving access and delivery of weather information, education, and improving technology." This weather R,E&D program, in collaboration with National Weather Service (NWS) and National Science Foundation programs, produce weather algorithms (technology), more rapid forecasting and delivery of forecasts (delivery), and the development of aviation weather instructional material and training courses (education).

This program supports FAA's strategic goal #4: "Meet system capacity needs for air and space transportation safety and efficiency through near-term actions targeted at specific problems and a long-term, comprehensive program of research, planning, and investment matching user needs." The specific applicable objective is "objective 4E: " weather forecasting, detection, and dissemination - reduce the capacity-impacting consequences of weather phenomena by improved weather forecasts and increased accuracy, resolution, and dissemination of observations on the ground and in the air."

Agency Outputs: The weather program focuses on conducting applied research to solve operational problems leading to the development of new and improved algorithms. These models predict weather events that affect aviation as well as procedural and policy changes/updates. The algorithms, developed for implementation on appropriate NAS platforms (including the weather and radar processor, the integrated terminal weather system, and NWS systems) continue to be transferred to private weather service companies which support the NAS. This enables companies to develop specialized aviation weather products based on FAA research efforts. Algorithm development provides the following capabilities:

- Accurately depicts current and forecasted in-flight icing areas to enhance safety, airspace efficiency, and aircraft utilization.
- Produces high resolution and timely gridded information for icing, winds, temperature, and turbulence to improve aviation advisories and forecasts issued by the NWS.
- Provides location, timing, and severity of convective weather hazards to improve flight safety and enhance capacity.

Customer/Stakeholder Involvement: The National Aviation Users' Forum has provided a process to develop a federal/industry consensus on their needs and priorities for aviation weather information. Participants include representatives from the Airline Pilots Association, United, American, and Delta Airlines, and industry. This forum serves as a basis to set priorities for research and development as well as system acquisition. The FAA's weather priorities and plans are consistent with users' recommendations made at this forum, and they address industry recommendations.

The weather program collects aviation weather service users' needs and requirements found in the Aviation Safety Action Plan. It also includes the above plan addressing industry recommendations, as well as requirements found in more than six other related documents and publications. Driven by these aviation community requirements, the weather program directs the conduct of applied research.

This research is aimed at solving operational weather problems where targeted research can make a difference.

The weather program has been briefed to the NAS R&D Panel, and the FAA R,E&D Advisory Committee. This research program is strongly endorsed by both groups as a high priority.

Accomplishments: The following represent major accomplishments of the weather program:

- Developed and implemented at the NWS a rapid update cycle analysis and forecast capability providing more accurate and higher resolution upper winds, temperature, and precipitation data. Use of this information has resulted in reduction of flight times and/or flight delays due to more accurate data on hazardous weather and jet streams.
- Issued the first-ever forecast of freezing precipitation aloft at the aviation weather center in Kansas City in response to FAA proposed rulemaking for turboprops flying into conditions conducive to in-flight icing. These forecasts have increased airspace efficiency, aircraft utilization, and safety, especially for commuter aircraft.
- Commenced flight test of humidity sensor on United Parcel Service (UPS) aircraft, as part of the Water Vapor Sensing System program, leveraged with the National Oceanic and Atmospheric Administration (NOAA). The availability of detailed water vapor data in real time will be utilized to make more accurate in-flight icing and ceiling and visibility forecasts.
- Completed upgrades to next-generation weather radar (NEXRAD) algorithms. Storm cell identification and tracking, hail detection, mesocyclone and tornado detection (leveraged with NWS). These upgrades have enabled better definition of location, timing, and severity of convective weather hazards resulting in enhanced flight safety and capacity.
- Completed storm growth and decay experiment on data collected in Memphis. This research will result in the accurate short-term prediction of the initiation, growth, and decay of storm cells. It will enhance safety and capacity by improving aircraft avoidance of hazardous weather, resulting in enhanced strategic and tactical flow management planning, allowing more effective routing of traffic to/from airports and runways.
- Operated weather support to deicing decisionmaking (WSDDM) test beds at LaGuardia and O'Hare in collaboration with the Port Authority of New York and several airlines providing ground deicing decisionmaking information to the airlines and cities. This information has resulted in increased safety (takeoffs), savings in use of de-icing fluids, associated equipment and personnel costs, efficiencies in runway and off-airport plowing, and efficiencies in departures and arrivals.
- Developed initial operating capability of the aviation gridded forecast system (AGFS) implemented at the NWS, providing an aviation-specific weather database for the aviation community.

R&D Partnerships: Program activities are closely coordinated and leveraged with industry, academia, and other government agencies. This is done directly through interagency agreements, university grants, and Memorandums of Agreement in conjunction with the National Science Foundation. Principal partners include the National Center for Atmospheric Research, NOAA's Forecast Systems Laboratory and National Severe Storms Laboratory, Massachusetts Institute of Technology Lincoln Laboratory, NWS's Aviation Weather Center and National Centers for Environmental Prediction, NASA Lewis, Office of Naval Research and UPS, as well as several universities, airlines, port authorities, and cities. In addition, international agreements with the United Kingdom, France, and Canada further leverage FAA efforts.

Research results are transferred to the private sector via cooperative research and development agreements with GTE, Kavouras, WSI, Harris, and AccuWeather.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Aviation weather analysis and forecasting.

- Conducted field program in the Great Lakes area to evaluate improved forecasts of in-flight icing.
- Enhanced AGFS automated tools to provide increased capability for forecasters to interact and add value to weather data.
- Commenced enhancements of detection accuracy of tornado and mesocyclone detection algorithms.

- Commenced second year of a two-year airborne humidity sensor demonstration of utility, with UPS, as part of the WVSS program.
- Conducted demonstration of 30-minute storm growth and decay forecast.
- Completed technology transfer of baseline Weather Support to Deicing Decisionmaking system to private industry.
- Implemented turbulence detection algorithm at the Aviation Weather Center.
- In the development of a sensor for the detection of clear-air turbulence, fabricated and tested a two-beam system for Project SOCRATES.
- Tested SOCRATES two-beam system at FAA/ Volpe Center Test Site at JFK International Airport.

KEY FY 1999 PRODUCTS AND MILESTONES:

- Incorporate satellite data into in-flight icing guidance product.
- Develop tools for interactive data assimilation in AGFS.
- Complete airborne humidity sensor flight demonstration of utility.
- Complete additional enhancements to NEXRAD algorithms to enhance the detection accuracy of the tornado and mesocyclone detection algorithms.
- Implement satellite data into storm growth algorithm.
- Inclusion of turbulence data into models.
- Commence development of 4-hour snow forecast.

FY 1999 PROGRAM REQUEST:

- Develop new algorithms for improved forecasts of freezing drizzle aloft.
- Continue to develop automated data analysis and assimilation techniques.
- Complete evaluation of airborne humidity sensor data for improvements in analysis and prediction of icing.
- Transition weather research products to NWS, FAA, and industry automation and weather systems.

A04a - Weather Program Product and Activities	Program Schedule FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
041-110 Aviation Weather Analysis and Forecasting						
Develop Aviation Gridded Forecast System (AGFS)						
Enhanced AGFS Automated Tools	♦					
Develop Tools for Interactive Data Assimilation/Distribution		◇				
Implement Ensemble Tools and Interactive Data Assimilation					◇	◇
Inflight Icing						
Conducted Great Lakes Field Program	♦					
Incorporate Satellite Data into Guidance Product		◇				
Imp. Yr.-Round Guidance Product & Severity/Type Forecasts			◇	◇		
Develop Terminal-Scale Icing Product & Field Program to Evaluate Radar/Satellite/Radiometer Detection Techniques					◇	◇
Weather Support to Deicing Decisionmaking						
Tech Transfer Baseline WSDDM to Industry	♦					
Develop 4-Hour Snow Forecast		◇	◇			
Develop Techniques to Detect/Forecast Precipitation Type and Rate, Incorporate Radar/Satellite Data					◇	◇
Storm Growth and Decay						
Conduct Demo of 30-Minute Forecast	♦					
Integrate Satellite Data into Algorithm		◇				
Incorporate Boundary Layer Data, Transition to ITWS			◇			
Demo 90-Minute Forecast						◇
Turbulence Algorithm						
Implement Detection Algorithm at AWC	♦					
Inclusion of Turbulence Data into Models		◇				
Improved Algorithm Using TDWR, Transition to ITWS				◇		
Incorporate NEXRAD and Satellite Data into Turbulence Forecast					◇	◇
NEXRAD Algorithms						
Enhance Det. Accuracy of Tornado & Mesocyclone Det. Algorithms	♦	◇				
Deliver Dual Polarization Algorithms to OSF						◇
Airborne Humidity Sensor						
Demonstrated Sensor	♦	◇				
Provide Recommendations			◇			
Project SOCRATES						
Fabricated and Tested a Two-beam System at the FAA/Volpe Center Wake Vortex Test Site at JFK International Airport	♦					

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	2,110	5,978	11,683	14,500	11,436
Personnel Costs	663	427	1,093	664	817
Other Costs	136	88	224	136	31
Total	**2,909**	**6,493**	**13,000**	**15,300**	**12,284**

2.2 Airports Technology Program Area Description

Mission

The U.S. airport system consists of over 18,000 landing areas, with 650 million square yards of pavement, thousands of buildings as well as thousands of other facilities to serve aircraft, passengers and cargo. Over 600 million passengers are enplaned in scheduled service each year, and additional millions in general aviation and other unscheduled service.

There is a huge public and private investment in airports. The replacement value of the pavements alone is estimated at $50-100 billion.

Continued growth in aircraft activity (passenger as well as cargo) is forecasted. Passenger activity is projected to double by 2015. The aircraft fleet will also grow steadily but, more importantly, aircraft will become larger and heavier, and will require more sophisticated interfaces with the airport.

The FAA legislative and regulatory basis for developing standards, criteria, and guidelines for planning, designing, constructing, operating, and maintaining the airport system is derived from 49 USC Sec 47105(b)3. The Airports Technology research, engineering and development mission is to provide solutions that will allow the nation's airports to accommodate the projected traffic growth without accidents or fatalities.

Research and development efforts in this program area may be conveniently grouped into the following categories: airport pavement, airfield planning and design, visual guidance systems, runway traction, rescue and firefighting, and wildlife control.

Intended Outcomes

The most important products of this program area are the reduction or elimination of aircraft accidents and reduction in the costs of developing and maintaining safe airports. The Airport Technology program area supports several FAA Strategic Plan goals:

- System Safety - to reduce the number of accidents in which airport surface condition is a cause or factor.
- System Capacity - to ensure airport capacity enhancements.
- Global Leadership - to promote U.S. aviation system technologies in cooperation with industry and other federal agencies.
- Environmental Responsibility - to create an environmentally effective and responsive FAA and aviation system.

Reduction or elimination of aircraft accidents is supported by a comprehensive R&D program seeking to prevent dangers caused by slippery runways due to water, snow, ice, and surface contaminants such as rubber and anti-icing materials. Improved runway traction is the central focus of this research. The effectiveness of such innovations as soft-material arrestor beds has already been demonstrated in stopping aircraft overruns. Now, national standards must be developed, and research into more economical materials and installation methods must be continued.

Global Leadership and System Capacity are supported by a comprehensive research and development program for new methodologies in airport pavement design. There is strong international interest and industry support for these efforts. The International Civil Aviation Organization (ICAO) is closely monitoring FAA pavement research to develop effective and affordable standards for worldwide airport/aircraft pavement compatibility. Approximately $2 billion is spent by federal, state, and local governments and by airport operators on constructing, rehabilitating, and maintaining airport pavements each year, but only about $4 million is spent on research. Increasing pavement life by as little as 10 percent through research would result in a benefit/cost ratio of 50:1. This is an attainable goal, and the FAA is working toward its achievement.

International research in visual guidance systems is focused on night and low-visibility ground operations. Providing pilots and vehicle operators clear, unambiguous information from state-of-the-art lights, signs, and markings will help to eliminate many aircraft collisions. FAA research results, and those in the United Kingdom and Europe, are being used by ICAO in the development of uniform international standards.

Research efforts are also focused on the development of strategies for attacking post-crash fires on

the new multi-level, high-density-seating passenger aircraft being designed by manufacturers around the world. Elevated waterway and boom penetration devices are examples of how emerging technologies can be used to provide increased passenger survivability. Training requirements and firefighting simulators must still be developed to fully utilize the new capabilities. ICAO is using the results of FAA research efforts to develop new international firefighting standards.

Program Area Outputs

The Airport Advisory Circular (AC) system is the FAA's principal means to communicate with the airport planners, designers, operators, and equipment manufacturers, who collectively comprise the agency's national user community. ACs present standards and recommended practices for use in airport design, construction, and maintenance, as well as the operation of certain safety-related equipment. In all cases where FAA provides funding through the Airport Improvement Program, project work must meet standards set in an AC. The nation's $100 billion airport pavement investment is, for example, protected by the requirement that pavement construction meet applicable design, performance, and durability standards. Advisory circulars also give information for safe and efficient airport operation under adverse weather conditions.

Over 100 ACs have been published on a wide range of technical subjects, including airport design (configuration) standards, pavement design and material, lighting and navigational aids, firefighting equipment and procedures, pavement maintenance to detect icing of pavements, wildlife control, terminal building design, snow/ice control, and friction measuring equipment and procedures.

The output of the Airport Technology program is essentially directed towards updating, improving, and expanding the information made available to the airport community through the AC system.

Program Area Structure

Various elements of the Airport Technology program area affect the safety and operation of aircraft at or near airports. Push back from gate, taxi to takeoff runway, visibility conditions, lighting, markings and signs, other ground traffic, runway surface conditions, presence of wildlife, available overrun area beyond the end of the runway, and pavement structural integrity are among the factors which determine the eventual safety of flight. In addition, the potential for rejected takeoff and possible rescue effort are safety concerns associated with every flight. The Airport Technology program area systematically addresses all these issues with a single purpose: to establish an operational environment free of accidents and fatalities.

Customer/Stakeholder Involvement

Major airport technology projects support the agency's overall mission to foster a safe, efficient airport system. Within the overall program, there are a number of research emphases. Runway traction research, for example, directly supports the Challenge 2000 recommendation to develop new technologies and standards for runway friction measurement and safety overrun arrestor systems.

Initiatives in the Aviation Safety Plan supported by airport technology research include:

- Supporting technology development to prevent runway incursions (initiative 2.1).
- Improving the monitoring of takeoff and landing performance (initiative 4.1.15).
- Improving airport surface operations (initiative 4.1.16).
- Supporting the development of environmentally acceptable alternatives for de-icing and anti-icing agents (initiative 4.4.1, 4.4.2, 4.4.3).
- Improving ground navigation technologies, signage, and procedures (initiative 6.4.15, 6.4.16).

Rescue and firefighting research supports an ICAO initiative to replace the environmentally harmful Halon 1211 now used to extinguish engine fires and other fuel fires.

New pavement design standards for the next-generation heavy aircraft are urgently needed by both the aircraft manufacturers and FAA. Manufacturers need them to ensure their products' compatibility with airport facilities. FAA needs them to ensure that federal funds for rebuilding or strengthening runways are being used prudently and the $100 billion investment in the infrastructure is protected. These standards will be developed from data collected on the National Airport Pavement Test Machine over a 10-year period, starting in late 1998. The project is being financed through a cooperative R&D agreement between the FAA and the Boeing Company. Boeing is providing

$7 million (one-third of the total cost) to build this unique machine, the first ever of its kind. The FAA, Boeing, and ICAO will use results of the project to develop pavement design and evaluation standards to ensure aircraft/airport compatibility. The design and construction of this machine is currently underway, with completion scheduled for late 1998.

Accomplishments

During the past five years, the Airport Technology program has provided products to enhance aircraft safety in the U.S. and around the world. Research currently underway, as well as planned, is intended to protect our environment, save the public billions of dollars, and still provide an operational environment which is free of accidents and fatalities.

Through development of a soft, ground-arresting system, we have provided an engineering solution for the problem of aircraft overruns. The Port Authority of New York and New Jersey has authorized installation of up to five systems at New York airports at a cost of $4,500,000. The first installation was completed in December 1996.

This program has developed a concept for an advanced taxiway lighting system that should reduce aircraft incursions. This system guides aircraft to and from the runway and ramps during low-visibility conditions by automatically controlling taxiway lights and signs. The system does not require radar input.

This program has:

- Demonstrated the improved performance of pavement marking materials when retro-reflective glass beads and silica are added to enhance their visibility, durability, and skid resistance.
- Successfully tested an innovative technology for aircraft deicing that uses infrared energy. This technology offers potential cost savings over conventional methods.
- Introduced a new pavement design standard to accommodate the introduction of Boeing B-777 aircraft in 1995. The new standard allows the B-777 to operate without weight penalties on existing pavements. In the absence of this standard, hundreds of millions of dollars would have been unnecessarily spent to strengthen airport pavements.
- Developed a driver's enhanced vision system to allow airport rescue and firefighting vehicles to navigate through fog, rain, sleet, and snow. This technology enables quick and effective response to accidents.

R&D Partnerships

The program has been especially successful in developing partnership arrangements with industry. Airport operators and experts from all branches of the aviation industry, DOD, academia, highway and transportation research organizations foreign countries, and ICAO have entered into agreements such as the following to ensure the cost-effective use of contract dollars:

- FAA-U.S. Army Waterways Experiment Station.*
- FAA-U.S. Army Philadelphia District Office.*
- FAA-U.S. Air Force, Tyndall Air Force Base.*
- FAA-University of Illinois/Northwestern University (Center-of-Excellence for Airport Pavement Research).**
- FAA-Boeing Company, Cooperative Research and Development Agreement ($7 million Boeing/$21 million total for National Airport Pavement Test Machine).**
- FAA-Agencies of Canadian Government (for pavement technology and winter operations safety).*.
- FAA-NASA (for joint runway traction research).*
- FAA-Port Authority of New York and New Jersey (for design and construction of aircraft arrestor bed).*
- FAA-industry (to test and develop infrared-deicing facilities and softground arrestor materials).

* Interagency agreement or MOA
** Partnership through matching funds.

Through these partnerships, research results are published in scientific journals, presented at technical conferences, and discussed at workshops.

Long Range View

The broad range of subject matter covered by the program will continue to be explored in future years to ensure a stream of improved measures relating to

airport safety and efficiencies of operation. Current projects will be completed and new ones undertaken as needs arise. Emphasis is likely to change as pavement efforts are completed and resources can be reallocated to lighting and runway safety. The National Airport Pavement Test Machine operation will continue for about ten years. The test machine data collected during this time will allow smooth introduction of new, heavy aircraft expected to join the fleet in the next century. The pavement design standards based on these data will: provide manufacturers assurance of the compatibility of their aircraft on airports throughout the world; provide airport operators precise cost estimates to permit new aircraft operations on their facilities; allow airlines to plan for new equipment and routes; and give airport designers confidence in their designs. Finally, these research findings will give the FAA the tools required to assure the public that federal funds are being judiciously employed and that public investment in infrastructure is prudently managed.

The elimination of runway slipperiness as a cause of accidents will continue to be an important long-term objective, as will the reduction of wildlife hazards. There will be increased emphasis on next-generation runway lighting and marking and an attempt to introduce sophisticated lighting controls. The introduction of new large aircraft will require a reexamination of many aspects of airport design and operation. The industry will look towards innovative technology to solve problems that cannot otherwise be resolved in an airport system that is largely in place.

A05a Airport Technology

GOALS:

Intended Outcomes: This program intends to improve airport system safety, efficiency, and capacity by developing technologies compatible with advancements in aircraft technology and air traffic control systems. It also intends to ensure that current standards in all areas of airport systems are adequate to:

- Reduce aircraft accidents due to incursions, particularly in low visibility conditions.
- Reduce aircraft accidents due to slipperiness caused by ice and snow on runways.
- Reduce environmental impacts due to chemical usage on airports during winter operations.
- Reduce the massive investment required for pavements.
- Improve post-crash rescue and firefighting capabilities.
- Reduce the negative impact of wildlife on airport safety.

Agency Outputs: The FAA is required by law to develop standards and guidance material for design, construction, and maintenance of airports. The airport advisory circular system is the principal means by which the FAA communicates with a user community consisting of U.S. airport planners, designers, operators, and equipment manufacturers. Advisory circulars are prepared for airport geometric design, pavement design, safety areas, visual aids, access roads, rescue and firefighting, ice and snow control, and wildlife control. The FAA and its regional offices enforce standards and guiding material when administering the Airport Improvement Program (AIP).

The Airport Technology program provides the technical information necessary to support these agency outputs and their timely update.

Customer/Stakeholder Involvement: Approximately $2 billion is spent annually to provide operationally safe and reliable airport pavements. About half of this amount is provided by the FAA in the form of AIP grants, and the remainder by state and local governments and airport operators. Projects funded under the AIP must conform to the FAA advisory circulars or standards.

Aircraft manufacturers and the FAA need new pavement design standards for operation of next generation heavy aircraft: Manufacturers need them to assure compatibility of their aircraft on airports throughout the world. The FAA needs them to assure the public that federal funds for rebuilding or strengthening runways are being judiciously employed, and also to protect the $100 billion investment in the infrastructure. To accomplish this, the FAA and the Boeing Company have entered into a Cooperative Research and Development Agreement to build a unique full-scale pavement test facility at the FAA William J. Hughes Technical Center. The data collected from the project will be used by the FAA, the Boeing Company and the International Civil Aviation Organization in the development of international pavement design standards.

Accomplishments: During the past five years, the Airport Technology research program has provided products to enhance the safety of aircraft operations in the U.S. and around the world. Research results are published as FAA advisory circulars and made available to users on a worldwide basis. Some major accomplishments are:

- Installed soft-ground arresting systems for stopping aircraft overruns at a major international airport.
- Installed prototype advanced taxiway guidance system.
- Developed improved pavement marking for enhancing visibility, durability, and skid resistance.
- Operationalized aircraft de-icing facility utilizing infrared energy at a mid-size airport.
- Developed driver's enhanced vision system for firefighting vehicles to navigate in rain, snow, and fog.
- Developed environmentally acceptable replacement for the CFC ozone depletor Halon 1211.
- Developed specification for 55-foot elevated boom and aircraft cabin skin penetration system.

- Issued new pavement design standards to allow operation of Boeing B-777 without weight penalties.
- Established a Center of Excellence (COE) in Airport Pavement Research at the University of Illinois and Northwestern University.
- Installed a comprehensive instrumentation system in concrete pavements at Denver International Airport (DIA).
- Established an airport pavement database containing field data collected at DIA, allowing online access to researchers worldwide.
- Published technical report - Intermodal Ground Access to Airports: A Planning Guide.

R&D Partnerships:

- FAA-U.S. Army Waterways Experiment Station.*
- FAA-U.S. Army Philadelphia District Office.*
- FAA-U.S. Air Force, Tyndall Air Force Base.*
- FAA-University of Illinois/Northwestern University (COE for Airport Pavement Research).**
- FAA-Boeing Company, Cooperative Research and Development Agreement ($7 million Boeing/$21 million total for National Airport Pavement Test Machine).**
- FAA-Agencies of Canadian Government (for pavement technology and winter operations safety).*
- FAA-NASA (for joint runway traction research).*
- FAA-Port Authority of New York and New Jersey (for design and construction of aircraft arrestor bed).*
- FAA-industry (to test and develop infrared-deicing facilities and softground arrestor materials).

* Interagency agreement or MOA
** Partnership through matching funds.

Through these partnerships, research results are published in scientific journals, presented at technical conferences, and discussed at workshops.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Airport planning and design technology.

- Published report on impacts of the introduction of new large airplanes.

Airport pavement technology.

- Continued 3D finite element model (FEM) development: concrete joint models, computational efficiency and model verification.
- Updated LEDFAA pavement design program package.
- Completed joint load transfer and layer interface models and field performance of stabilized base materials.
- Completed National Airport Pavement Test Machine design.
- Continued basic research activities at the center of excellence for airport pavement technology.

Airport safety technology.

- Published advisory circular on aircraft arrestor beds in an operational environment.
- Developed means to acquire and report runway surface friction values for pilot use.
- Completed installation and continued evaluation of prototype advanced taxiway guidance system.
- Completed new technology approach lighting demonstration evaluation and issued report.
- Initiated investigation of new technology lighting sources.
- Issued specifications for airport signs.
- Initiated study on stability of heavy rescue vehicle and anti-rollover systems.
- Developed full-scale post crash interior fire suppression facility to include second-level passenger seating cabin fires.

KEY FY 1999 PRODUCTS AND MILESTONES:

- Complete construction and start operation of the National Airport Pavement Test Machine.
- Complete acceptance and pavement response tests.

- Collect and analyze full-scale machine data to relate performance to designs.
- Continue 3D FEM Model Development
- Continue evaluation of prototype advanced taxiway guidance system.
- Develop next generation airport circuitry component test bed for system and component testing.
- Issue specifications for improved airport lighting.
- Publish testing standards for airport fire-fighting extinguishing agents.
- Conduct study to develop new standards for anti-rollover and stability requirements for heavy airport rescue vehicles.

FY 1999 PROGRAM REQUEST:

The Airport Technology FY 1999 research program is a collaborative effort between many government organizations, universities, and industry associations. The funding requested by this budget item provides the contract support necessary for an integrated, effective research program that delivers the standards and guidelines for maintaining and enhancing our airport infrastructure.

A05a - Airport Technology Product and Activities	Program Schedule FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
051-110 Airport Planning and Design Technology						
Published Report on Impacts of the Introduction of New Large Aircraft	♦					
Published Report on the Critical Airport Research Requirements	♦					
051-120 Airport Pavement Technology						
Completed Joint & Interface Models & Performance of Stabilized Base Materials	♦					
Continue 3D FEM Model Development	♦	◇	◇	◇		
Updated LEDFAA Airport Pavement Design Program Package	♦					
Continue Data Collection and Analysis at DIA	♦	◇	◇	◇		
Collect and Analyze Full-Scale (Machine) Data to Relate Performance to Designs		◇	◇	◇	◇	◇
Finish Field Performance of Pre-Stressed Fibrous Concrete Pavements			◇			
051-121 National Dynamic Airport Pavement Test						
Completed Test Machine Design	♦					
Complete Construction and Start 1st Year Operation of the National Airport Pavement Test Machine		◇	◇			
Complete Acceptance & Pavement Response Tests		◇	◇			
Complete Performance (Life) Tests				◇		◇
051-130 Airport Safety Technology						
Completed Installation Advanced Taxiway Guidance System	♦					
Published Advisory Circular for Softground Arresting System	♦					
Issued Specifications for Airport Signs	♦					
Issue Specifications for Improved Airport Lighting		◇				
Establish Testing Requirements for Airport Fire Fighting Agents		◇				
Continue Evaluation Prototype Advanced Taxiway Guidance System		◇	◇			
Next Generation Airport Circuitry/Component Test Bed		◇	◇	◇	◇	◇
Conduct Study to Develop New Standards for Anti-Rollover & Stability Requirements for Heavy Rescue Vehicle		◇	◇	◇	◇	
Publish Advisory Circular on Aircraft Infrared Deicing			◇			
Develop Innovative Methods for Deicing/Anti-Ice Runways				◇		

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	5,833	3,742	2,709	2,604	5,086
Personnel Costs	1,965	1,874	2,068	1,989	2,016
Other Costs	402	384	423	407	281
Total	**8,200**	**6,000**	**5,200**	**5,000**	**7,383**

2.3 Aircraft Safety Program Area Description

Mission

This program develops technology, technical information, tools, standards, and practices to ensure the safe operation of the civil aircraft fleet within a safe global air transportation system.

The Aircraft Safety program area addresses the many hazards facing all aircraft in flight, as well as special hazards that apply to select portions of the civil aircraft fleet. For example, older aircraft are more susceptible to structural problems associated with fatigue and corrosion. New aircraft, with their digital flight control and avionics systems, associated imbedded software, and construction of new non-metallic materials, present significant challenges in certification, continued airworthiness, and operation. All aircraft, old or new, must deal with the hazards imposed by adverse weather.

Intended Outcomes

The Aircraft Safety program area supports the agency's first strategic goal: System Safety—Zero Accidents. Eliminate accidents and incidents in aviation and protect public safety and property in space transportation systems by targeting the most critical areas.

To achieve this goal, the Aircraft Safety Program Area focuses on improving system safety in the following research programs:

- Aging Aircraft - by developing technologies, procedures, and practices to ensure the continued airworthiness of aircraft structures in the civil fleet.
- Catastrophic Failure Prevention - by developing technologies and methods that assess risk and prevent potentially catastrophic defects, failures, and malfunctions of aircraft, aircraft components, and aircraft systems.
- Flight Safety and Atmospheric Hazards - by addressing atmospheric hazards in the design, development, and certification process.
- Propulsion and Fuel Systems - by enhancing the airworthiness, reliability, and performance of civil turbines and piston engines as well as the safe performance of their propellers, fuels, and fuel management systems.
- Fire Research and Safety - by developing near-term fire safety improvements to prevent uncontrollable in-flight fires and to increase post-crash fire survival rates; and by conducting long-range research to develop ultra-fire-resistant cabin materials.
- Advanced Materials and Structural Safety - by ensuring both the safety of U.S. civil aircraft constructed of advanced materials and passenger survival in the event of an accident.
- Aviation Safety Risk Analysis - by improving FAA and industry measurement of, and accountability for, safety performance through risk assessment and operational indicators and the shared use of safety-related data.

Aircraft safety improvements reduce fatalities, injuries, and hull losses. They also improve aircraft designs, crew performance, maintenance, and inspection procedures. Each program in this program area has the potential to provide significant benefits. The following two examples illustrate this point:

- Statistics show the U.S. has approximately 30 to 35 fire fatalities per year in otherwise survivable accidents. There are about 135 such fatalities a year worldwide. At an estimated cost of $2.7 million per life saved, saving 24 lives per year would pay for the entire aircraft safety research, engineering, and development effort.
- A more reliable inspection technique was developed and approved as an alternate inspection technique for corrosion detection on a DC-9 in the area where the wing joins the fuselage. The new technique saves over 700 man-hours per inspection, compared to the current inspection method. The new technique also requires less disassembly of the aircraft part to conduct the inspection, resulting in less chance for damage during the disassembly and reassembly. One airline estimates savings of more than $2 million over the maintenance cycle of its fleet of DC-9s using the new inspection technique.

Program Area Outputs

The FAA establishes basic rules for aircraft certification, operation, inspection, maintenance, and repair. The Aircraft Safety program then publishes advisory

circulars to outline specific means to satisfy these rules. Additional technical information is disseminated in various forms to industry and to agency airworthiness inspectors to improve aircraft construction and maintenance practices. Technical information is also developed and circulated regarding safety systems, such as seat restraints and protective breathing equipment. The objective behind all of these information products is to improve system safety based on elimination of aircraft and flight hazards. The research in aircraft safety provides the technical information necessary to support these agency products.

The customers for Aircraft Safety research include all segments of the aviation industry (manufacturers, operators, maintenance facilities) as well as the general public. Sponsors of Aviation Safety research are FAA personnel in flight standards and aircraft certification. Aircraft Safety research either directly or indirectly supports the development of rules, regulations, and standards.

Program Area Structure

Aircraft Safety includes research in a wide range of areas related to the safety of aircraft, crew, and passengers. The program focus is the elimination of hazards to a safe air transportation system, both in preventing accidents from happening and mitigating the effects of any accidents which do occur. Aircraft Safety research activities have been structured to cover both prevention and mitigation as follows:

- Prevent accident/incident occurrences
  - Build stronger aircraft - prevent structural failure.
  - Build more reliable propulsion systems - prevent power failure.
  - Build more reliable mechanical and electrical systems - prevent system failure.
  - Increase flight safety - prevent operational hazards.
- Mitigate accident/incident effects
  - Build more crashworthy aircraft minimize loss of life and equipment.
  - Increase fire safety - minimize occurrences and effects of fires.

Customer/Stakeholder Involvement

Research programs within Aircraft Safety directly support the Aviation Safety Plan (February 1996) through research into priority issues of three of the six workshops: safety data collection and use, application of emerging technologies, and aircraft maintenance procedures and inspection.

The Subcommittee on Aircraft Safety of the FAA Research, Engineering and Development Advisory Committee periodically reviews segments of the Aircraft Safety Program Area. A review of the Aircraft Safety Program was completed in 1997. The program described here is fully responsive to the advice of the subcommittee.

The primary mission of the FAA, as originally mandated in Sections 312 and 316 of the Federal Aviation Act of 1958, is to develop, modify, test, and evaluate systems, procedures, facilities, and devices to meet the needs of safe and efficient aviation. The research mission of the FAA was expanded by the Aviation Safety Research Act of 1988 (Public Law 100-591) to "undertake or supervise research to develop technologies and to conduct data analysis for predicting the effects of aircraft design, maintenance, testing, wear, and fatigue on the life of aircraft and on air safety, to develop methods of analyzing and improving aircraft maintenance technology and practices." The 1988 act authorized the FAA to generate technology breakthroughs where needed but not to forget the importance of long-range research. The passage of the Aircraft Catastrophic Failure Prevention Program, under the Omnibus Reconciliation Act of 1990 (Public Law 101-508), further expanded the agency's congressional mandate to foster research.

While the FAA research mission was originally focused on airplane improvements, the 1990 amendment added proactive research to make airplanes free from catastrophic failure. Safety aviation research reduces hazards of operating aircraft, improves the level of safety, and also enhances the competitiveness of manufacturers and operators in the U.S. aviation industry.

Accomplishments

The results of safety research are disseminated to the agency (aircraft certification and flight standards) and to industry (aircraft manufacturers, operators, and maintainers) in the form of:

- Technical and regulatory guidance for airframe maintenance in the form of handbooks, technical bulletins, aircraft-specific inspection requirements, advisory circulars, and rules.

- Validated instrumentation, procedures, and methodologies for aircraft maintenance, inspection, and repair.
- Reports providing relevant technical information for aircraft manufacturers, operators, and maintainers.
- Technical data provided to the community at conferences, symposia, workshops, and hardware/software prototype demonstrations.
- Criteria to support certification of aircraft and their safety and emergency equipment.
- Technical data to support regulatory oversight in inspection, maintenance, repair, and standards development.
- Training materials in areas such as damage tolerance requirements, corrosion control, inspection, and maintenance and repair.

Several prototype inspection devices developed, tested, and validated in this research program, have shown significant potential for more accurate, reliable flaw detection in the airframe and in engines. In particular, one method for engine component inspection has shown a four-fold improvement in its ability to detect the type of flaw that lead to the Sioux City accident (1989, 211 fatalities).

Numerous ACs have been developed for a wide range of aviation safety-related activities, including design of composite structures, corrosion control, aircraft de-icing, inspection, and repair. For aircraft ground deicing of large transport airplanes (AC 120-58, 9/92) as well as smaller commuter airplanes (AC 135-17, 12/94), recommendations and guidelines have been provided to ensure safe operation of airplanes during icing conditions.

Technical research data has supported the development of standards, certification processes, and Airworthiness Directives and Notices of Proposed Rulemaking. An alternative method of compliance was developed to reduce fatigue testing time and ensure the required service life of composite structures. This method has been used successfully in the certification process of many aircraft components (a recent example, General Electric GE90 turbofan engine fan blades), and has been adopted as a worldwide standard.

R&D Partnerships

Program activities are closely coordinated with related initiatives underway in the Department of Energy (DOE), DOD, NASA, and other government agencies. Formal agreements of cooperation are in place with the U.S. Air Force, Army, and Navy, NASA, and DOE. One particular cooperative effort develops standardization data for materials in MIL-HDBKS 5 and 17. The program has international agreements with government agencies and research laboratories in the United Kingdom, the Netherlands, France, Italy, Australia, Canada, and Russia. Many grants are in place with universities and research laboratories to leverage their interests and capabilities. Partnerships have been established with academia and industry through consortia and centers of excellence. A consortium consisting of Iowa State University and various engine manufacturers (General Electric, Pratt & Whitney, and Allied Signal) was formed to improve on or develop new methods for production and in-service inspection of engine rotating components.

Technology transfer occurs through a variety of mechanisms (including the publication of technical reports) to document research results and the sponsorship or cosponsorship each year of numerous conferences on a wide range of subjects. FAA personnel participate in the committees of technical societies, such as the American Society on Testing and Materials, Society of Automotive Engineers, and American Institute of Aeronautics and Astronautics, to ensure the transition of research results to standards and guidelines. Hardware and software prototype demonstrations and technology workshops provide technological information to industry. The Aging Aircraft Nondestructive Inspection Validation Center disseminates highly-specific technological information. This center was established to demonstrate and validate cost-effective aircraft inspection equipment and techniques to industry together with the Center for Aviation System Reliability.

Long-Range View

The need for long-range safety research is expected to continue indefinitely. With the emergence of new and advanced technologies, there is a continuing need to improve safety in the air transportation system. There will always be a need, for example, to understand the impact of new technology on operator performance. As air traffic continues to increase, and as aircraft continue to age, the need

will remain to address issues related to aging aircraft. With new technology, new types of damage may introduce hazards that must be understood and addressed. The requirement to understand the impact of technological change on the design, operation, regulation, and certification of equipment, procedures, and training mandates continued research in Aircraft Safety.

A06a Fire Research and Safety

GOALS:

Intended Outcomes: The FAA intends to improve system safety by developing technologies, procedures, test methods, and criteria for preventing accidents caused by in-flight fires and eliminating burning cabin materials as a factor in postcrash fire survivability. The Fire Research and Safety program focuses principally on:

- Long-term research to develop new interior materials that meet fire resistance criteria mandated in the Aviation Safety Research Act of 1988.
- Near-term improvements in aircraft fire detection and suppression systems.
- Aircraft design improvements that delay the spread of fire into and through the passenger cabin.
- Test methods and acceptance criteria for materials and systems that provide aircraft safety improvements.

Agency Outputs: The FAA establishes rules for aircraft fire safety in terms of material selection, design criteria, and operational procedures. The agency also provides advisory material on methods of compliance with fire safety regulations and guidelines. The fire research and safety program is the major source of technical information used to develop this regulatory material. Additionally, the program provides industry with new safety products developed through long-term applied research. These products are typically embodied in new materials and formulations, new test methods, government-owned patents, reports, and journal publications.

Customer/Stakeholder Involvement: The FAA has broad industry and government participation in each aspect of the Fire Research and Safety program.

- The subcommittee of the FAA Research, Engineering and Development Advisory Committee has repeatedly endorsed the fire research and safety program and placed high priority on its activities.
- Long-term research in fire resistant materials is required by specific language in the Aviation Safety Research Act of 1988 and is directly supported by the aircraft industry and materials producers through university-based FAA research consortia.
- The project on halon replacement is supported by an international ad hoc working group consisting of FAA certification groups, international airworthiness authorities, airlines, aircraft manufacturers, and fire extinguishing system manufacturers.
- An FAA sponsored international working group on material test methods includes all major airframe manufacturers and interior material suppliers.
- The National Transportation Safety Board (NTSB) relies heavily on program personnel for on-site accident investigation such as the ValuJet, TWA 800, and FedEx DC-10 accidents.

Accomplishments: Results of fire research and safety were provided to FAA certification personnel and inspection personnel for use in fire safety regulations and advisory material, approval of regulatory fire test procedures, and approval of aircraft fire protection installations. Recent program accomplishments include:

- Conducted fire tests that demonstrated oxygen canisters were probable cause of ValuJet accident.
- Proposed rulemaking to require fire detection and suppression systems in all large transport cargo compartments (3000 airplanes).
- Completed performance criteria for lavatory halon replacement agents.
- Demonstrated new insulation materials that will aid in prevention of postcrash fire fuselage burnthrough.
- Developed inexpensive, totally non-combustible composite facesheets for interior cabin applications.
- Completed fire test guidelines for improved fire resistant flight recorders.
- Completed fire test guidelines for ignition resistant airline blankets.
- Filed FAA patent for a microscale flammability device (1997).

- Substituted polyphenylenes developed with low heat release and two to three times strength and stiffness of current interior plastics.
- Filed patent on ethynyl polymers which have 75% char yield and do not burn (University of South Carolina).
- Synthesized chemically modified urethanes for seat cushions which are self-extinguishing in fire tests.
- Demonstrated novel fire retardant effects of adding submicroscopic particles to plastics.
- Developed light-weight non-combustible composites with mechanical properties and heat resistance exceeding steel and aluminum.

In addition, approximately two dozen reports and published papers are generated yearly from the in-house activity. Fire test laboratories are used annually to train FAA certification engineers, and program personnel participate in approximately three major accident investigation yearly at the request of the NTSB. The FAA operates the most extensive aircraft fire test facilities in the world.

R&D Partnerships: The FAA sponsors an international halon replacement working group. This group collaborates in research and development leading to alternate agent selection for aircraft applications as well as test methods and criteria. The FAA also sponsors an international aircraft materials fire test working group. This group strives to improve material fire tests standardization, such as engaging in round-robin testing to ensure that the lab-to-lab variation in results is acceptably small. The FAA organized an interagency working group on fire and materials to provide a vehicle for technology exchange among U.S. Government agencies and to prevent unwarranted duplication of work. The FAA has interagency agreements with the U.S. Air Force and the National Institute of Standards and Technology for common interest research. The agency has initiated a memorandum of cooperation with the British Civil Aviation Administration for a variety of fire safety research efforts and separate letters of cooperation with Canadian, Japanese, and European aviation authorities. The Fire Research and Safety program also has grants with many educational institutes. Several Fortune 100 companies share costs of developing new fire resistant materials at university-based FAA research consortia.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Fire resistant materials.

- Scaled-up benzoxazine chemistry and produced fire resistant, non-toxic interior panels for evaluation of heat release rate.
- Improved fracture toughness of non-combustible geopolymer composite fire barriers to enable use as interior and secondary composites.
- Developed analytical methods for surface temperature and toxic hazards of materials in bench-scale heat release rate tests.

Fire detection and suppression.

- Developed minimum acceptable levels of performance and criteria for gaseous halon replacement agents in engine fire extinguishing systems and for hand-held extinguishers.
- Completed full-scale fire test evaluation of solid propellant gas generator technology.

Fire safety design.

- Completed design guidelines for postcrash fire burnthrough resistance hardening of aircraft fuselages.
- Evaluated high-speed civil transport composite skin burnthrough resistance and pyrolysis toxic gas hazards within aircraft interior.

KEY FY 1999 PRODUCTS AND MILESTONES:

Fire resistant materials.

- Develop database on heat release rate of state-of-the-art plastics and composites lined to the National Institute for Standards and Technology fire on the web internet site for use by aircraft manufacturers and certification personnel.
- Validate microscale combustion test method for heat release rate testing of candidate aircraft cabin materials.
- Demonstrate cabin interior decorative panel (composite/honeycomb/decorative film) with 50 percent heat release rate compared to 1996 materials.

Fire detection and suppression.

- Optimize cargo compartment water mist fire suppression system.

- Develop cargo compartment water mist system minimum performance standard.
- Determine smoke signature associated with cargo fires.

Fire safety design.

- Initiate study of aircraft hull losses and fatalities caused by oxygen system malfunction or damage.

FY 1999 PROGRAM REQUEST:

Conduct full-scale fire tests to develop and validate near-term improvements to prevent uncontrollable in-flight fires. Optimization of a cargo compartment water mist system and the development of a performance standard culminates a multi-year effort to evaluate and specify the performance of new extinguishing agents to replace the currently used, environmentally unacceptable, halons. The program also conducts tests to characterize the smoke signature of various types of cargo fires. This is the initial task of a new activity to develop standard means of testing detectors for compliance with regulatory response time requirements. Near-term improvements in postcrash fire survivability are also to be completed in FY 1999. Full-scale fire tests support the development and validation of design guidelines for fuselage burnthrough resistance. Additional testing evaluates a composite fuselage (vs. conventional aluminum alloy) for resistance to fuel fire burnthrough and for the dangers of toxic and combustible gas buildup inside the cabin due to thermal degradation.

A06a - Fire Research and Safety Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
061-110 Fire Research & Safety						
Fire Safety Design						
Completed Design Guidelines For Postcrash Fire Burnthrough Resistance Hardening of Aircraft Fuselages	♦					
Evaluated HSCT Composite Skin Burnthrough Resistance	♦					
Initiate Study of Aircraft Hull Loses and Fatalities Caused by Oxygen System Malfunction or Damage		◇				
Develop Fire Test Procedures for HSCT Composite Fuselage Skin			◇			
Publish Updated Material Fire Test Handbook						◇
Fire Resistant Materials						
Scaled-Up Benzoxazine Chemistry & Produced Fire Resistant, Non-Toxic Interior Panels for Evaluation of Heat Release Rate	♦					
Improved Fracture Toughness of Non-Combustible Geopolymer Composite Fire Barriers	♦					
Developed Bench Methods for Toxic Hazards of New Materials	♦					
Validate Microscale Combustion Test Method		◇				
Demonstrate Decorative Panel with 50% Reduction in Heat Release		◇				
Develop Database on Heat Release Rate of 1999 State-of-the-Art Plastics and Composites "Baseline"		◇				
Develop Plastic & Composite Materials with 50% Reducion in Heat Release					◇	
Fire Detection and Suppression						
Developed Minimum Acceptance Levels of Performance and Criteria for Gaseous Halon Replacement Agents in Engine Fire Extinguishing Systems & Hand-Held Extinguishers	♦					
Completed Full-Scale Test Evaluation of Solid Propellant Gas Generator Technology in Engine Nacelle Test Article	♦					
Optimize Cargo Compartment Water Mist Fire Suppression System		◇				
Develop Cargo Compartment Water Mist System Minimum Performance Standard		◇				
Characterize Smoke Signature Associated with Cargo Fires		◇				
Revise Draft Advisory Circular for Smoke/Fire Detection				◇		
Develop False-Alarm-Free Smoke/Fire Detectors					◇	
Assess O2/N2 Separation Membrane Technology					◇	
Draft Oxygen Systems Safety AC						◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	3,032	1,999	2,963	3,377	2,098
Personnel Costs	2,214	3,072	3,345	3,001	2,315
Other Costs	454	629	685	615	337
Total	**5,700**	**5,700**	**6,993**	**6,993**	**4,750**

A06b Advanced Materials/Structural Safety

GOALS:

Intended Outcomes: The FAA intends to ensure the safety of U.S. and foreign made civil aircraft constructed of advanced materials as well as to improve passenger survival in the event of an accident. The advanced materials program focuses on the following technical areas:

- Standardized analysis and test methods for world-wide harmonization.
- Better understanding of the effects of repeated loads, damage, and joint configurations on remaining strength and life of composite aircraft structure.
- Reliability methods, as they apply to the design of composite aircraft components, and criteria for acceptable risk.

The Structural Safety area focuses on the following technical areas:

- Enhanced occupant survivability and reduced personal injury in the event of an accident.
- Improved crash characteristics of aircraft structures, cabin interiors, auxiliary fuel tank systems, and occupant seat/restraint systems.
- Improved analytical and modeling capabilities to develop improved structural, occupant, and seat restraint systems.

Agency Outputs: The FAA establishes rules for aircraft certification and operation and publishes advisory circulars to provide acceptable means of achieving compliance with those rules. While the rules are the same for composite or metal structure, the means of compliance reflect behavioral differences in the structural materials. Advisory Circular (AC) 20-107A, "Composite Structure" has been published, but advances in technologies and materials necessitate periodical update and expansion of the AC. Technical information is disseminated to regulatory personnel through technical reports, handbooks, and guidance by the FAA National Resource Specialist. The goal is to develop pertinent data, so that the regulatory processes keep pace with industry advances, including state-of-the-art test and evaluation for state-of-the-art technology and design. The advanced materials/structural safety program provides support in rulemaking and the development of guidance material for industry compliance. In structural safety, the FAA revises or updates Federal Aviation Regulations to accommodate new information for overhead stowage bins, auxiliary fuel tanks, and seat/restraint systems.

Customer/Stakeholder Involvement: The FAA has established the need for the advanced materials/structural safety program through consensus building activities including:

- The Aviation Rulemaking Advisory Committee (ARAC) is an FAA/industry forum established to ensure that agency rulemaking is effective in achieving intended results. ARAC is also effective in identifying requirements and priorities for supporting R&D activities.
- The Challenge 2000 report concludes that FAA should enhance its already effective program of gathering data and improving the certification of composite structures.
- A recent National Research Council report highlights the needs related to advanced materials and urges FAA to step-up advanced materials research for aircraft community benefits.
- The 1994 Department of Transportation Strategic Plan established Goal 3.3, "support the use of advanced materials in manufacturing and constructing transportation facilities and equipment."
- The Advanced Materials/Structural Safety program is responsive to Public Law 100-591, Aviation Safety Research Act of 1988, and House of Representatives Report 100-894 to develop technologies, to conduct data analysis for current aircraft, and to anticipate problems of future aircraft.

Accomplishments: Results of this program are provided to aircraft manufacturers, maintainers, and operators in the form of technical reports, handbooks, ACs, and guidance in the process of certification.

In the Advanced Materials area, the program has updated or issued two ACs and four handbooks, published more than 40 technical reports, articles, and papers, and has co-sponsored three technical conferences with attendance of approximately 1200 experts. A three-volume report on test methods for composites was disseminated to industry and

government to provide an authoritative compendium on state-of-the-art composites testing, with recommendations for usage and identified gaps. An alternative method of compliance to demonstrate repeated load life was developed and now significantly reduces fatigue testing time to ensure required service life. This method has been used successfully in the certification process of many aircraft components (recent example, the General Electric 90 fan blades) and has been adopted as a world-wide practice.

In the structural safety area, three reports on in-house commuter crash testing, as well as reports on aircraft ditching and aircraft flotation, have been widely disseminated. Rulemaking has been proposed for commuter seat/restraint systems. Also, in-service overhead stowage bins have been made more resilient to crash impact. A workshop on a crash impact modeling code developed by the FAA was held for certification engineers and industry participants.

R&D Partnerships: In the advanced materials area, the FAA coordinates with NASA to leverage research expenditures. The FAA concentrates on safety and certification issues, including testing, while NASA has the lead in analysis and design issues. Currently, the FAA supports NASA efforts to develop a composite property data base for general aviation (GA) aircraft under the NASA Advanced GA Transport Experiments/Integrated Design and Manufacturing Program. The FAA co-sponsors, with the U.S. Army, MIL-HDBK-17, a primary and authoritative source for statistically-based characterization data of current and emerging composite materials. This international reference reflects the best available data and technology for testing and analysis, and includes data development and usage guidelines. The handbook is used by FAA officials as a primary supporting document in structural substantiation in the certification process. On recommendations by the ARAC committee, material data contained in this handbook will be acceptable for use in the certification process. An international agreement has also been put in place to share work on reliability prediction methods for composites.

In the Structural Safety area, there have been agreements for cooperative programs with the U.S. Army and NASA Langley Research Center. There has been coordination with the French and Italian governments through memoranda of cooperation and an exchange of personnel in the crash testing area. A cooperative research program in the development of crash modeling software tools is underway with the United Kingdom. The program has also worked closely with Wichita State University to develop crash dynamic models and experimental, energy-absorbing seats. The structural safety area has established working relationships with airframers such as Boeing and Beechcraft and with manufacturers of overhead bins and auxiliary fuel tanks. A cooperative research and development agreement is in place with the bin manufacturer Northwest Composites.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Advanced materials.

- Updated composite material design and analysis handbook (two volumes) for use by rulemaking and compliance personnel.
- Completed development of a refined analytical model that predicts the response and failure of bolted composite joints. This aids in developing certification criteria for composite structural components.
- Completed research on damage accumulation in composites due to repeated loads. This aids in developing certification criteria for composite structural components.
- Developed an analytical model for composite structure response to impact damage. This aids in developing certification criteria for composite structural components.

Structural safety.

- Completed vertical drop testing of a Shorts 330 commuter aircraft fuselage to determine structural dynamic loads.

KEY FY 1999 PRODUCTS AND MILESTONES:

Advanced materials.

- Standardize mechanical test method for shear loading of composite structures to provide information for an authoritative compendium on state-of-the-art composites testing, with recommendations on test methods.
- Verify previously developed risk assessment software using different estimation methods.

- Identify the principal risk drivers that control the safety of composite airframes.

Structural safety.

- Complete vertical drop test of two B-737 fuselage sections with and without overhead storage bins and auxiliary fuel tank to determine the dynamic loads imposed on storage bins and fuel tanks.
- Complete assessment of the crash resistance of transport fuel systems.
- Establish guidelines for conducting head injury criteria component testing to supplement full scale testing.

FY 1999 PROGRAM REQUEST:

In FY 1999, the program continues to focus on the areas listed at the beginning of the GOALS section above. Specific areas are shear test methods, test protocols for repeated loads, and establishing risk drivers and reliability targets for composite civil aircraft. Within the structural area, characterization of crash-induced commuter airplane loads, transport category overhead storage bins, and auxiliary fuel tank systems are continued.

A06b - Advanced Materials/Structural Safety Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
062-111 Advanced Materials Structures						
Advanced Materials						
Completed Development of a Refined Analytical Model Bolted for Joints	♦					
Updated Composite Material Design and Analysis Handbook	♦					
Completed Research on Damage Accumulation in Composites Due to Repeated Loads	♦					
Developed Analytical Model for Composite Structure Response to Impact Damage	♦					
Establish Standardized Test Methods for Shear Loading		◇				
Verify Developed Risk Assessment Software		◇				
Identify Main Risk Drivers of Composite Airframes		◇				
Establish Guidelines for Probabilistic Design Certification				◇		
Update AC-107A Composite Structure for Durability			◇			
Establish Delimitation Growth Threshold Methodology			◇			
Develop Database on Verified Design Practice for Adhesive Joints					◇	
062-110 Structural Safety						
Structural Safety						
Completed Vertical Drop Testing of a Shorts 330 Commuter	♦					
Complete Vertical Drop Test of a B737 Fuselage Section		◇				
Establish Guidelines for Conducting HIC Component Testing		◇				
Complete Assessment of the Crash Resistance of Transport Fuel Systems		◇				
Publish Data Ditching and Water Impact			◇			
Establish Criteria for Transport Aircraft Side-Facing Seats			◇			
Publish Data on Crash Resistance of Transport Aircraft Stowage Bins				◇		
Publish Data on Crash Resistance of Transport Aircraft Fuel Tanks				◇		
Identify Transport Ditching Requirements					◇	
Establish Crash Test Database						◇
Define Rotorcraft Crash Pulse						◇
Define New Occupant Injury Criteria						◇
Water Impact FULL Scale Model Validation						◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	3,435	332	1,249	2,059	809
Personnel Costs	1,502	1,384	1,507	835	803
Other Costs	308	284	309	171	122
Total	**5,245**	**2,000**	**3,065**	**3,065**	**1,734**

A06c Propulsion and Fuel Systems

GOALS:

Intended Outcomes: The FAA intends to improve system safety by enhancing the airworthiness, reliability, and performance of civil turbine and piston engines, their propellers, fuels, and fuel management systems. The major outcomes from this program include:

- Continued reliability and safety of general aviation operations by providing a safe transition to a new high-octane unleaded aviation gasoline.
- A reduction in the number of intrinsically caused turbine rotor failures by improved and standardized design and life management procedures.
- Improved manufacturing process standards for premium quality titanium alloy, turbine rotor components.
- Reduced turbine engine failure/downtime and improved maintenance efficiency through advanced diagnostic hardware and software.

Agency Outputs: The FAA maintains the airworthiness of aircraft engines, fuels, and airframe fuel management systems by issuing certification and advisory standards, and by supporting technical society specifications and recommended practices. The FAA also publishes technical information in the public domain in various forms. Technology may also be provided to the industry through hardware and software prototype demonstrations and technology workshops or various training medium. This research program provides the resources and oversight to deliver the necessary propulsion, fuel, and fuel transfer system technology in support of these agency outputs.

Customer/Stakeholder Involvement

- The FAA collaborates with the engine industry to identify and implement cost-effective safety improvements that address incidents and accidents caused by in-service engine failures. This collaboration was initiated by the FAA Titanium Rotating Components Review Team. This team advises on the adequacy of industry standards and procedures to ensure the safety of titanium alloy high energy rotating components of turbine engines. Industry participation is through working committees under the Aerospace Industries Association (AIA), including the Materials and Structures Committee, Rotor Integrity Subcommittee and the Jet Engine Titanium Quality Committee.
- The AIA committees identify potential improvements in manufacturing process control, manufacturing and in-service inspection, and design and life management of failure critical rotating engine parts. These improvements are the basis for identifying specific R&D already underway or planned for this program.
- The FAA participates and provides leadership in testing capability for the Coordinating Research Council (CRC) Unleaded Aviation Gasoline Development Group. This group was formed in February 1995 to oversee research and testing for the development of the next generation high-octane unleaded aviation gasoline. Environmental Protection Agency regulations and the Clean Air Act of 1990 mandate removal of lead from all gasolines. The critical need for the development of this fuel is reflected by the list of participants on the CRC group. Active participants and members of this group include: most major oil companies (U.S. and worldwide); general aviation airframe and engine manufacturers; general aviation user groups such as the Aircraft Owners and Pilots Association, Experimental Aircraft Association, and General Aviation Manufacturers Association; our sponsor, FAA New England Region Engine and Propeller Directorate; and FAA Small Airplane Directorate in Kansas City.
- The FAA Sponsored Technical Oversight Group On Aging Aircraft (TOGAA) ensures effective technical coordination of the airworthiness assurance R&D activities with related activities in DOD and industry. TOGAA has provided feedback on the progress of the turbine engine program over the last three years.
- The Subcommittee on Aircraft Safety of the FAA Research, Engineering and Development Advisory Committee was briefed on the propulsion program, an initiative which the subcommittee strongly supports.
- The FAA/industry initiative on turbine engine rotor integrity research in this program addresses National Transportation Safety Board recommendations A-90-89 and A-90-90.

- A congressional mandate, expressed in Public Law 100-591, the Aviation Safety Research Act of 1988, amended section 312 for the FAA to perform more basic and applied research in areas including propulsion systems and fuels, to enable the agency to generate technology breakthroughs where technology gaps need to be closed at fundamental levels.
- The program addresses recommendations of the FAA Titanium Rotating Components Review Team Report which was presented to industry in a public meeting held in May of 1991.

Accomplishments: Results of the propulsion and fuels research program provided to engine and aircraft manufacturers, maintainers, and operators:

- Drafted an advisory circular on the correlation, operation, design, and modification of turbo fan/jet engine test cells which provide guidance on the testing of aircraft engines.
- Hosted a joint FAA/Air Force public workshop with published proceedings on the application of probabilistic design methodology to gas turbine rotating components.
- Demonstrated integrated titanium alloy probabilistic design code (version 1.0) to provide commercial aircraft engine manufacturers a tool to augment their current safe-life management philosophy.
- Demonstrated defect deformation modeling code (MAAP-2D; version 1.0) for analysis of turbine disk forging process.
- Determined the fleet octane requirement to be the single most critical parameter for development of high-octane unleaded aviation gasoline.
- Completed validation of ground-based procedures for determining octane requirements to be used in the development of a new high-octane unleaded aviation gasoline.
- Tested a series of seven aviation piston engines to determine octane requirement. It was determined that isooctane (100 rating) does not fully satisfy octane requirements for all phases of engine operation, including leaning to best power.
- Participated in establishing matrix components to be used in developing candidate fuel formulations.
- Conducted engine tests on new fuel formulations.
- Completed report on engine octane requirements.

R&D Partnerships:

- A cooperative grant was awarded to the Southwest Research Institute in August 1995, which teamed with major engine manufacturers Pratt and Whitney, General Electric, Allied-Signal, and Allison. This work develops probabilistic-based turbine rotor material design and life management tools for improved rotor integrity. This work is closely coordinated with the Air Force Wright Laboratory, which conducts complementary research. This program is also coordinated with ongoing research activities of the FAA Engine Titanium Consortium sponsored under budget item A06e, Aging Aircraft. The FAA plans to transfer the completed probabilistic engine design code to the user in the public domain via a training workshop. A dialog has been initiated with the Air Force Wright Laboratory Manufacturing Technology (Man Tech) program to set up an interagency agreement for the FAA to leverage the Man Tech titanium alloy hearth melt processing technology.
- The partnership exhibited by the CRC Unleaded Aviation Gasoline Development Group provides an arena to conduct research that is unprecedented in the aviation gasoline industry. The proprietary and competitive forces inhibiting progress, in the high-octane aviation gasoline development, have been set aside. This allows the transfer of technology to and from government and industry to benefit all participants. Industry participants include Texaco, Exxon, Phillips Petroleum, Chevron, British Petroleum, Cessna, Raytheon (Beech), Teledyne Continental, and Textron Lycoming.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

- Demonstrated and delivered the final titanium alloy defect deformation modeling code (MAAP-2D) for analysis of turbine disk forging process.
- Demonstrated the intermediate probabilistic rotor design code (version 2.0) including the fracture mechanics life module.
- Conducted initial tests on industry-submitted candidate fuel formulations.

- Completed and issued the report on fleet octane requirements to provide specifications for new unleaded aviation gasoline.
- Completed unleaded fuels flight testing using isooctane.

KEY FY 1999 PRODUCTS AND MILESTONES:

- Complete unleaded fuels flight testing to validate new aviation gasoline specification.
- Complete characterization and testing of industry-supplied candidate fuels using ground test facilities.
- Deliver improved titanium alloy defect distribution model.
- Deliver technical report on parametric benchmarking on titanium alloy defect morphology.
- Complete summary report on hard alpha crack nucleation. This report provides data necessary to predict crack formation and growth in engine titanium components; and to improve reliability of those components.

FY 1999 PROGRAM REQUEST:

The program continues development of a probabilistically-based turbine engine rotor design code with damage tolerance assessment. This code is a public domain, generic design, and life management tool to augment the current safe-life design approach for integration into engine manufacturer rotor design procedures. The application of this tool, as a recognized design certification standard, is intended to improve turbine rotor structural integrity while reducing the risk of failure.

The program also continues research on industry-provided lead-free fuel formulation candidates to replace the low lead aviation gasoline (ASTM D910 100LL) currently in use. These tests evaluate new fuel formulation effects on engine detonation, material compatibility, volatility, engine performance, storage stability, water reaction, emissions, fuel consumption and engine durability. All parameters impact on safe engine operation and all data supports eventual certification of a replacement fuel.

A06c - Propulsion and Fuel Systems Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
063-110 Propulsion Systems Research						
Engine Rotor Structural Integrity						
Delivered Final Titanium Alloy Defect Deformation Code(MAAP-2D)	♦					
Demonstrated the Intermediate Probabilistic Rotor Design Code (Version 2.0)	♦					
Complete Summary Report on Hard Alpha Crack Nucleation		◇				
Deliver Technical Report Parametric Benchmarking on Titanium Alloy Defect Morphology		◇				
Deliver Improved Titanium Alloy Defects Distribution Model		◇				
Conduct Training Workshop on Probabilistic Design Code			◇			
Complete Titanium Alloy Rotor Materials Data/Models on Surface Anomalies				◇		
Publish Draft AC on Manufacturing Process Standards for Titanium Alloys					◇	
Fuel Safety						
Completed and Issued Report on Fleet Octane Requirement	♦					
Completed Unleaded Fuels Flight Testing Using Isooctane	♦					
Conducted Initial Tests on Industry Submitted Candidate Fuel Formulations	♦					
Complete Characterization & Testing of Candidate Fuels		◇				
Complete Unleaded Fuels Flight Testing to Validate New Aviation Gasoline Specification		◇				
Complete Draft and Final ASTM Specification for High Octane Unleaded Aviation Gasoline			◇			◇
Complete Fleet Evaluation of Candidate Unleaded Aviation Gasoline				◇		

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	2,044	1,716	1,566	3,643	1,761
Personnel Costs	1,155	1,398	1,522	1,126	932
Other Costs	237	286	312	231	138
Total	**3,436**	**3,400**	**3,400**	**5,000**	**2,831**

A06d Flight Safety/Atmospheric Hazards Research

GOALS:

Intended Outcomes: The FAA intends to improve aircraft safety by developing technologies, technical information, procedures, and practices. These ensure safe operation of the civil fleet in icing conditions and in the electromagnetic environment, and address safety issues pertaining to digital flight controls and avionics systems.

In the area of aircraft icing, the program focuses principally on establishing operating rules and procedures for deicing and anti-icing to ensure a clean aircraft at takeoff. It also focuses on developing technology to determine the existence of frozen contamination and the failure of anti-icing fluids on critical aircraft surfaces. It addresses characterization of the atmospheric icing environment by collecting and analyzing supercooled cloud and precipitation data. It also develops technology (ice protection and detection), certification requirements, and advisory material to ensure that aircraft meet performance, stability, and control safety standards during or after inflight operation in icing conditions.

The electromagnetic test and analysis area focuses on protecting aircraft electrical and electronic systems against the effects of lightning and high intensity radiated fields (HIRF). These effects may come from airborne, shipborne and ground-based emitters, and from portable electronic devices, i.e., tape players, laptop computers, cellular phones, etc.

The digital flight controls and avionics systems area addresses aircraft safety issues. These issues involve the use of emerging, highly complex, software-based digital flight controls and avionics systems in flight-essential and flight-critical applications.

Agency Outputs: The FAA establishes rules for aircraft operation in icing conditions and the electromagnetic environment. It establishes rules pertaining to digital flight controls and avionics systems. It also publishes advisory circulars to outline acceptable means for meeting the rules and disseminates various forms of technical information to agency certification and airworthiness specialists, agency inspectors, and to the aircraft and avionics industry. The program also fosters development of promising technologies such as sensors, to detect frozen contamination, and anti-icing fluid failure. The aircraft icing project joins with the Society of Automotive Engineers (SAE) in annual updates to aircraft holdover time guidelines. These provide time estimates of the effectiveness of de/anti-icing fluids.

Customer/Stakeholder Involvement: The program directly supports the Aviation Safety Plan by assisting the zero accident goal. It does this through enhancements to aircraft certification, inspection, and maintenance relative to atmospheric hazards and advanced digital systems. It also directly supports Challenge 2000 through research and increased awareness in the area of software and standardization efforts among the certification directorates. In addition, it supports the free flight initiative, addressing highly integrated avionics and ground-based systems safety and certification issues, using very complex software. A key supporter is the Aviation Rulemaking Advisory Committee (ARAC) Electromagnetic Effects Harmonization Working Group (EEHWG).

The ARAC Flight Test Harmonization Working Group addresses performance and handling requirements standardization, and guidance material for operation in icing conditions. SAE committees also address aircraft lightning protection (AE4L), and aircraft HIRF protection (AE4R). These two government and industry committees develop advisory circulars, test standards, and related users manuals to improve flight safety. The FAA provides leadership to the SAE G-12 Aircraft Ground Deicing Committee. This committee addresses holdover time guideline updates, standards establishment for de/anti-icing methodologies and fluids, and sensor criteria to determine the existence of frozen contamination. It also addresses the failure of anti-icing fluids on critical aircraft surfaces.

Accomplishments: The program provided aircraft icing regulatory guidance and operating procedures to aircraft manufacturers and operators. This consisted of technical reports, handbooks, information bulletins, advisory circulars and rules. Since 1992, the program has updated or issued two advisory circulars, five technical bulletins, and the *Aircraft Icing Handbook*, and it has published more than 30 technical reports or papers, including reports on ice phobic technologies. It has held international conferences on aircraft ground deicing (more than 600 participants from more than 10 countries) and on aircraft inflight icing (more than 400 participants from 20 countries). It has also

issued holdover time guidelines for deicing and anti-icing fluids.

The program initiated an effort to assess modified condition/decision coverage requirements for avionics software testing. It initiated a study on applying formal methods to software partitioning in order to protect avionics software in highly integrated systems.

The program published electromagnetic test and analysis reports on stochastic evaluation of HIRF testing environment for aircraft. It also collected and published HIRF environmental conditions for civil aircraft. It published a report addressing electromagnetic interference bench testing of a full authority digital engine controller for rotorcraft. The program updated The FAA research electromagnetic database containing lightning strike data and waveforms. This included C-160 aircraft data.

R&D Partnerships: The program has established many cooperative relationships, including:

- ARAC, EEHWG international certification authority/ industry forum.
- SAE, two committees.
- RTCA Special Committee-182, "A Minimum Operational Performance Standard for an Avionics Computer Resource".
- RTCA Special Committee-190, and DO-178B software guidance for issues missed or arising since publication of the document.
- The multi-year FAA/NASA interagency agreement with Langley Research Center to cooperate in the assessment of software-based digital flight controls and avionics systems and electromagnetic hazards research.
- The multi-year FAA/Department of Energy interagency agreement with Idaho National Engineering Laboratory in characterization of lightning strike data and development of a lightning waveform database.
- The multi-year interagency agreement with Naval Air Warfare Center Aircraft Division to assess the HIRF environment for aircraft.
- Cooperative efforts on aircraft icing activities with the NASA Lewis Research Center.
- Aircraft icing has more than six grants and agreements in place with academia and other government agencies to "leverage" interests and capabilities.
- An international agreement exists with Transport Canada on research on aircraft ground deicing issues.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Aircraft icing.

- Published final report on determination of susceptibility of aircraft to icing induced tailplane stall.
- Evaluated time effectiveness of recently developed new and environmentally friendly deicing/ anti-icing fluids.
- Published report on development and testing of passive surface ice detection system utilizing polarized infrared radiation.
- Reported on technologies and prototype equipment developments to provide aircraft-mounted wide-area coverage ice detection on aircraft upper-wing surface prior to takeoff.
- Published report on effect of large droplet ice accretions on airfoil and wing aerodynamics and control.
- Continued collecting supercooled large droplet data aloft.
- Reported on survey of technology to remotely assess icing conditions.
- Reported on 2D ice accretions on modern airfoils.
- Completed developing a wide-area surface ice detector technology prototype.

Flight controls and digital avionics systems.

- Published streamlining software aspects of certification (SSAC) task management plan for data collection, analysis, and identification of solutions.

Electromagnetic test and analysis.

- Published user's manuals for lightning and HIRF draft advisory circulars.

- Completed feasibility study of a portable electronic device detector.
- Published update to commercial lightening strike database.

KEY FY 1999 PRODUCTS AND MILESTONES:

Aircraft icing.

- Evaluate time effectiveness and aerodynamic performance of environmentally friendly and other modern fluids.
- Complete final report on large droplet ice accretions effect on airfoil and wing aerodynamics and control.
- Report on prototype technology to remotely assess icing conditions.

Flight controls and digital avionics systems.

- Publish report on HIRF digital upset phenomenon.
- Develop prototype and implement SSAC.

Electromagnetic test and analysis.

- Publish user's manuals for lightning and HIRF draft advisory circulars.
- Publish update to commercial lightning strike database.

Aircraft icing.

- Collect and assess the global atmospheric icing environment data with emphasis on the SLD environment. Validate criteria and enhancements for icing tankers, tunnels, and analytical icing computer codes; and quantitatively characterize ice roughness, shape and aerodynamic effect.

Flight controls and digital avionics systems.

- Initiate Phase II of the SSAC project. This phase implements and prototypes identified techniques for relaxation of software process requirements.

Electromagnetic test and analysis.

- Continue lightening protection work.

A06d - Flight Safety/Atmospheric Hazards Research Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
064-110 Flight Safety						
Flight Control & Avionics System						
Published Task Management Plan for SSAC	♦					
Development of Prototype and Implementation of SSAC		◇				
Published Report on HIRF Digital Upset Phenomenon		◇				
Publish Approval Criteria for Ground/Airborne Software					◇	
Publish Acceptance Criteria for Software Service History						◇
064-111 Atmospheric Hazards						
Aircraft Icing						
Published Final Report on Determination of Susceptibility to ICTS	♦					
Reported on 2D Ice Accretions on Modern Air Foils	♦					
Published Report on Passive Surface Ice Detection System	♦					
Reported on Survey of Tech. to Remotely Assess Icing Conditions	♦					
Evaluate Time of Effectiveness & Aerodynamic Performance of Modern Fluids	♦	◇	◇			
Report on Technologies and Prototype Equipment Developments to Provide Aircraft Mounted Wide Area Coverage Ice Detection	♦		◇			
Publish Reports on Effect on Large Droplet Ice Accretions on Airfoils and Wing Aerodynamics and Control	♦	◇				
Report on Prototype Tech. to Remotely Assess Icing Conditions		◇				
Report on Consolidation of SLD Data at Flight Altitudes			◇			
Report on Quantitative Characterization of Ice Roughness and Shape and Aerodynamic Effect				◇		
Report on Global Atmospheric Icing Environment					◇	
Pub. Fluid Failure & Holdover Times Procedures for Manufacturers						◇
Electromagnetic Test and Analysis						
Published User's Manual for HIRF	♦					
Completed Feasibility Study for Portable Electronic Device Detector	♦					
Published Update to Commercial Lightning Strike Database	♦					
Publish User's Manual for Lightning		◇				
Publish Update to Lightning Protection of Aircraft Handbook				◇		
Publish Updated HIRF Testing Methods					◇	
Publish Worldwide HIRF Environment						◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	3,190	3,535	1,368	705	1,494
Personnel Costs	1,502	530	577	1,127	973
Other Costs	308	108	118	231	152
Total	**5,000**	**4,173**	**2,063**	**2,063**	**2,619**

A06e Aging Aircraft

GOALS:

Intended Outcomes: The FAA intends to improve system safety by developing technologies, technical information, procedures, and practices that ensure the continued airworthiness of aircraft structures and components in the civil fleet. The aging aircraft research program focuses principally on:

- Analytical methodologies development and validation – to predict the onset of widespread fatigue damage (WFD) and residual strength of aircraft structures.
- Nondestructive inspection techniques development and validation – to detect and quantify damage in the forms of corrosion, cracking, disbonding, and material processing defects.
- Flight and landing loads airworthiness standards updates and validation – for civil transport aircraft by acquiring/analyzing actual usage data.
- Maintenance and repair requirements and procedures establishment – for airframes.
- Crack-growth based predictive methodology development – to derive inspection and maintenance programs for non-rotating, safety critical components of aircraft engines.
- Fatigue substantiation methodology, health/usage monitoring methodology, and updated design load spectrums (based on actual usage) – for the rotorcraft fleet development.

Agency Outputs: The FAA establishes rules for aircraft certification, inspection, maintenance, and repair and publishes advisory circulars to outline acceptable means for compliance. In addition, it disseminates technical information in various forms (such as FAA orders) to agency airworthiness inspectors and industry. This improves aircraft construction and maintenance practices. The objective of all of these products is flight safety based on continued airworthiness of aircraft. The Aging Aircraft research program provides the technical information necessary to support these agency outputs.

Customer/Stakeholder Involvement: The FAA has established an extensive network for collaboration in aging aircraft.

- The Aviation Rulemaking Advisory Committee (ARAC) is an FAA/industry forum established to ensure that agency rulemaking is effective in achieving intended results. It ensures that the resources of industry are used to their fullest extent. ARAC also identifies requirements and priorities for supporting R&D activities.
- The FAA-sponsored Technical Oversight Group - Aging Aircraft (TOGAA) ensures effective coordination of aging aircraft program activities with related activities DOD and industry. TOGAA meets several times a year to assess program progress and review research priorities, in light of technical progress and the needs of aircraft manufacturers, operators, and maintainers.
- The Subcommittee on Aircraft Safety of the FAA Research, Engineering and Development Advisory Committee completed a review of the Aging Aircraft program. The program described here is fully responsive to the advice of the subcommittee.
- The Aging Aircraft program directly supports the Aviation Safety Research Act of 1988 (Public Law 100-591). This Act increased the scope of the FAA's mission to include research on methods for improving maintenance technology and detecting the onset of cracking, delamination, and corrosion of aircraft structures. In particular, this legislation directed the FAA to focus attention on maintaining the airworthiness of the aging commercial fleet.

Accomplishments: An on-going research effort provides guidance for complying with assessment programs on widespread fatigue damage in both the civil and military aircraft fleets. This research is co-funded by the FAA, NASA and the USAF, and conducted by McDonnell Douglas. The effort includes analytical methods developed by both the FAA and NASA. Testing is done by the FAA and the U.S. Air Force. This integrated effort continues to validate government-developed analysis codes to predict the onset of WFD.

A small crack detection structured experiment was completed by the FAA's Aging Aircraft Non-Destructive Inspection Validation Center (AANC). The experiment demonstrated that commercially available instruments can detect small cracks in aircraft skins under the rivet heads. Prototype

instruments developed by Northrop Grumman and NASA could detect cracks before reaching the edge of the rivet head. This is significant because these cracks are indicative of the WFD identified in the Aloha Airlines accident. This information assists the FAA and industry in specifying and approving future inspection equipment.

Civil transport flight and ground loads data collection programs for both large and small transport aircraft were re-established. Optical quick access recorders have been installed on several B-737/400 and MD-82 aircraft and usage data is being analyzed. Similar recording technology is being developed for commuter aircraft. Airplane landing contact parameters have been obtained from analysis of video images recorded during surveys conducted at representative high activity commercial large transport and commuter airports.

A team comprised of the FAA, the AANC, Lockheed and Delta Airlines, Textron, and Warner Robbins AFB successfully applied the first composite reinforcement doubler on a U.S. commercial aircraft. The doubler replaced the standard reinforcement which consists of four riveted aluminum sheets. The composite reinforcement improves the fatigue resistance and substantially reduces the cost of the repair.

R&D Partnerships: Program activities are closely coordinated with related initiatives underway at NASA, DOD, and industry. The FAA and NASA, through a Memorandum of Agreement, have co-sponsored several conferences in the area of aging aircraft and airworthiness assurance. Interagency agreements are in place between the FAA and NASA, U.S. Navy, the USAF, National Institute of Standards and Technology, and Department of Energy. International agreements are in place between the FAA and the regulatory authorities in the United Kingdom, the Netherlands, Australia, and Canada. A Center of Excellence for Airworthiness Assurance was established in FY 1997. The Center for Aviation Systems Reliability (CASR) is a consortium of four universities, Iowa State University, Northwestern University, Wayne State University, and Tuskegee University. The CASR was formed to develop nondestructive inspection techniques. The AANC is a partnership with Sandia National Laboratory to test and evaluate inspection techniques in a realistic hangar environment and enhance technology transfer. The Engine Titanium Consortium, consisting of Iowa State University, Pratt & Whitney, General Electric, and Allied-Signal, was formed to develop methods for the inspection of engine components. Numerous research grants have been awarded though the aviation research grants program, and are in place with universities and not-for-profit laboratories to leverage their interests and capabilities. Cooperative research and development agreements are in place with two airline operators as part of the flight loads data collection program.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

- Completed development of a software to assess the risk of the onset of WFD in aircraft structures to aid in establishing maintenance and inspection schedules.
- Completed the inter-layer crack detection structured experiment, the analysis of visual inspection baselining reliability program, and the transfer of the thermal wave imaging technology for disbond detection to industry.
- Published technical report providing large quantities of flight loads data for B-737 and MD-82 aircraft and technical reports summarizing the landing contact parameters at JFK International and Washington National Airports.
- Conducted annual video landing loads survey.
- Developed Supplemental Inspection Document for the Fairchild Metro airplane.
- Published advisory circulars on nondestructive inspection of aircraft and on designing visually inspectable repairs for use in the maintenance and repair of aircraft.
- Published revisions to the advisory circular for aircraft metal propeller maintenance and to the advisory circular on continuous airworthiness maintenance programs.
- Completed draft advisory circular for minimum health/usage monitoring (HUMS) requirements. Updated database to support revision of FAR 27/29.571 advisory material (new fatigue spectrum definition and new damage tolerance guidance) and rulemaking (changes to part 29.571, fatigue substantiation of part 29 rotorcraft).

KEY FY 1999 PRODUCTS AND MILESTONES:

- Complete development and validation of a suite of ultrasonic and eddy current inspection tools for production and in-service inspection of engine components.
- Complete the development of an engineering manual with guidelines for predicting the onset of WFD and residual strength; and complete the risk assessment of two of the structural details identified by the industry working group as prone to WFD.
- Complete development of a crack-growth based predictive methodology for static engine parts.
- Complete the transfer of the thermal wave imaging technology for corrosion detection to industry.
- Complete the transfer of pulsed eddy current technology for inter-layer crack detection to industry.
- Complete development and validation of ultrasonic and eddy current inspection tools.
- Conduct a video landing loads survey at Denver International Airport to quantify high altitude landing parameters for civil transport aircraft.
- Publish flight loads data reports for additional aircraft models, i.e., B-767, A-320 and BA-146.
- Develop recommendations for inspection procedures and replacement or modification of components for continued safe operation of Piper Navajo airplane.
- Establish landing loads data facility.
- Publish advisory circulars on inspection and repair of composite aircraft structures; composite doublers for reinforcement and repair; and minimum HUMS for rotorcraft.

FY 1999 PROGRAM REQUEST:

The program continues to focus on the areas listed at the beginning of the GOALS section above. The near-term emphasis is on a better understanding of the effects of widespread fatigue damage, developing supplemental inspection requirements to better account for airframe and component damage, and developing and validating enhanced inspection techniques.

A06e - Aging Aircraft Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
065-110 Aging Aircraft						
WFD and Residual Strength Analysis						
Developed Risk Assessment Tool to Predict WFD	♦					
Completed Development of a Crack-Growth Based Predictive Methodology of Static Engine Parts		◇				
Produce Engineering Manual with Guidelines for onset of WFD		◇				
Publish AC on Inspection and Maintenance of Static Engine Parts				◇		
Commuter Aircraft Inspection Requirements						
Developed SID for Fairchild Metro	♦					
Develop SID for Piper Navajo			◇			
Develop Recommendations for Development of Supplemental Inspection Programs for Commuters			◇			
Airborne Data Monitoring Systems						
Publish Technical Report of Current Flight Loads Data	♦	◇	◇	◇	◇	◇
Conduct Annual Video Landing Loads Survey	♦	◇	◇	◇	◇	◇
Establish Landing Loads Data Facility		◇				
Maintenance and Inspection						
Published AC on Guidelines and Procedures for NDI	♦					
Published AC on Designing Visually Inspectable Repairs	♦					
Completed the Inter-layer Crack Detection Structured Experiment	♦					
Complete the Transfer of the Thermal Wave Imaging for Corrosion		◇				
Complete the Transfer of Pulsed Eddy Current Technology		◇				
Complete Development and Validation of Ultrasonic and Eddy Current Inspection Tools		◇				
Publish AC on NDI for Engines			◇			
Complete Development of Ultrasonic Inspection Tools for Engines					◇	
Complete AC on Repair and Maintenance of Engine Propellers					◇	
Release Repair Analysis Software Tool for Commuter Aircraft						◇
Develop Prototype for Detection of WFD-Size Cracks						◇
Rotorcraft Structural Integrity						
Complete Draft and Publish Final AC on Minimum HUMS for Rotorcraft	♦	◇				
Update AC 29-2A and 27-1 for Fatigue and Damage Tolerance						◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	21,797	16,615	10,585	18,466	11,945
Personnel Costs	2,658	2,810	2,742	2,551	2,381
Other Costs	545	575	562	523	368
Total	**25,000**	**20,000**	**13,889**	**21,540**	**14,694**

A06f Aircraft Catastrophic Failure Prevention Research

GOALS:

Intended Outcomes: The FAA intends to improve system safety by developing technologies and methods to assess risk and prevent defects, failures, and malfunctions in aircraft, aircraft components, and aircraft systems which could result in aircraft catastrophic failure.

The Aircraft Catastrophic Failure Prevention program focuses principally on using historical accident data to attack known problem areas such as:

- Turbine engine uncontainment events, including mitigation and modeling of uncontainment and aircraft vulnerability to uncontainment (AC20-128, phase II).
- Developing alternate means of controlling an aircraft when the primary flight control system is damaged or degraded.
- Examining issues associated with inappropriate crew response to propulsion malfunctions and working with industry to develop solutions to this critical problem.

Agency Outputs: The FAA establishes certification criteria for aircraft and publishes advisory circulars to outline acceptable means for meeting these rules. The program's objective is to ensure safe aircraft operation in the public domain.

The Aircraft Catastrophic Failure Prevention program provides the technical information necessary to support these agency outputs.

Customer/Stakeholder Involvement: The FAA continues to establish collaborative efforts ensuring a balanced, responsive program:

- Aviation Rules Advisory Committee (ARAC) is an FAA/industry forum established to ensure that agency rulemaking is effective in achieving intended results and that the resources of industry are fully utilized in accomplishing these results. ARAC also is effective in identifying requirements and priorities for supporting R&D activities. The ARAC Powerplant Installation and Harmonization Working Group provides guidance to this program for the update of AC20-128.
- The FAA sponsors an annual workshop on turbine engine uncontainment characterization, modeling, and mitigation. This workshop brings together industry and government (civil and military) to review progress to date on this subject and to make recommendations on the future courses of action.
- The FAA (through Lawrence Livermore National Laboratories) has obtained letters of intent from Boeing, United Technologies (Pratt & Whitney) and Allied-Signal Engines, to participate in a collaborative effort to develop a modeling toolkit for the modeling of engine uncontainment events.
- The FAA supports the Aerospace Industries Association - Transport Committee project on propulsion system malfunction plus inappropriate crew response. This project brings industry and the FAA together to develop recommendations (and associated regulations and advisory material) on the subject of safety concerns.
- The program also responds to Public Law 100-591 (the Aviation Safety Act) and Public Law 101-508 (the Omnibus Reconciliation Act) which specifically established the aircraft catastrophic failure prevention program.

Accomplishments: Results of the Aircraft Catastrophic Failure Prevention program research are provided to certification officials to provide the technical basis for rule changes as well as new or modified advisory circulars. Results are also provided to airframe and engine manufacturers and designers. Recent accomplishments include:

- Completed uncontained engine failure fuselage damage data base. This database is useful for scientific uncontained engine debris evaluation that will result in significant revision to AC20-128. Accident investigations indicate debris damage spread angles are larger than current AC material indicate.
- Developed a baseline aircraft vulnerability model to predict aircraft vulnerability to engine uncontainment events.
- Completed a detailed analytical study on the potential for fuel tank fires resulting from uncontained engine failures.
- Completed a detailed report examining DOD armor technology and its potential application to turbine engine uncontainment mitigation.

- Completed a report analyzing causal effects for accidents and incidents from 1975 to 1995 for commercial transport. Recommendations for changes to the Federal Aviation Regulation were made based on the results of the analysis.

R&D Partnerships: Program activities are closely coordinated with government, academia, and commercial experts to take full advantage of existing expertise through interagency agreements, grants, and contracts.

Significant program benefit is realized from the following agreements, leveraged on existing facilities and expertise:

- Interagency Agreement with Naval Air Warfare Center Weapons Division, China Lake, which partners with Boeing and McDonnell Douglas, to modify military vulnerability analysis tools. These tools are used in examining the vulnerability of commercial transport aircraft to turbine engine uncontainment events.
- Interagency Agreement with Naval Air Warfare Center Aircraft Division, Trenton, to utilize existing spin test facilities and expertise to test containment structures.
- Interagency Agreement with Lawrence Livermore National Laboratory, which partners with Boeing, Allied-Signal Engines, and Pratt & Whitney, to develop a modeling toolkit to address turbine engine uncontainment events modeling.
- Interagency Agreement with NASA Dryden, which, in partnership with McDonnell Douglas, universities, and Boeing; develops the Intelligent Damage Adaptive Control System (IDACS). This system offers alternative means of controlling an aircraft with a damaged flight control system.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Engine uncontainment research.

- Completed uncontained turbine rotor fragment characteristics and typical debris analysis.
- Determined applicable turbine rotor fragment advanced barrier materials to mitigate uncontained engine failures.
- Completed phase I development of the model of uncontained debris from turbine engine rotating components.
- Continued airframe manufacturers' evaluation of aircraft vulnerability model.

Flight control system research.

- Completed report on fault detection and recognition and fault tolerant flight control systems.
- Continued IDACS program with NASA, Dryden.

KEY FY 1999 PRODUCTS AND MILESTONES:

Engine uncontainment research.

- Complete airframe manufacturers' evaluation of aircraft vulnerability model.
- Begin modifications to vulnerability code based on airframe manufacturers' evaluations.
- Begin phase II development of model of uncontained debris from turbine engine rotating components.

Flight control system research.

- Continue IDACS technology work with NASA, Dryden.

FY 1999 PROGRAM REQUEST:

The program modifies aircraft vulnerability codes to incorporate suggestions obtained from airframe manufacturers' evaluations. It continues developing a calibrated design system, for certification purposes, to examine engine uncontainment by developing toolkit components that model mitigation effects of advanced materials.

The joint FAA/NASA IDACS continues with culmination of phase I in FY 2000. This demonstrates the technology, in a simulator, to maintain control of an aircraft with a damaged flight control system.

A06f - Aircraft Catastrophic Failure Prevention Research Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
066-110 Aircraft Catastrophic Failure Prevention Research						
Engine Uncontainment Research						
Completed Uncontained Turbine Rotor Fragment Characteristics	♦					
Determined Applicable Advanced Turbine Rotor Fragment Barrier Materials to Contain Engine Failures	♦					
Completed Phase 1 Development of Model of Uncontained Debris from Turbine Engine Rotating Component	♦					
Continued Airframe Manufacturers' Evaluation of Aircraft Vulnerability Model	♦					
Complete Vulnerability Model		◇				
Begin Modifications to Vulnerability Code Based on Airframe Manufacturers' Evaluations		◇				
Begin Phase II Development of Model of Uncontained Debris		◇				
Complete Advanced Analytical Uncontainment Mitigation Tool Kit				◇		
Develop Dynamic Aircraft Model for Evaluation of Engine Failure Loads						◇
Flight Control System Research						
Completed Report on Fault Detection and Recognition and Fault Tolerant Flight Control Systems	♦					
Continue IDACS Program with NASA Dryden	♦	◇				
Complete Intelligent Damage Adaptive Control System (IDACS) Program Report and Simulator Demonstration			◇			
Initiate IDACS Flight Test Validation			◇			
Crew Response to Propulsion Problems Research						
Initiate Research on Crew Response to Propulsion			◇			
Develop Recommendations for Training & Operation of Existing Systems						◇
Develop AC Material & Recommendation for Future Design Certification						◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	2,427	2,298	2,650	3,289	1,329
Personnel Costs	231	338	369	590	397
Other Costs	47	69	75	121	61
Total	**2,705**	**2,705**	**3,094**	**4,000**	**1,787**

A06g Aviation Safety Risk Analysis

GOALS:

Intended Outcomes: The FAA intends to improve system safety by developing a means for industry and the agency's own programs and systems to measure and account for safety performance. This is done through risk assessment, operational indicators, and the shared use of safety-related data. The Aviation Safety Risk Analysis (ASRA) program focuses primarily on:

- Development and/or enhancement of safety critical performance measures embedded in FAA analytical systems, e.g., flight standards service Safety Performance Analysis System (SPAS), and the aircraft certification service safety management program products/risk-based analytical tools. These measures encompass particulars about aircraft design, aircraft maintenance, discrepancy reports, air carriers, air agencies, and air personnel.
- Development of advanced analytical/decision support capabilities and graphical techniques. These allow the FAA to more effectively and efficiently use information contained in various FAA and industry databases.
- Development and/or enhancement of safety assessment methods and a structured, safety management program pertinent to certification and continued airworthiness of civil aircraft.
- Improvement of the aviation safety monitoring and oversight process through an examination of FAA's business practices as they pertain to certification and surveillance. This item entails improved identification and testing of relevant major attributes (i.e., characteristics) of safety and applicable data.
- Development of data standards, promotion of international harmonization, and development of techniques to improve and standardize data collection procedures and terminology.
- Development of an internet-based information system for aviation safety related data with emphasize on general aviation.

Agency Outputs: The Federal Aviation Act of 1958 and the Federal Aviation Regulation (FAR) provide the FAA the statutory authority and responsibility to conduct surveillance of air operators, air agencies, aircraft, and airmen to ensure conformance with the FAR and aviation safety standards. The outputs from this research program improve the data, data gathering techniques, and decision support tools related to FAA certification and surveillance processes. These outputs enable systematic potential risk assessment and take proactive steps to reduce the rate of aviation-related accidents and incidents. The FAA increases its leverage of aviation safety inspector and certification engineering resources by targeting these resources based on risk.

Customer/Stakeholder Involvement: The Federal Aviation Authorization Act of 1996 requires that the Administrator give "high priority to developing SPAS." The legislation calls for deployment of SPAS II, initiated in FY 1997, to be completed by December 1999. ASRA enhances SPAS decision support capabilities through additional risk analysis/predictive models, expert system capabilities, and critical safety performance indicators.

The ASRA Program responds directly to recommendations in the Challenge 2000 Report and the FAA 90-day safety review. Maximum information sharing alerts both the FAA and industry to pending aviation safety-related problems. Developing a certification and surveillance program built on targeting resources to address safety risks ensures the corrective action is taken much sooner. Thus, the primary beneficiaries of this effort is the general/flying public.

Several analytical tools such as SPAS, will be used by the DOD in their oversight of defense contract carriers and charters.

The FAA worked with Helicopter Association International to develop and release the maintenance malfunction information reporting system. This software tool improved the collection, storage, and transfer of service difficulty reports and part warranty information.

Data improvement and standardization efforts respond to recent Congressional hearings and the General Accounting Office report recommendations that the FAA improve the quality and timeliness of their aviation safety data. More importantly, analytical and decision support tools rely on good quality data to identify potential safety risk areas.

Accomplishments: Full deployment of a production SPAS system (i.e., SPAS II) was initiated in FY 1997 and is scheduled to be completed by December 1999. SPAS is a computer-based analytical tool used by FAA aviation safety inspectors and certification engineers, as well as DOD aviation analysts, to support their oversight activities of FAA certificate holders (i.e., air operators, air agencies, aircraft, and air personnel).

Initiated reengineering to ensure the surveillance, investigation, certification, and oversight processes to be driven primarily by data, instead of human judgment. Initial emphasis was on improving the aviation safety monitoring and oversight process through the identification and testing of FAA and industry major attributes (i.e., characteristics) of two major surveillance activities: airworthiness ramp inspection and flight operations en-route inspection.

Initiated a study to establish baseline risk parameters related to continued airworthiness of aircraft and to analyze the factors which are precursors to aircraft accidents.

R&D Partnerships: The U.S. Air Force/Air Mobility Command provides technical support and assistance in developing safety critical performance measures. The Flight Safety Foundation works with both the FAA and industry to analyze worldwide accidents and serious incidents and to establish and prioritize causal factors. An interagency agreement is established with the Department of Energy enabling Sandia National Laboratories to provide their technical expertise in system development and data quality strategy/data quality improvements implementation. The FAA has arranged, with the National Academy of Sciences, to develop a generally applicable, structured, safety management program for aircraft certification services. Finally, several university grants have been awarded to support development and testing of aviation safety risk models. The aviation safety digital library is developed in cooperation with general aviation groups such as the Experimental Aircraft Association, Aircraft Owners Pilot Association, General Aviation Manufacturers Association, etc., under a phase II small business innovative research contract.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Risk analysis decision support.

- Implemented new and enhanced risk analysis models and capabilities.
- Developed and implemented safety critical performance measures into flight standards SPAS II and aircraft certification aviation safety management program initiatives.
- Re-engineered flight standards safety critical work process models.
- Validated flight standards information model.
- Continued to study a taxonomy of worldwide accident/serious incidents to establish/prioritize casual factors. This project provides a baseline to identifying opportunities for risk mitigation.
- Initiated a study to develop a set of recommendations for aircraft certification service. This initiates a generally applicable, structured, safety management program into its constituent offices.

Aircraft maintenance information technology.

- Released the aviation safety digital library prototype.
- Continued safety attribute mapping development, testing, and validation.
- Initiated development of a methodology for evaluating and assessing aircraft engine maintenance.
- Released a report, based on the collection and analysis of data, recommending improvements to aircraft strobe light functioning and compliance. (Note: actually released September 1997.)

KEY FY 1999 PRODUCTS AND MILESTONES:

Risk analysis decision support.

- Continue to develop, test, and validate new and enhanced risk analysis models and capabilities.
- Continue to develop safety critical performance measures.
- Continue to develop the safety management program.
- Initiate design of a re-engineered data collection process supporting both flight standards business process and information requirements.

- Initiate development of techniques to standardize terms and data collection procedures between the FAA and industry.

Aircraft maintenance information technology.

- Continue to develop methodology for evaluating and assessing aircraft engine maintenance.
- Continue to develop, test, and validate the mapping of safety attributes.
- Expand the maintenance malfunction information reporting system (released in FY 1996) to include an international helicopter parts tracking system.
- Continue to develop a production aviation safety digital library.

FY 1999 PROGRAM REQUEST:

Research continues to focus on the areas listed at the beginning of the GOALS section above. Data assimilation and analysis supporting the ASRA initiatives continues. The analysts work with government and industry aviation safety subject matter experts to ensure that safety critical performance measures are properly defined, developed, tested, and evaluated prior to implementation into decision support systems. The program investigates, tests, and recommends improvements (including standardization) to the quality (and quantity) of data used in the performance measures. It completes studies to identify and verify flight standards and aircraft certification safety information requirements.

A06g - Aviation Safety Risk Analysis Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
060-110 Aviation Safety Risk Analysis						
Risk Analysis/Decision Support (RADS)						
Re-engineered Flight Standards Safety Critical Work Process Models	♦					
Established & Prioritized Causal Factors Related to Accidents/Incidents	♦					
Validated Flight Standards Information Model	♦					
Initiated a Study for Development of a Set of Recommendations for Aircraft Certification Service to Institute a Safety Mgmt. Program	♦					
Implement New & Enhanced Risk Analysis Models	♦	◇	◇	◇		
Develop Safety Critical Performance Indicators (i.e. Operator, Air Agency, Aircraft, Air Personnel)	♦	◇	◇	◇		
Standardize Terms & Data Collection Procedures Between FAA & Industry		◇	◇	◇		
Initiate Design of a Re-engineered Data Collection Process		◇				
Continue Development of the Safety Management Program for Aircraft Certification		◇	◇	◇		
Develop New Concepts & Techniques to Extract Metrics of Aviation Safety from Raw Data					◇	
Develop User Defined Performance Measures					◇	
Develop Next Generation Work Process Models						◇
Develop Intelligent Safety Performance & Evaluation System (Production Version)						◇
Aircraft Maintenance Information & Tech. Initiatives						
Released a Report on Improvements to Aircraft Strobe Light Functioning and Compliance Recommendations	♦					
Released Aviation Safety Digital Library Prototype	♦					
Initiate Development of a Methodology for Evaluating & Assessing Aircraft Engine Maintenance	♦	◇	◇	◇		
Continue Safety Attributes Mapping Development	♦	◇	◇	◇		
Expand the Maintenance Malfunction Information Reporting System		◇	◇	◇		
Continue Development of a Production Aviation Safety Digital Library		◇	◇	◇	◇	
Develop, Validate, and Implement the PTRS Re-engineering Based on the Safety Monitoring Process Guidelines						◇
Methodology for Implementing Fault Tolerant into Software Design						◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	0	0	3,619	5,289	5,555
Personnel Costs	0	0	316	1,039	794
Other Costs	0	0	65	213	122
Total	**0**	**0**	**4,000**	**6,541**	**6,471**

2.4 Aviation Security Program Area Description

Mission

The Aviation Security Research and Development (R&D) Division is the FAA's lead organization responsible for the improvement of civil aviation security through strategic research. The division's mission is to counteract the current and anticipated efforts of terrorists to disrupt civil aviation. Its strategy for success is to accelerate and expand the research, development, and implementation of the best available security technologies and methodologies. The division will continue its R&D security efforts with its partners in industry, academia, and other U.S. and international government agencies. Its future emphasis will rely less upon direct human intervention in security matters and continually more upon automated security systems which integrate innovative technologies from a variety of disciplines.

Intended Outcomes

The main goal of the Aviation Security program is to mitigate the terrorist threat to the civil aviation system. Promoting public confidence has direct economic benefit to the aviation industry. The increasing extent and sophistication of terrorism makes it imperative that the FAA identify and develop practical, effective technologies applicable to security systems. Security systems must be comprehensive, addressing all potential security vulnerabilities in the airport, in air traffic control facilities, and on the aircraft itself.

The FAA is conducting extensive R&D to detect explosives, weapons, and other more sophisticated threats before they can be placed onboard aircraft. The Aviation Security program focuses on automated security systems and screening protocols that are the least intrusive and enable the highest throughput, thus minimizing passenger delays and inconvenience. The FAA also conducts research to identify methods to harden the aircraft to mitigate the damaging effects of explosives, weapons, surface to air missiles, and electromagnetic interference.

Program Area Outputs

Through the Aviation Security R&D Program, the agency promotes the development of technologically improved products in explosives detection, aircraft hardening, airport security, and human factors. Products from Aviation Security R&D are explosives detection systems (EDS), explosives detection devices (EDD), technologies, specifications, and technology integration plans. These products are for use by airports, air carriers, and airframe manufacturers to improve civil aviation security.

Program outputs include:

- Development of standardized test protocols and performance criteria to aid in the operational deployment of improved security systems.
- Designation of approved EDDs and EDSs for air carriers, airports, and other agencies of the government.
- Definition of security directives with standardized traceable methods of airport security screener training and evaluation.
- Testing of explosives resistant luggage containers.
- Exploration of other blast mitigation techniques that will help ensure that potentially catastrophic terrorist acts do not result in the loss of aircraft.

Program Area Structure

The Aviation Security program is divided into four interrelated program areas: Explosives and Weapons Detection, Aircraft Hardening, Human Factors, and Airport Security Technology Integration. Each program area makes a significant contribution toward achieving the goals of the aviation security system of the future.

The focus of the Explosives and Weapons Detection program area is to develop new, improved methods and technologies to detect explosives in checked and carry-on baggage, on passengers, in air cargo, and in mail. These are for use in airports prior to aircraft boarding. This program area also determines standards and specifications for detection equipment.

One purpose of the Aircraft Hardening program area is to conduct research to increase civil aircraft survivability in the event of an in-flight explosion. An additional purpose of this program is to identify the minimum weight of an explosive that will result in aircraft loss. Another consideration is to protect aircraft avionics and systems from the damaging effects of false electromagnetic or high energy signal interference.

The objective of the Aviation Security Human Factors program area is to improve the human element of the aviation security system and methods to measure and maintain performance levels as security components merge into an integrated system. This program area emphasizes staffing, personnel, training, performance, human factors engineering, and health and safety aspects of human performance capabilities and constraints.

The Airport Security Technology Integration program area focuses on technologies to prevent unauthorized access to aircraft and airport facilities. These technologies include state of the art perimeter control, automated access control systems, and passenger baggage matching systems to prevent unaccompanied luggage from being loaded into aircraft. The program also develops simulation and modeling tools to integrate, improve, and reduce operating costs for technologies developed by related programs.

Any one program will not solve all the issues. Because technology development has not reached a point where it can operate autonomously, a systems oriented approach is being adopted. A continued balanced application of people, procedures and technology tailored to each threat classification is the desired structure.

Customer/Stakeholder Involvement

The Aviation Security Improvement Act of 1990 (Public Law 101-604) provides direction to expand the FAA's System Security Technology Program for aviation security as follows:

- Accelerate the FAA's System Security Technology Program over a 36-month period.
- Expand the FAA's System Security Technology Program to address current and future threats.
- Expand FAA security initiatives in aircraft hardening and human factors.

In 1996, the White House Commission on Aviation Safety and Security strongly emphasized continued research in all program areas, and recommended the deployment of existing explosives detection technology. Congress funded further research and the FAA's purchase and installation of EDSs and EDDs. Currently, the FAA Security Equipment Integrated Product Team (SEIPT) is deploying this detection equipment at various airports throughout the United States.

Other stakeholders include the Aviation Security R&D Scientific Advisory Panel, R&D Advisory Council, and the Aviation Security Advisory Committee, which hold frequent reviews of research plans and results. Their recommendations include changes in the direction or emphasis of research plans.

Accomplishments

The FAA Aviation and Security R&D Program has been in effect since 1974. The following are significant accomplishments:

- Certified the CTX 5000 and established a demonstration effort that delivered four certified CTX 5000 EDSs to the air carriers for operational testing. Data was collected and analyzed at airports in San Francisco, Atlanta, and Manila.
- Provided critical input for effective deployment by the SEIPT for an initial delivery of 54 CTX 5000 explosives detection systems that began in January 1997.
- Determined trace explosive detection to be effective for deployment in major airports. The R&D Security Program provided critical input to the SEIPT for deployment of over 210 trace EDDs to 18 initial airports in FY97 with about 280 more to be purchased and to be installed in FY98.
- Initiated study of various trace detection prototypes as a result of testing in airport environments.
- Performed Boeing 747 explosives tests jointly with the United Kingdom.
- Supported the 1996 Olympics in Atlanta by deploying trace detection devices and the CTX 5000 system. (The FAA is also supporting the 2000 Olympics in Australia.)
- Completed developmental testing of a second generation computer tomography system.
- Scheduled initial demonstration effort on hardened LD-3 luggage containers.
- Established criteria to limit cross-contamination of explosives used to train and certify K-9 detection teams.
- Began operational testing of a number of screener training enhancements.

- Conducted international study of radio frequency identification tags to make Positive Passenger Baggage Matching (PPBM) cost-effective and operationally feasible.
- Completed an industry-wide economic analysis on the costs of PPBM, and provided the results to industry and FAA rulemaking teams.

R&D Partnerships

Since its inception, the Aviation Security program has fostered the establishment of productive relationships with many organizations in the U.S. Government, industry, academia, and foreign governments. Each of the FAA's partnering organizations contributes to the aviation security mission by providing information, research, equipment, and/or facilities. The FAA uses these partnership agreements to leverage its R&D project investments. Two recent projects are testimony to this leveraging. A partnership with the Defense Advanced Research Projects Agency, in which FAA investments were $25,000, resulted in airport security research efforts exceeding $16 million. A partnership in the industrial sector with Science Applications International Corporation resulted in a bulk detection effort worth $35 million from a $5 million FAA investment.

The FAA is currently in a cost-sharing agreement with the two manufacturers to develop additional certified EDSs. These systems, scheduled for marketing in 1998, are expected to increase the efficiency and effectiveness of available detection options while reducing their costs. Agreements are also in place with aircraft manufacturers and airlines to conduct R&D and operational testing.

Long-Range View

The FAA envisions an integrated security system for the 21st century which incorporates the strengths of a variety of technologies and which is continuously being monitored and upgraded to respond to changes in the threat environment. This integrated system will allow security professionals to perform at maximum levels of effectiveness. The application of automated detection technologies will enhance screener performance by providing detection that is constantly vigilant and not subject to distraction or fatigue like human or canine screeners. This understanding of the aviation security system of the future provides guidance and direction for future R&D efforts and supports decisions for future FAA investment.

Terrorists will continue to increase capability and continue to evolve in their techniques. This ever-changing threat necessitates continued funding of research for the foreseeable future.

Aviation Security R&D efforts will continue to focus on modifications and other technical improvements to deployed explosives detection equipment. Identification and evaluation of explosives mitigation techniques will also continue. The focus of effort will continue to expand to include the entire aviation spectrum, including airports, airplanes, and other areas of the National Airspace System, as needed.

A07a Explosives and Weapons Detection

GOALS:

Intended Outcomes: This program supports goal 2 of the FAA Strategic Plan: "Aviation Security-Zero Incidents." It intends to eliminate the possibility of terrorist ability to successfully conceal improvised explosives devices, weapons, and flammable gas or liquid explosives on aircraft. Specifically, it applies to objective 2B, in that it strengthens the baseline of security through accelerated development and application of advanced technology.

These goals are accomplished by making improved explosives detection systems (EDS) and other devices available to the airlines and groups responsible for airline security (domestic and international). These systems and devices decrease the U.S. air carrier and airport vulnerability to terrorist acts. Specifically, this program:

- Meets increased passenger flow while minimizing cost by developing automated systems.
- Enhances the confidence of the world-wide flying public.
- Promotes adaptation of the best existing and emerging U.S. technologies in response to continually evolving threat possibilities.

Agency Outputs: The FAA establishes policies and rules for airline compliance with security directives. This rulemaking process depends upon research and development, testing and evaluation, and data packages which support equipment mandating decisions. The objective of these processes is to enhance the security of the flying public, based on continuous involvement in present and future threat detection and mitigation.

Customer/Stakeholder Involvement: The FAA is the world leader in explosive detection research, and in testing and evaluating related equipment. Agency interaction with other interested organizations includes:

- The FAA cooperates with industry, academia, other government agencies, oversight groups, special interest groups, congress, foreign governments, national laboratories, individual researchers, and the general public.
- The FAA sponsors the National Academy of Sciences to assess that organization's program research initiatives and to review explosives detection research priorities. The Committee on Civil Aviation meets six times a year for its panels to address specific crucial areas of interest such as personnel screening and the configuration management of explosives detection hardware and software. The committee's findings and recommendations directly affect the ability of equipment to meet FAA criteria.
- The Explosives and Weapons Detection program must respond to congressional mandates such as P.L. 101-604, the Aviation Security Improvement Act of 1990, the White House Commission on Aviation Safety and Security, the Aviation Security Advisory Committee Baseline Working Group, the General Accounting Office, and section 303 of the Federal Aviation Administration Reauthorization Act of 1997.

Accomplishments: Explosives and weapons detection research results are provided to the Office of Civil Aviation Security to assist them in the rulemaking process. Since 1991, the program has:

- Certified the world's first explosives detection system.
- Established test and evaluation criteria and protocols for checked baggage.
- Developed the basis for a trace detection standard for electronic items.
- Held two international symposia on explosives detection.
- Sponsored three International Society for Optical Engineering conferences on domestic and international explosives detection.
- Conducted an International Civil Aviation Organization (ICAO) workshop on trace detection standards for electronics explosives detection.
- Completed an airport demonstration of certified explosives detection equipment at San Francisco and Atlanta international airports.
- Supported the 1996 Olympic Games with explosives detection equipment installations at five airports.
- Developed competing technologies to the certified EDS.

- Developed and tested personnel portal scanning systems.
- Provided technical support to the Security Equipment Integrated Product Team for airport deployment of bulk and trace detection equipment.
- Tested carry-on baggage screening systems with the operator assist function.

R&D Partnerships: The Explosives and Weapons Detection program works closely with academia, industry, and other national laboratories. Partnerships with organizations reduce costs, where possible, by combining research initiatives that use the same technologies for slightly different purposes. More than ninety contracts, grants and interagency agreements are in place with industry, academia and other government agencies. Examples include:

- InVision Inc., working with the FAA, has produced the first certified EDS in the world; it is now available and being sold domestically and internationally.
- Industry and the FAA share development in carry-on, checked, and cargo scanning systems. This involvement includes joint funding agreements, cooperative research and development agreements, and consultation from the FAA to help companies improve existing systems through joint testing efforts.
- The interagency Technical Support Working Group supports explosives and weapons detection projects that can be applied to other agencies; these include document scanners, cargo screening systems, miniaturization, and performance improvement of trace detection technologies and industry collaboration with foreign governments' technology development.
- Bilateral R&D agreements are in place between the FAA and several international counterparts.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Bulk explosives/weapons detection.

- Developed competitive computed tomography based EDS.
- Developed improved quadrupole resonance prototype.
- Developed new technologies based on emerging threats.
- Set standards for carry-on and cargo screening systems.

Trace detection.

- Built automated trace baggage system.
- Upgraded trace systems for ICAO markers.
- Developed automated ticket screening device.

Combined technology.

- Developed automatic passenger screening portal combining bulk and trace detection technologies.

KEY FY 1999 PRODUCTS AND MILESTONES:

Bulk explosives/weapons detection.

- Develop new technologies based on emerging threats.

Trace detection.

- Develop Trace/X-Ray Backscatter Portal.
- Enhance systems to handle emerging threats.
- Set trace detection standard for electronic items.

Combined technology.

- Combine explosives/detonator development.
- Develop combined technology personnel inspection system.

FY 1999 PROGRAM REQUEST:

The program develops or enhances technologies that detect or discover emerging threats in both the trace and bulk detection areas. In some cases, capabilities are added to existing systems or completely new technology methods to handle the threats not addressed by current technologies. In each case, standards are developed to characterize the performance of the newly developed systems.

Combined technologies are used that merge a system's ability to analyze and integrate data from multiple sensors, thus providing an improved detection over single system capability. This applies to baggage, cargo, and personnel scanning devices. The results of this research should increase the probability of detection and decrease the false alarm rates relative to existing technologies performing

similar individual functions. New combinations of devices are being considered for use in environments inaccessible to public view.

Research continues into the development of faster, more automated, and cheaper systems which could more easily be integrated into an airport environment. The program makes maximum use of data and experience gained from deploying existing equipment.

A07a - Explosives and Weapons Detection	Program Schedule					
Product and Activities	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
071-110 Explosives/Weapons Detection						
Bulk Explosives/Weapons Detection						
Developed Competitive Computed Tomography Based Explosives Detection System	♦					
Developed Improved Quadrapole Resonance Prototype	♦		◇			
Automated Carry-On Baggage Screening System Prototype			◇			
Advanced Checked Baggage Screening System				◇		
Develop New Technologies Based on Emerging Threats	♦	◇	◇	◇	◇	◇
Test and Evaluate All Commercially Available Cargo Systems		◇				
Trace Detection						
Determined Feasibility of Cargo Screening System		◇				
Build Automated Trace Baggage System Prototype	♦					
Upgraded Trace Systems for ICAO Markers	♦					
Develop Trace/X-Ray Backscatter Portal		◇				
Developed Competitive Trace Auto-Sampler			◇			
Enhance Systems to Handle Emerging Threats		◇				◇
Advanced Lab Prototype Based on Updated Threats			◇		◇	
Airport Test of Advanced Prototypes				◇		◇
Complete Standards for Automated Trace Systems		◇				
Develop Chemical Weapons Mitigation Systems					◇	
Combined Technology						
Develop Phase 1 Lab Prototype Combined X-Ray/Trace System			◇			
Combined Explosives/Detonator Development		◇				
Develop Combined Technology Inspection Personnel System		◇				
Develop Checkpoint Suite Prototype					◇	

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	19,220	25,044	38,629	30,832	35,541
Personnel Costs	3,698	3,283	2,297	2,796	3,462
Other Costs	757	673	471	572	542
Total	23,675	29,000	41,397	34,200	39,545

A07b Airport Security Technology Integration

GOALS:

Intended Outcomes: This program supports goal 2 of the FAA Strategic Plan: "Aviation Security-Zero Incidents." Specifically, it addresses plan objective 2A & 2C (addressing specific aviation security vulnerabilities, and reduction of international security incidents through cooperation with foreign governments). In order to achieve these objectives, the program strives to block terrorist access to the aircraft through analysis of airport vulnerabilities, investigation of advanced perimeter control surveillance systems, and development of systems that provide for strict accountability for luggage loaded onto aircraft.

Additionally, the program supports the other aviation security programs by:

- Identifying advanced threats that the aviation community may face in the near future.
- Developing sophisticated models to predict the operational effects of inserting security measures into the existing aviation system.
- Developing communication protocols that allow advanced systems to work together.

Overall progress on meeting these goals results from: (1) providing methods of increased passenger flow and reduction in costs associated with security risk mitigation; (2) identifying and developing new technologies, methodologies, and procedures to enhance the performance of security professionals in the performance of their aviation security mission; and (3) developing and maintaining an integrated security system approach for countermeasures to the identified threats of the civil aviation system.

Agency Outputs: The FAA establishes the regulations governing airport and airline security and rules for security inspections. It publishes these rules and regulations, with guidance for their implementation, in the form of advisory circulars. The Airport Security Technology Integration (ASTI) program also provides reports and other forms of technical information to aid the civil aviation security community in improving security methods.

Customer/Stakeholder Involvement: The FAA develops an extensive collaboration within the domestic and international aviation security communities. R,E&D efforts include industry participation through the Air Transport Association (ATA) to study the operational costs and effects of positive passenger baggage matching (PPBM). This effort is designed to prevent the loading of unaccompanied baggage on aircraft. The FAA collaborates with the Societe Internationale De Telecommunications Aeronautiques and the International Air Transport Association in the development of standards for baggage tracking and reconciliation systems and tagging technologies.

The program responds to Public Law 101-604, the Aviation Security Act of 1990, the Aviation Security Advisory Committee recommendations, and the recommendations of the White House Commission on Aviation Safety and Security. These provide impetus for security research requirements and dissemination of the research results to industry.

Accomplishments: Results of the ASTI program are provided to the aviation community for their use, and to the Office of Civil Aviation Security to assist them in the rulemaking process. These results have included:

- Completed assessments of radio frequency (RF) technology for PPBM.
- Completed evaluations of commercial off-the-shelf (COTS) airport vulnerability assessment tools against developed functional requirements.
- Developed and implemented baseline methodology for vulnerability analysis of airports. Provided statistical analysis of findings to industry.
- Integrated security vulnerability countermeasures into an operational test-bed to validate security benefits and operational impact.
- Published functional requirements for an airport vulnerability analysis tool, and validated selected COTS vulnerability assessment tools against these requirements.
- Completed a technical report which identifies and prioritizes advanced technical threats against civil aviation. (This report drives research requirements and guides current and future research trends.)
- Completed an airport explosives security survey analysis and correlated information to identify

vulnerabilities across 76 domestic airports. Information was provided back to airports on areas of concern for corrective action.

- Published guidelines for industry on security revolving doors for use at concourse screening points.
- Published functional guidelines for PPBM system.
- Developed guidelines for mitigating risk to blast effects.
- Performed testbed studies in feasibility area of personnel access control.

R&D Partnerships: Through partnership with RTCA Subcommittee (SC) 183, and with the participation of industry, the ASTI program developed a standard for airport security access control systems. Relationships with ATA and the Regional Aircarrier Association focus on the study of economic effects of PPBM on the industry. A year-long cooperative study culminated with the publication of a project report which analyzed the economic effects of PPBM on the aviation industry. The FAA continues this relationship to fulfill the requirements of the White House Commission on Aviation Safety and Security recommendations for PPBM. The ASTI program determines the operational effects of alternative approaches to, and research of, technologies to increase the efficiency and security of reconciling baggage with passengers.

The program is working with Airports Council International-North America (ACI-NA) to integrate operational airport design needs into a Passenger Baggage Flow Model tool. Upon completion, this software package will be transferred to industry for use as a tool in configuring security systems and technologies into the airport environment.

The ASTI program and the State of Illinois are cosponsoring research on the security of cargo shipments in transit from the remote cargo facilities to the airlines' receiving points. The test will determine the feasibility of a positive driver ID and cargo seal system.

The program has interagency agreements with the DOD Office of Special Technology to coordinate activities relative to technology assessments. Also, the agency coordinates efforts with the U.S. Air Force and the DOD Defense Special Weapons Agency related to simulation and modeling of blast effects and biological and chemical effects on aviation facilities.

The ASTI program is the designated lead for the bilateral agreement with Canada's Department of Transport for physical security of airports. Participation in the General Services Administration, Interagency Advisory Committee on Security Equipment provides a forum for technology interchange.

Additionally, grants, cooperative research and development agreements, and memorandums of understanding/agreement with industry, academia, and other government agencies provide leverage for the program in areas of mutual interest.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

- Transferred assessments of RF technology for PPBM to industry.
- Operationally tested RF based baggage matching system in multiple airports.
- Developed cargo profiling system.
- Evaluated COTS airport vulnerability assessment tools.
- Validated vulnerability assessment tools against airport passengers security data.
- Refined threat/countermeasures database.
- Researched advanced countermeasures.
- Researched personnel access control monitor research.
- Developed a protocol standard for explosives detection systems to communicate with baggage handling systems to ensure accurate tracking of alarmed bags.
- Developed a protocol standard for security monitoring equipment information integration.
- Investigated systems to ensure in-transit security of cargo bound for carriage on passenger aircraft.

KEY FY 1999 PRODUCTS AND MILESTONES:

- Report on countermeasures to identify advanced technical means of attack against civil aviation components.
- Publish a threat analysis report for NAS specific subsystem component.

- Publish a report on operational test of RF based baggage matching system.
- Publish a communication protocol standard for EDS integration into automated baggage handling systems.
- Publish a report on in-transit security of air cargo bound for carriage on passenger aircraft.
- Develop functional specifications for cost-benefit model.
- Complete a passenger and baggage flow modeling tool.
- Access control monitor.

FY 1999 PROGRAM REQUEST:

The ASTI program is completing several key efforts and publishing their results for use by the aviation community. These publications include reports on RF technology that will likely influence establishment of worldwide standards in the field. In cooperation with industry, the program will finalize a standard for communication between advanced detection systems and automated baggage-handling systems. Such a standard is critical to effective use of the new detection technologies. Additionally, the program will finalize its passenger baggage flow model. Airport and airline planners will use this planning tool to find the most efficient layout of security equipment within existing and future terminals. The program will continue its support for the other aviation security programs by assessing future threats to aviation security, developing sophisticated simulation tools, and addressing integration issues of the new technologies.

A07b - Airport Security Technology Integration Product and Activities	Program Schedule FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
073-110 Airport Security Technology Integration						
Domestic Air Travel						
Transferred Radio Frequency (RF) Technology for Positive Passenger Bag Match (PPBM) to Industry	♦					
Published Bi-Annual Report on Countermeasures to Identify Advanced Means of Attack Against Civil Aviation		◇		◇		◇
Publish Threat Analysis Report for NAS Specific Subsystem Components	♦	◇				
Developed Functional Specifications for Cost-Benefit Model		♦				
Developed Cargo Profiling System	♦					
Integrate Cost-Benefit Model into Passenger and Baggage Flow (PPBM) Simulation Tool-Kit			◇			
Refine Cargo Profiling System and Integrate into All Airlines Cargo Management System				◇		
Airport Security						
Integrated EDS & Other Security Vulnerability Countermeasures into Operational Testbed				◇		
Evaluated Commercial Off The-Shelf (COTS) Airport Vulnerability Assessment Tools	♦					
Validated Vulnerability Assessment Tools Against Airport Security Data	♦					
Refined Threat/Countermeasures Database	♦					
Published Performance Assessment Report of New Technologies			◇	◇	◇	
Developed Guidelines for Mitigation Risk to Explosive Blast Effects	♦					
Complete Passenger and Baggage Flow Modeling Tool		◇				
Develop Airport Vulnerability Assessment Tool			◇			
Advanced Countermeasures Researched			◇			
Personnel Access Control Monitor Research	♦	◇				
Evaluate Emerging Technology w/Cost Effectiveness Models		◇	◇	◇	◇	◇
System Integration Assessment/Survey		◇				
Perform Feasibility Study Based on System Integration			◇			
Develop Demonstrations of System Integration				◇	◇	
Sensor Integration Simulation Model					◇	

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	23	490	3,165	1,127	4,520
Personnel Costs	811	423	492	1,127	754
Other Costs	166	87	101	231	122
Total	1,000	1,000	3,758	2,485	5,396

A07c Aviation Security Human Factors

GOALS:

Intended Outcomes: This program supports goal 2, "Security-Zero Incidents," of the 1996 FAA Strategic Plan and also targets the Plan's objective 2B: "Strengthen the overall baseline of security through better selection and training of screeners and other security personnel, improved training and performance monitoring procedures, and accelerated development and application by industry of standards."

This program leverages funding for equipment development by producing usable and feasible products:

- Improved aviation security system performance and efficiency through better operator selection and training and performance monitoring techniques for the various detection technologies.
- Developed computer aided profiling systems to reduce the number of domestic passengers needing special additional security treatment.
- Optimized human performance contributes to the overall aviation security system performance, merging individual detection systems into a combined technology system, through enhanced machine interfaces and integration.

Agency Outputs: The FAA establishes standards for security activities and this program conducts R&D for technical input essential to:

- Reduce security costs as a result of automation.
- Reduce vulnerability to terrorist threats.
- Decrease risk of catastrophic financial loss resulting from sabotage of an airplane.
- Increase public confidence in the safety of air travel.
- Increase global U.S. industrial competitiveness.
- Develop technology that is also applicable to other government agencies (e.g., Customs Service).

Customer/Stakeholder Involvement:

This program supports the Office of the Associate Administrator for Civil Aviation Security as mandated by the Aviation Security Improvement Act of 1990 (PL 101-604). The program also responds to requirements from the Aviation Improvement Act of 1990, the White House Commission on Aviation Safety and Security, Baseline Working Group on Aviation Security, and the General Accounting Office.

Accomplishments: Results of Aviation Security Human Factors research are provided to the Office of Civil Aviation Security to assist them in the rulemaking process:

- Refined definition of knowledge, skills, and abilities needed for checkpoint screening.
- Developed functional requirements for the Screener Proficiency Evaluation and Reporting System (SPEARS) components of screener selection, training, and performance monitoring.
- Measured baseline checkpoint security performance.
- Developed screener selection tests for estimating future performance, interpreting both conventional X-ray and computed tomography (CTX 5000) images.
- Developed computer-based training (CBT) for both checkpoint operations and checked baggage evaluation with the CTX 5000.
- Developed threat image projection for both conventional X-ray machines and the CTX 5000.
- Developed dupe checklist system.
- Developed manual domestic passive profiling system.
- Developed Computer Assisted Passenger Screening profiling system.

R&D Partnerships: This program works closely with a variety of agencies and groups involved in aviation:

- Groups, such as the International Aviation Security Human Factors Technical Advisory Group, to ensure effective communication of research results and avoid duplication of efforts.
- Groups participating through cooperative research grants in the development and operational testing of passenger profiling.

- Lawrence Livermore National Laboratory through an inter-agency agreement.
- Cooperative research grants to develop and operationally test SPEARS screener selection, training, and performance monitoring components.
- Domestic airlines and research organizations including:
  - Alaska Airlines
  - Aloha Airlines
  - American Airlines
  - Continental Airlines
  - Delta Airlines
  - EG&G Astrophysics
  - Embry Riddle Aeronautical University
  - InVision Technologies
  - Northwest Airlines
  - Public Computer Systems
  - Rapiscan Security Products
  - Trans World Airlines
  - United Airlines
  - U.S.Airways

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Screener selection/training/testing.

- Refined definition of knowledge, skills, and abilities for using emerging detection technologies.
- Improved screener selection, screener-machine interfaces, CBT multimedia training, and performance monitoring systems for emerging detection technologies.
- Established criteria and data for rulemaking about screener selection, training, and proficiency assessment.

Passenger profiling.

- Developed new techniques for passive and active profiling.
- Developed profiling implementation guidelines.

Human systems integration (HSI).

- Evaluated detection systems involving emerging technologies such as bottle screening and millimeter wave detection.
- Optimized combined detection technologies through component integration within futuristic screener stations.
- Integrated new and emerging detection technologies into their operational environment.
- Provided HSI evaluations on the manpower, personnel, training, human factors engineering, health, and safety aspects of security systems, especially those involving explosive detection system (EDS) and weapons detection technologies.

KEY FY 1999 PRODUCTS AND MILESTONES:

Screener selection/training/testing.

- Determine knowledge, skills, and abilities for using emerging detection technologies.
- Improve screener selection, screener-machine interfaces, CBT multimedia training, and performance monitoring systems for emerging detection technologies.
- Establish criteria and data for rulemaking about screener selection, training, and proficiency assessment.

Passenger profiling.

- New techniques for passive and active profiling.
- Profiling implementation guidelines.

HSI.

- Continue to evaluate detection systems involving emerging technologies such as bottle screening and millimeter wave detection.
- Integrate new and emerging detection technologies into their operational environment.
- Provide HSI evaluations on the manpower, personnel, training, human factors engineering, health, and safety aspects of security systems, especially those involving EDS and weapons detection technologies.

FY 1999 PROGRAM REQUEST:

This program focuses on producing key products to accomplish stated goals. Its results emphasize R&D within the areas of screener selection/training/ testing, passenger profiling, and human systems integration. The program improves screener selection, screener-machine interfaces, CBT multimedia training, and performance monitoring systems for emerging detection technologies. This research provides the basis for establishing criteria and data for rulemaking. It develops new techniques for passive and active profiling and provides plans for their implementation. It evaluates detection systems involving emerging technologies such as bottle screening and millimeter wave detection. It optimizes detection technologies through component integration within futuristic screener stations and integrates new and emerging detection technologies into their operational environment. Finally, it provides HSI evaluations on the manpower, personnel, training, human factors engineering, health, and safety aspects of security systems, especially those involving EDS and weapons detection technologies.

A07c - Aviation Security Human Factors Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
076-110 Aviation Security Human Factors						
Screener Selection/Training/Testing						
Improve Screener Selection, Screener-Machine Interfaces, Training Programs, and Performance Monitoring	♦	◇	◇	◇	◇	◇
Establish Criteria and Data for Rulemaking	♦	◇	◇	◇	◇	◇
Determine Knowledge, Skills, & Abilities Required for Screeners to Use Emerging Technologies	♦	◇	◇	◇	◇	◇
Passenger Profiling						
Develop New Techniques for Passive and Active Profiling	♦	◇	◇	◇	◇	◇
Develop Profiling Implementation Guidelines	♦	◇	◇	◇	◇	◇
Human Systems Integration (HSI)						
Evaluate New Detection Systems (e.g. Bottle Screening, Millimeter Wave Detection	♦	◇	◇	◇	◇	◇
Integrate New and Emerging Technologies into Operational Environment	♦	◇	◇	◇	◇	◇
Optimize Combined Detection Technologies Within Futuristic Screener Stations	♦	◇	◇	◇	◇	◇
Provide HSI Evaluations on Manpower, Personnel, Training, Human Factors Engineering, Health and Safety Aspects of Security Systems	♦	◇	◇	◇	◇	◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	2,567	2,039	4,446	4,723	4,078
Personnel Costs	462	423	492	679	1,064
Other Costs	95	87	101	138	140
Total	**3,124**	**2,549**	**5,039**	**5,540**	**5,282**

A07d Aircraft Hardening

GOALS:

Intended Outcomes: In accordance with the strategic goal of eliminating security incidents in the aviation system, the overriding goal of the Aircraft Hardening program is to protect commercial aircraft from catastrophic structural or critical system failure due to an in flight explosion. Secondary objectives are to investigate vulnerability from some spurious electromagnetic or high-energy signal interfering with aircraft electronic systems and to assess the threat presented by manually operated, highly mobile, surface-to-air missiles.

The program is designed to determine and identify: (1) the minimum size explosive that would result in aircraft loss; (2) the methods and techniques that can be applied to the current and future fleet of commercial aircraft to increase the level of vulnerability to explosive effects; and (3) the threat to aircraft from electromagnetic (EM), projected energy, and surface to air missiles and practical countermeasures.

Agency Outputs: The Aircraft Hardening program is tasked with delivering documented explosive vulnerability data to the explosive detection community and, depending on research results, providing recommendations for rulemaking relative to mitigation techniques. In the area of other threats, the program provides reports to the staff of the Associate Administrator for Civil Aviation Security characterizing specific commercial aircraft vulnerability to threats as well as possible countermeasures. In order to meet these requirements, the program has been divided into the following separate projects: explosive vulnerability and aircraft design-related mitigation techniques, container hardening, and protection against advanced terrorist threats.

Customer/Stakeholder Involvement: The Aircraft Hardening program was initiated in 1990 in response to the directives of the White House Commission on Aviation Safety and Security and the mandates set forth in the Aviation Security Improvement Act of 1990. The program is continually assessed by the Security Subcommittee of the FAA R,E&D Advisory Committee and has been subjected to scrutiny and endorsed by the General Accounting Office. The content of the program is in direct support of the customer, the Associate Administrator for Civil Aviation Security, and complies with the aviation security requirements document of the Office of Civil Aviation Security. Additionally, the program is required to periodically report technical progress directly to Congress.

Accomplishments: Program-sponsored research has validated established detection standards through analysis and explosive testing of the minimum size, type, and location of explosives which could result in catastrophic aircraft failure. The program has proved the feasibility of and determined the standards for explosive resistant luggage containers used in wide body aircraft. As a continuation to the container effort which was suggested by various members of Congress, the program will shortly provide prototype containers to allow airlines to conduct an operational assessment of the cost and improved security effectiveness of using hardened containers. While working with the Department of Defense and other government agencies, a process to assess the vulnerability of commercial aircraft to terrorist induced electronic and mobile missile threats has been initiated.

R&D Partnerships: From the onset, the Aircraft Hardening program has used expertise from the U.S. Air Force, U.S. Army, and U.S. Navy as well as consulted with various Department of Energy laboratories and NASA. Relationships also have been established with the U.S. aircraft and container manufacturing industries and research efforts have been coordinated with the United Kingdom and France. The program uses the services of many defense and aircraft related industries. The prime program objective is the collection of data in support of rulemaking. As the program utilizes a wide spectrum of industry experts, all developed technologies have been or will be directly transferred to the appropriate private market.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Container hardening.

- Continued assessment of other than LD-3 size containers to include demonstration project with the airlines.
- Transitioned container technologies to private industry.
- Completed operational assessment of LD-3 hardened containers with airlines.

Aircraft vulnerability.

- Identified and validated appropriate hardening techniques.
- Initiated effort to address security implications of new 800-1000 passenger jumbo jets and the high speed civil transport.

Projected energy, electromagnetic, and other terrorist threats.

- Identified possible mitigation techniques to counter projected energy and other threats.
- Developed procedures/rules for man-portable air defense systems (MANPADS).

KEY FY 1999 PRODUCTS AND MILESTONES:

Container hardening.

- Investigate and demonstrate protection for limited number of bags on narrow bodied aircraft.
- Complete assessment of other than LD-3 size containers; make the decision on rulemaking.

Aircraft vulnerability.

- Validate appropriate new techniques.
- Develop new aircraft certification criteria.

Projected energy, electromagnetic, and other terrorist threats.

- Develop procedures/rules for electromagnetic interface.

FY 1999 PROGRAM REQUEST:

The Aircraft Hardening program continues to focus on the areas listed at the beginning of the GOALS section above. As the vulnerability assessments evolve, ideas to mitigate blast (either through retrofitting the current fleet or instituting new design techniques and materials) are being identified. These ideas and concepts are analyzed and tested and recommendations for new specifications are made as required. Special emphasis is placed on assessing and recommending hardening actions regarding the long-term implications of terrorism on new commercial aircraft concepts such as the 800 to 1000 passenger jumbo jets and high speed civil transport aircraft. In addition, analyses of the impact of EM, projected energy, and MANPADS on commercial aircraft are underway and anticipated to be complete by the end of 1999. These research efforts are primarily investigative in nature and involve an assessment of the potential vulnerability of an aircraft to these threats.

A07d - Aircraft Hardening Product and Activities	Program Schedule FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
075-110 Aircraft Hardening						
Container Hardening						
Completed Operational Assessment of LD-3 Hardened Containers with Airlines	♦					
Continue Assessment of Other Than LD-3 Size Containers to Include Demonstration Project With the Airlines	♦	◇				
Complete Assessment of Other Than LD-3 Size Containers, Make Decision on Rulemaking			◇			
Investigate and Demonstrate Protection for Limited Number of Bags on Narrow Bodied Aircraft		◇				
Develop rules for narrow body protective units					◇	
Transition Container Technologies to Private Industry	♦				◇	
Aircraft Vulnerability						
Appropriate New Hardening Techniques Validated	♦					
Determine Special Security Considerations for Both Large(800-1000) Passengers Jumbo Jets as Well as High Speed Civil Transports					◇	
Develop New Aircraft Certification Criteria						◇
Projected Energy/Electromagnetics/Other Terrorists Threats						
Identify Possible Mitigation Techniques to Counter Projected Energy and Other Threats	♦					
Develop Procedures/Rules for Electromagnetic Interface		◇				
Develop Procedures/Rules for Projected Energy		◇				
Develop Procedures/ Rules For Man Portable Air Defense Systems (MANPADS)			◇			
Publish Reports Identifying Cost-effective Alternatives For Mitigating The Threat Of Electromagnetic, Projected-energy Weapons and MANPADS	♦	◇	◇			
Assess Aircraft Design Implications relative to Chemical/BiologicalThreats					◇	
Develop procedures/rules for Chemical/Biological Threat						◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	7,271	2,986	6,268	1,393	3,788
Personnel Costs	462	423	492	504	754
Other Costs	95	87	101	103	107
Total	7,828	3,496	6,861	2,000	4,649

2.5 Human Factors and Aviation Medicine Program Area Description

Mission

The Human Factors and Aviation Medicine Program intends to: (1) conduct applied research to identify methods which, when implemented, will contribute to the goal of reducing the fatal accident rate by 80 percent; (2) introduce innovative research and management initiatives to ensure that human factors issues are addressed in the acquisition and integration of all new and modified FAA aviation systems; and (3) meticulously review medical patterns in civilian flight to develop recommendations for protective equipment and procedures as well as for standards and regulations to protect all aircraft cabin occupants.

The rapid evolution toward increased operational demand, diversity of aircraft and systems, changing technology, and globalization of the airline/aircraft industry pose a collective challenge to the Offices of Human Factors and Aviation Medicine. The program will meet its goals by: ensuring that research is focused on those areas directly impacting aviation safety; capitalizing on opportunities to leverage government and industry resources; forming partnerships with research and university laboratories in order to rapidly transfer the results of research to the aviation community; and undertaking major efforts to ensure that human factors expertise is represented across functional disciplines and that human factors considerations are addressed across the FAA acquisition process.

Intended Outcomes

Human factors research is increasing the safety and efficiency of the National Airspace System (NAS) by developing scientifically validated information and guidance for improving the performance and productivity of air traffic controllers and NAS system maintenance technicians. This program directly responds to *FAA Strategic Plan* goals to "eliminate accidents and incidents caused by human error" and to "implement new decision support systems and associated functional improvements that fully account for the proper role of people in the system." This research also provides human factors support that addresses the FAA goal to "reduce the costs of flying by making the air traffic management system more efficient to use." Human factors research is developing human-centered flight controls and displays, and is increasing considerations of human factors in aircrew training. This research also explores prospects for safety enhancement through automated statistical analysis of flight-recorded data and through certification of new aircraft and equipment design and modification. Human factors research develops more effective methods for inspector and maintenance technician training, and improves inspector and maintenance technician task performance. The program enhances the safety of general aviation through the improvement of pilots' decisionmaking skills.

Aviation Medicine research improves the health, safety, and survivability of aircraft passengers and aircrews by identifying human failure modes and developing formal recommendations for means to counteract their negative effects. On the basis of this research, the FAA develops the bioaeronautical guidelines, standards, models, and certification procedures which fulfill the agency's vital regulatory mandate. Thus, research findings result in an improved cabin environment through the introduction of better equipment.

Program Area Outputs

The Human Factors Program identifies operational needs and problems involving human performance; funds and guides research programs to address operational priorities; forms partnerships with industry and academia; elicits participation by the nation's top scientists and professionals; and facilitates transfer of research products to the operational community. The Aviation Medicine Program produces data and other forms of information which support notices and regulations applicable to aircraft occupant health and safety. It also develops output options in response to public demand (e.g., better restraints for children in aircraft settings); and it assesses disease transfer and other aircraft occupant health factors.

The FAA works to ensure the safety and efficiency of NAS operations, a critical element of which is operator performance. Through guidelines, handbooks, advisory circulars, rules, and regulations, the agency provides industry human performance information and guidance critical to the design, operation, regulation, and certification of equipment, training, and procedures. The Human Factors Program performs the research which

provides the technical information necessary to generate these products and services.

Automation has been cited as a contributing factor in aircraft accidents (e.g. Cali:AA065). Human factors research is examining flight deck automation design, operation, and use, and has developed a taxonomy of issues to be addressed. Air carrier training initiatives such as the Model Advanced Qualification Program (air carrier pilot training program which integrates both technical and crew resource management performance requirements) will allow air carriers to develop and utilize proficiency-based training. Pre-hiring screens for air traffic controllers will enable the FAA to select people with needed skills, thus reducing training required after employment. The Automated Performance Measuring System will allow airlines to analyze routine operations for dangerous trends and tendencies, and will provide insight into the details of daily carrier line operations.

The Aviation Medicine Office and the National Institute for Occupational Safety and Health (NIOSH) are examining cabin air quality issues and their effects on passengers and crew. Aviation Medicine is also developing bioengineering criteria to support aircraft seat and restraint system certification; biomedical criteria to support protective breathing equipment and operational procedures certification; and biochemical and toxicological criteria supporting the use or certification of aircraft interior fire, smoke, and toxicity limits.

Program Area Structure

The Human Factors program addresses operational requirements through research in the following five technical thrust areas (agreed to by the FAA, NASA, and DOD in the *National Plan for Civil Aviation Human Factors*):

Human-Centered Automation: This research focuses on the role of the operator and the cognitive and behavioral effects of using automation to assist humans in accomplishing their assigned tasks. Research in this area addresses the identification and application of knowledge concerning human strengths and limitations in an automated environment. It investigates the implications of computer-based technology in the design, evaluation, and certification of controls, displays, and advanced systems.

Selection and Training: Research in this area strives to: understand the relationship between human abilities and aviation task performance; enhance the measures and methods for the prediction of future job/task performance; establish a scientific basis for the design of training programs, devices, and aids for individuals and teams; define criteria for assessing future training requirements; and identify new ways to select aviation system personnel.

Human Performance Assessment: Research in this area identifies the intrinsic characteristics of individuals and teams which determine how well they are able to perform aviation tasks; characterizes the impact of environmental and individual factors on human performance; and improves and standardizes methods for measuring human performance.

Information Management and Display: Research in this area addresses the presentation and transfer of information among components in the NAS. It seeks to identify the most efficient and reliable ways to display and exchange information; determines when and how one might best display and transfer specific information to system components; designs a system to reduce the frequency of information transfer errors and misinterpretations; and strives to minimize the impact when errors occur.

Bioaeronautics: Research in this area involves the bioengineering, biomedicine, and biochemistry associated with performance and safety. The objective is to enhance personal performance and safety by maximizing crew and passenger health and physiological integrity. The program includes three research initiatives: human protection and survival; medical and toxicological factors of accident investigation; and Federal Air Surgeon program support. Protecting humans in decelerative environments, protective breathing equipment, cabin evacuation, and water survival are investigated in the human protection and survival initiative. Toxicological assessment and sudden or subtle pilot incapacitation are key features of the accident investigation initiative. New vision corrective methods for aviation personnel, aircraft cabin environmental hazards, and air ambulance medical requirements represent current clinical investigations under the Federal Air Surgeon program support initiative.

Customer/Stakeholder Involvement

The Human Factors Program directly supports a number of aviation community initiatives and congressional mandates:

- Office of the Associate Administrator for Research and Acquisitions Performance Plan, Goal 1 ("Through research, identify methods that, when implemented, would reduce the fatal aviation accident rate by 80 percent by 2007 when compared to 1990-1996 baseline data"), and Goal 2 ("Ensure that critical human factors issues are addressed in the acquisition and integration of 100 percent of new and modified FAA aviation systems by 2005").
- The *National Plan for Civil Aviation Human Factors*, published in March 1995, with FAA, NASA, and DOD as signatories. This document, which had extensive aviation community participation in its development, outlines a coherent national agenda for human factors and bioaeronautical research and application leading to significant improvements in NAS safety and efficiency.
- The *Aviation Safety Plan*, which calls for research supporting priority issues associated with crew training, safety data collection and use, application of emerging technologies, and aircraft maintenance procedures and inspection. The Aviation Medicine Program significantly contributes to the application of emerging technologies, as highlighted in the plan
- Implementation of the FAA report on "The Interfaces Between Flight Crews and Modern Flight Deck Systems."
- Public Law 100-591, which establishes requirements for human factors research and its application; the FY 1997 Department of Transportation Appropriations Act, which cites human factors as the greatest cause of aviation accidents and calls for high priority research; and The Aviation Safety Research Act of 1988, which requires that human factors research be conducted to "enhance air traffic controller performance, develop a human factor analysis of the hazards associated with new technologies, identify innovative and effective corrective measures for human errors, and develop dynamic simulation models of the ATC system."
- RTCA "Free Flight Action Plan," which specifically addresses recommendations to: establish more flexible decision support systems involving collaborative decisionmaking; conduct human-in-the-loop simulations for assessing controller and pilot perceptions of hazards, risks, and discomfort; measure performance, workload, and situation awareness associated with controller and pilot responses to time and distance; conduct real-time human-in-the-loop simulations to systematically study controller and pilot behaviors, interactions, and effects within NAS environments that represent dynamic densities and sector configurations anticipated for free flight.

The Aviation Medicine Program is an integral participant and research provider under the FAA, Joint Aviation Authorities, and Transport Canada's *Aviation Aircraft Cabin Safety Research Plan* (established in 1995), which sets forth long-term research goals and ensures coordination among agencies.

Accomplishments

The program has accomplished the following:

- Developed and field tested (with several airlines) a prototype Automated Performance Measurement System to allow for the gathering and analysis of data from aircraft flight data recorders. This capability is utilized by the Flight Operations Quality Assurance Program, a joint FAA and airline venture to enhance aviation safety.
- Developed a model Advanced Qualification Program (AQP) for use by training centers to support regional air carrier participation in AQP, a proficiency-based approach to pilot training.
- Published the *Aircraft Maintenance Human Factors Guide.*
- Developed pilot performance data through flight simulation for use in establishing certification standards for general aviation autonavigation and control systems.
- Sponsored the National Research Council's assessment of human factors issues in the air traffic control system and the publication entitled *Flight to the Future - Human Factors in Air Traffic Control.*
- Conducted a human/system performance assessment of the Departure Sequencing Engineering Development Model.

- Completed a human factors audit of the Converging Runway Display Aid installed at St. Louis Airport to help terminal radar controllers efficiently space aircraft arriving on separate, converging runways.
- Measured taskload and document work processes of personnel at maintenance control centers.
- Developed guidelines to reduce inflight sudden/ subtle incapacitation.
- Evaluated autopsy data from fatal aviation accidents to recommend protective equipment and design practices.
- Assessed flight attendant reproductive health hazards.
- Reported on the suitability of component tests for showing regulatory compliance with crashworthiness standards for aircraft.
- Completed definitive evacuation escape slide angle and strength studies to minimize escape injuries and escape failures.
- Developed improved aviation oxygen mask systems.
- Assessed operational hazards of in-flight laser exposure.
- Evaluated effect of refractive surgery on vision tasks in aviation.
- Developed performance-based narrow and wide-bodied aircraft cabin evacuation approval guidelines.

R&D Partnerships

The Human Factors Program is linked to NASA and DOD under the auspices of the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*. Specific areas of coordinated program execution with NASA include cockpit automation, fatigue, crew resource management, team decision-making, air-ground communication, and the Automated Performance Measurement System. DOD joint efforts involve fatigue, team performance, and decisionmaking research. Additionally, the Human Factors Office maintains membership in the DOD Human Factors Engineering Technical Advisory Group which provides a forum for the coordination of research across a variety of technical areas.

The Human Factors Office participates with the Netherlands National Research Laboratory in flight deck automation research, and with the Office of Aviation Medicine. The office maintains an active membership on all Society of Automotive Engineers G-10 human factors subcommittees related to on-going and future research areas to ensure transition of the results to standards and guidelines. Members from the National Transportation Safety Board work with the Human Factors Office in the areas of fatigue, flight deck automation, and error mitigation. The Human Factors Office has awarded grants to eight universities supporting research on air carrier training, flight deck automation, human performance integrity, and aircraft maintenance technician training. Coordinated research efforts are conducted with NASA Ames in the areas of free flight and shift-work-induced fatigue and associated countermeasures. An Interagency Agreement with the U.S. Naval Air Warfare Center facilitates collaborative research in areas of selection and training. Additionally, elements of the controller performance research project are conducted in concert with the U.S. Air Force's Armstrong Laboratory.

The Office of Aviation Medicine participates with NIOSH on a collaborative study addressing the cabin environment and flight attendant and passenger symptomatology and diseases. A liaison is also maintained with the American Society of Heating, Refrigeration, and Air Conditioning Engineers Committee addressing aircraft cabin air quality status and research.

The Office of Aviation Medicine maintains direct cooperative research processes with all the manufacturers responsible for safety products (seats, restraint systems, oxygen masks, evacuation slides, etc.). The Office of Aviation Medicine is further represented on appropriate subgroups of organizations such as the Aerospace Medical Association, the Civil Aviation Medical Association, and the Professional Aeromedical Transport Association. Appropriate liaison with the military is maintained either through direct project collaboration (e.g., crashworthiness, eye injury from lasers) or through the more global participation in the Tri-Services Aeromedical Research Panel, and the North American Treaty Organization aerospace medical advisory group.

Long-Range View

The FAA has accepted national responsibility to initiate and maintain research and development programs in support of modernization, regulation, certification, and NAS issues; and, with equal importance, national responsibility to initiate proactive research to identify emerging safety trends. The human factors investment strategy will directly support proactive research efforts to identify and reduce targeted safety issues.

Baseline data will be established to show direct causal relationships between research outputs and accidents and incidents. Research programs will be directed at targets which will have the greatest impact on aviation safety, will be multi-year efforts, and will require stabilized resources to plan, execute, and complete. Successful implementation of research outputs will require full partnerships and close cooperation within FAA organizations and the aviation community.

Research strategies will focus on technology, partnerships, and measurements. Methods will be developed to identify interventions to address human performance issues in flight maintenance and air traffic operations and to reduce operational hazards. A five-year integrated safety research plan will be developed with NASA to address long-range, high pay-off priorities. Measurement strategies will be developed to accurately monitor trends and identify opportunities for research to mitigate risks.

Public and Congressional interest is not abating for the maintenance of a healthy and comfortable environment for each category of civil aviation's participants. This concern is demonstrated by the activation of a new five-year interagency agreement between FAA and NIOSH in FY97 to address infectious disease and other health considerations in the aircraft cabin environment.

FAA goals related to minimizing injury, associated pain, necessary rehabilitation, and death as a consequence of aviation accidents make the work of the Aviation Medicine Program a critical component of coordinated steps to increase human survivability, one of the accepted corporate strategies for decreasing fatality accidents. The Aviation Medicine Program will emphasize reduction in the severity of injuries encountered in aviation accidents and in such precautionary events as evacuation of passengers from an aircraft after recognition of a safety concern by the flight crew. This approach will cut rehabilitation time, decrease medical costs, and improve the quality of life for persons who suffer injuries.

Additionally, in concert with the targets expressed in Challenge 2000 and with FAA's broad commitments to harmonize safety regulations on a global scale, the Aviation Medicine Program will focus its collaborative interactions with domestic and international laboratories to generate research data for use in the development of internationally harmonized aviation standards and regulations. Aeromedical research will be increasingly required to interpret data derived from around the world, and to assess if this data should be accepted or recollected before being integrated into regulatory considerations and outputs.

A08a Flightdeck/Maintenance/System Integration Human Factors

GOALS:

Intended Outcomes: The FAA intends to improve air transportation safety by:

- Developing more effective methods for aircrew, inspector, and maintenance technician training.
- Developing more human-centered flight controls and displays.
- Increasing human factors considerations in certification of new aircraft and equipment design and modification.
- Improving aircrew, inspector, and maintenance technician task performance.

Agency Outputs: The FAA is concerned with ensuring the safety and efficiency of operator performance, a vital element in NAS operations. Through guidelines, handbooks, advisory circulars, rules, and regulations, it provides industry with human performance information and guidance critical to the design, operation, regulation, and certification of equipment, training, and procedures. The Human Factors Program conducts and manages the research which provides the technical information necessary to generate these products and services.

Customer/Stakeholder Involvement: The Human Factors Program directly supports a number of aviation community initiatives:

- Office of the Associate Administrator for Research and Acquisition Performance Plan, Goal 1 (reduce fatal aviation accident rate by 80 percent) and Goal 2 (ensure that human factors are addressed in all new and modified FAA systems).
- The *National Plan for Civil Aviation Human Factors - An Initiative for Research and Application* was published in March 1995, with FAA, NASA, and DOD as signatories. This document, which had extensive aviation community participation in its development, outlines a coherent national agenda for human factors research and application leading to significant improvements in NAS safety and efficiency.
- The *Aviation Safety Plan*, through research supporting priority issues associated with four of the six workshops: crew training, safety data collection and use, application of emerging technologies, and aircraft maintenance procedures and inspection.
- The implementation of the FAA report on "The Interfaces Between Flight Crews And Modern Flight Deck Systems."
- The Human Factors Program is responsive to Public Law 100-591, which establishes requirements for human factors research and its application.

Accomplishments

The programming output of data packages, models, and regulatory documents includes:

- Developed, and currently field testing with several airlines, a prototype automated performance measurement system (APMS) which allows for the gathering and analysis of data from aircraft flight data recorders. This information and analysis capability provides the backbone for the Flight Operations Quality Assurance Program, a joint FAA and airlines venture to enhance aviation safety.
- Developed an advisory circular and handbook on crew resource management for aircrew members.
- Developed a model Advanced Qualification Program (AQP) to include regional air carrier participation. This is a proficiency-based approach to pilot training that is considered to be highly effective and efficient for aircrew training.
- Published the *Aircraft Maintenance Human Factors Guide.*
- Provided educational outreach to the aviation community through the NASA/FAA fatigue countermeasures training module.
- Developed pilot performance data, through flight simulation, for use in establishing certification standards for general aviation autonavigation and control systems.
- Developed aircraft certification human factors and operations checklist for stand-alone global positioning system receivers.

R&D Partnerships: The program is linked to NASA and DOD under the auspices of the *National Plan for*

Civil Aviation Human Factors: An Initiative for Research and Application. Specific areas of coordinated program execution with NASA include cockpit automation, fatigue, crew resource management, team decisionmaking, air-ground communication, and automated performance measurement system. DOD joint efforts are in fatigue, team performance, and decisionmaking. Additionally, the FAA is represented on the DOD Human Factors Engineering Technical Advisory Group, a forum for the coordination of research across a variety of technical areas. The FAA participates with the Netherlands National Research Laboratory in flight deck automation as well as on all of the Society of Automotive Engineers G-10 human factors subcommittees related to our research areas to ensure transition of the results to standards, guidelines, etc. Members from the National Transportation Safety Board have worked with the program in the areas of fatigue, flight deck automation, and error mitigation. The FAA also has extended grants to ten universities supporting research on air carrier training, flight deck automation, and aircraft maintenance technician training.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Selection and training.

- Provided proceduralized crew resource management guidelines for regional airlines.
- Validated human performance transfer functions for level B full flight simulator.
- Completed research and developed draft advisory circular on aircraft maintenance resource management.
- Completed guidelines for maintenance technician situation awareness training.
- Completed research and published draft advisory circular on training for automated flight deck operations.

Human performance assessment.

- Completed advanced APMS prototype.
- Completed user needs studies at air carriers participating in APMS development.
- Developed mapping of flight data parameters onto AQP qualification standards.

Human-centered automation.

- Completed human factors guidelines for assessing advanced general aviation transportation experiments (AGATE) cockpit controls/displays.
- Provided recommendations for improved utilization of automated flight management systems.

Information management and display.

- Completed software tools for enhanced maintenance documentation.

KEY FY 1999 PRODUCTS AND MILESTONES:

Selection and training.

- Provide tools for scenario based evaluations in line-oriented flight training.
- Implement advanced training techniques for general aviation pilots.

Human performance assessment.

- Define general aviation pilots decisionmaking skills required for training module development.
- Complete research and develop draft advisory circular on aircraft maintenance error detection/reporting systems.
- Develop and implement phase 1 APMS at partner air carriers.

Human-centered automation.

- Provide recommendations for improved utilization of automated flight management systems.
- Provide human factors evaluation for AGATE flight systems configurations.
- Develop certification guidelines for integrated technology in general aviation cockpits.

Information management and display.

- Develop guidelines for the use of simplified English in aircraft maintenance technician instructions and documentation.
- Develop flight data recording and analysis capability for flight simulators.
- Develop and publish secure internet flight information data warehouse standards.

FY 1999 PROGRAM REQUEST:

The program continues to focus on providing technical information and consultation to improve aircrew, inspector, maintenance technician, and aviation system performance. Emphasis is on developing guidelines, tools, and training to enhance error capturing and mitigation capabilities in the flight deck and maintenance environments; and developing human factors tools to ensure that human performance considerations are adequately addressed in the design and certification of flight decks and equipment.

A08a - Flight Deck/Maintenance/System Integration Human Factors Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
081-110 Flightdeck/Maintenance/System Integration Human Factors						
Selection and Training						
Provided Proceduralized Crew Resource Management Guidelines for Regional Airlines	♦					
Validated Human Performance Transfer Functions for Level B Full Flight Simulator	♦					
Provide Tools for Scenario Based Evaluation in Line Oriented Flight Training (LOFT) Scenarios		◇	◇	◇	◇	
Complete Research and Develop Draft Advisory Circular on Maintenance Resource Management	♦	◇	◇			
Implement Advanced Training Techniques For General Aviation Pilots			◇	◇	◇	◇
Completed Guidelines for Maintenance Technician Situation Awareness Training	♦					
Human Performance Assessment						
Complete Advanced Prototype Automated Performance Measurement System (APMS)	♦	◇				
Define General Aviation Pilots Decisionmaking Skills Required for Training Module Development	♦	◇				
Complete Research and Develop Draft Advisory Circular on Aircraft Maintenance Error Detection/Reporting Systems		◇				
Completed User Needs Studies at Air Carriers Participating in APMS Development	♦					
Developed Mapping of Flight Data Parameters onto AQP Qualification Standards	♦					
Human Centered Automation						
Complete Human Factors Guidelines for Assessing AGATE Cockpit Controls/Displays	♦		◇	◇		
Provide Recommendations for Improved Utilization of Automated Flight Management Systems	♦	◇	◇	◇	◇	◇
Provide Human Factors Evaluation for AGATE Flight Systems Configurations		◇				
Information Management and Display						
Develop Guidelines for the Use of Simplified English in Aircraft Maintenance Technician Instructions and Documentation	♦	◇	◇			
Develop Flight Data Recording and Analysis Capabilities for Flight Simulators			◇	◇	◇	◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	15,307	7,857	8,430	10,365	7,400
Personnel Costs	997	2,760	2,048	1,814	1,940
Other Costs	204	565	420	371	563
Total	**16,508**	**11,182**	**10,898**	**12,550**	**9,903**

A08b Air Traffic Control/Airway Facilities Human Factors

GOALS:

Intended Outcomes: The FAA intends to increase the safety and efficiency of the National Airspace System (NAS) by developing scientifically validated information and guidance for improving the performance and productivity of air traffic controllers and NAS maintenance technicians. This program is relevant to Fiscal Year 1996 FAA Strategic Plan goals to: "eliminate accidents and incidents caused by human error" (system safety goals #3A, B, & C) and to "implement new decision support systems and associated functional improvements that fully account for the proper role of people in the system" (system safety goal #4G). It also provides human factors support that addresses the Fiscal Year 1996 FAA goal to "reduce the costs of flying by making the air traffic management system more efficient to use" (system capacity goal #5C). This program is directly responsive to the Office of the Associate Administrator for Research and Acquisition Performance Plan, Goal 1 (reduce fatal aviation accident rate by 80 percent) and Goal 2 (ensure that human factors are addressed in all new and modified FAA systems).

Agency Outputs: This program develops research products that provide essential assistance to FAA's Air Traffic Services (ATS) for implementing and enhancing advanced operational concepts, including the systems, subsystems, and procedures integral to these concepts. The research products are distributed in the form of guidelines, reference handbooks, data bases, technical reports, checklists, and briefings. They are also shared with the international aviation community. The research is focused on the following issues:

- Producing guidelines and models for optimally allocating operational functions and tasks between human operators and their equipment.
- Creating qualitative and quantitative human factors reference information to assist in the design, integration, and evaluation of evolving air traffic control (ATC) and airway facilities (AF) systems.
- Using real-time simulations, rapid prototyping, and computational models to generate reference data that support FAA specifications, acquisitions, and tests for improving NAS equipment and procedures.
- Developing and applying analysis tools and standards for assessing/predicting operator workload and performance.
- Providing insight into the root causes of operational errors by creating the capability to integrate routinely-recorded radar and voice transmission data into a radar display format that re-creates events from the perspective of the air traffic controller.
- Developing and validating tools and reference information for improved controller selection and training programs.
- Identifying the effects of rotating shift work on operator performance and offering effective countermeasures to potential negative impacts.
- Analyzing pilot-controller miscommunications and providing recommendations to reduce the likelihood they will recur.

Customer/Stakeholder Involvement: The Air Traffic Control/Airway Facilities Human Factors R,E&D program directly supports the following aviation community initiatives:

- It is responsive to The Aviation Safety Research Act of 1988, section 3, wherein Congress stipulates that human factors research be conducted to: enhance air traffic controller performance; develop a human factor analysis of the hazards associated with new technologies; identify innovative and effective corrective measures for human errors; and develop dynamic simulation models of the ATC system.
- Research directly supports the RTCA Free Flight Action Plan by specifically addressing the following recommendations: #8, "...establish more flexible decision support systems [involving collaborative decisionmaking];" #33f, "... conduct human-in-the-loop simulations for assessing controller and pilot perceptions of hazards, risks, and discomfort. Performance, workload, and situation awareness associated with controller and pilot responses to time and distance buffers will be measured;" and #34, "Real-time human-in-the-loop simulations should be conducted to systematically study controller and pilot behaviors, interactions, and effects within NAS environments that represent dynamic densities

and sector configurations anticipated for free flight."

- It operates within the framework of the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application,* published in March 1995, with FAA, NASA, and DOD as signatories.

- It is consistent with the House Appropriations Committee's 1997 Department of Transportation Appropriations Bill, which cites human factors as "far and away the greatest cause of aviation accidents" and calls for a "high priority" on research into "human factors problems experienced by air traffic controllers and FAA maintenance personnel."

Accomplishments

The program has performed or sponsored the following research and resulting products:

- Sponsored the National Research Council's assessment of human factors issues in the air traffic control system. The Council's recent publication, *Flight to the Future - Human Factors in Air Traffic Control,* a product of this study, contains a wealth of information, conclusions, and recommendations from this distinguished panel of aviation human factors experts is widely disseminated in the FAA.

- Published an extensive volume of information and advice on human factors issues in the design and evaluation of ATC systems and subsystems. To date, this book and its associated electronic checklist have been widely distributed within the FAA to ATS and integrated product team (IPT) customers for internal use.

- Supported FAA emphasis on the procurement of commercial-off-the-shelf (COTS) and non-developmental items (NDI) for application in ground-based NAS systems. This was done by creating and distributing a comprehensive reference book to aid in identifying and addressing human factors issues associated with the procurement, design, development, and testing of COTS/NDI systems.

- Validated the current air traffic controller pre-training screen selection instrument to ensure that it was both effective and free of any race, gender, or cultural bias.

- Completed development of en route Systematic Air Traffic Operations Research Initiative (SATORI), a high-fidelity research tool that uses routinely recorded ATC computer and voice data to re-create and display ATC operational incidents. SATORI has been transitioned to ATS, where it was procured for installation in all air route traffic control centers for use as a training tool and to study operational incidents.

- Conducted a human/system performance assessment of the departure sequencing engineering development model. Findings were briefed to ATS while the system was under consideration for national deployment.

- At the request of the Director, Air Traffic Services, conducted a human factors audit of the converging runway display aid installed at St. Louis Airport. This system is a decision support tool that helps terminal radar controllers efficiently space aircraft arriving on separate, converging runways.

- For the Director, Air Traffic Office of Plans and Requirements, conducted an assessment of the potential productivity gains that might be experienced by air traffic controllers in airport tower cabs due to the tower control computer complex that was then under development.

- For the Airway Facilities Operations Management Team, measured taskload and documented work processes of personnel at present maintenance control centers.

R&D Partnerships NASA, DOD, and FAA are cooperative partners in the development and execution of the *National Plan for Aviation Human Factors: An Initiative for Research and Application.* This document lays out a coherent national agenda for human factors research and provides the conceptual framework for the ATS Human Factors Program. Coordinated research efforts are conducted with NASA Ames in the areas of free flight and shift-work-induced fatigue and associated countermeasures. An inter-agency agreement with the U.S. Navy at the Naval Air Warfare Center is in place to facilitate collaborative research in areas of selection and training. Additionally, elements of the controller performance research project are conducted in concert with the U.S. Air Force at its Armstrong Laboratory. Grants are in place with universities to study human factors issues in air traffic management and automated systems. Internationally, research results on the development and

validation of controller applicant selection methods are shared among project leaders in this program and their functional equivalents in Sweden and Denmark.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Selection and training.

- Developed and validated controller work team measures.
- Developed and transitioned prototype framework for implementing self-managed teams in the AF work environment.

Human performance assessment.

- Validated methodology for measuring air traffic controller performance.
- Developed strategies for human error prevention/mitigation in AF maintenance control centers.
- Identified impacts of alternative work schedules on controller performance.

Information management and display.

- Provided guidelines to enhance operator situation awareness.
- Provided recommendations regarding the optimal allocation of communications tasks between controllers and data linked systems.
- Enhanced capability to recreate operational incidents using recorded data from the display system replacement.

KEY FY 1999 PRODUCTS AND MILESTONES:

Selection and training.

- Identify controller skills and abilities required for future ATC systems.
- Develop and validate controller work team measures.
- Complete human factors analysis of air traffic control specialist (ATCS) roles and responsibilities in free flight.

Human performance and assessment.

- Provide validated ATCS performance measures.
- Develop and validate strategies for human error prevention/mitigation in AF maintenance control centers.
- Provide recommendations on work scheduling to reduce the impact of shift-induced operator fatigue.

Human-centered automation.

- Provide recommendations for display of complex data from multiple sources in air traffic management.

Information management and display.

- Provide guidelines to enhance operator situation awareness.
- Develop guidelines for air-to-air communications via data link in free flight.
- Develop guidelines for shared information displays in air-ground communications.

FY 1999 PROGRAM REQUEST:

The FY 1999 research program reflects a heightened emphasis on working with ATS to meet the pressing challenge of successfully fielding new technologies and procedures over the next several years. Research projects focus on providing timely information to answer critical human factors questions associated with these new systems and procedures (such as free flight) and thus help to optimize human performance in the evolving and increasingly complex NAS.

A08b - Air Traffic Control/Airway Facilities Human Factors Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
082-110 AirTraffic Control/Airway Facilities Human Factors						
Selection and Training						
Identify Controller Skills and Abilities Required for Future ATC Systems	♦	◇	◇	◇	◇	◇
Develop and Validate Controller Work Team Measures	♦	◇	◇			
Complete Human Factors Analysis of ATCS Roles and Responsibilities in Free Flight		◇	◇			
Human Performance Assessment						
Validate Methodology for Measuring ATCS Performance	♦	◇	◇	◇		
Upgrade SATORI Tool to Analyze Data from Display System Replacement (DSR)	♦	◇				
Develop Strategies for Error Identification and Mitigation in AF Work Environment	♦	◇	◇	◇		
Identify Impacts of Alternative Work Schedules on ATCS Performance	♦	◇				
Human Centered Automation						
Complete Recommendations on ATM Display Parameters			◇	◇		
Information Management and Display						
Provide Guidelines to Enhance Operator Situation Awareness	♦	◇	◇	◇	◇	
Provided Recommendations on ATCS Communication Task Allocation	♦					
Enhanced Capability to Recreate Operational Incidents Using Recorded Data From the DSR	♦					
Develop Guidelines for Air-To-Air Communications via Data Link in Free Flight		◇	◇			
Develop Guidelines for Shared Information Displays in Air-Ground Communication		◇	◇	◇		

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	8,004	4,836	4,356	5,454	4,008
Personnel Costs	2,702	4,286	3,528	3,773	3,117
Other Costs	553	878	722	773	1,172
Total	11,259	10,000	8,606	10,000	8,297

A08c Aeromedical Research

GOALS:

The FAA safety mission dictates that existent injury and death patterns in civilian flight misadventures be meticulously reviewed, that recommendations for protective equipment and procedures be developed, and that options be evaluated on behalf of FAA regulatory and medical certification staff charged with the proposal of safety regulations addressing all aircraft cabin occupants.

A concurrent mission is the identification of pilot, flight attendant, and passenger medical conditions that are incompatible with in-flight clinical and physiological demands on the occupant, both in the absence and presence of flight emergency conditions.

Intended Outcomes: The outcomes addressed by this research program are improved health, safety, and survivability of aircraft passengers and aircrews. This research program identifies human failure modes (physiological, psychological, clinical) both in uneventful flight, and during civil aircraft incidents and accidents. Formal recommendations for counteracting measures are derived from in-house research.

FAA is able to develop bioaeronautical guidelines, standards, and models for aircraft cabin equipment, procedures, and environments as a base for regulatory action to enhance appropriate human performance. By reviewing pilot medical and flight histories and information from accidents and incidents, new medical criteria, standards, and assessment/certification procedures can be proposed to ensure full performance capability. By assessing flight attendant and passenger work, behavioral, and disease issues, guidelines for actions to improve the health and safety of the cabin occupant can be rationally proposed.

Agency Outputs:

The program has developed the following criteria for use in regulatory and certification processes:

- Quantitative bioengineering criteria to support aircraft seat and restraint system certification.
- Quantitative biomedical criteria to support protective breathing equipment and operational procedures certification.
- Quantitative biochemical and toxicological criteria supporting the use or certification of aircraft interior fire, smoke, and toxicity limits.
- Quantitative biomedical criteria to support flotation and onboard rescue equipment certification.
- Identification of medical/toxicological factors and human factors in aviation incidents and accidents.
- Recommendations for aircrew medical criteria, standards, and assessment/certification procedures.
- Quantitative data about the occupational health status of flight attendants to support regulatory oversight.
- Quantitative data about passenger behavior and health to support regulatory oversight.

Customer/Stakeholder Involvement: This program provides the primary bioaeronautical research (note: defined as the bioengineering, biomedicine, and biochemistry issues associated with safety and performance) called for in the *National Plan for Civil Aviation Human Factors* of 1995). (This plan committed to major deliverables referenced in the system safety goals of the FAA Strategic Plan of the following year.)

This program contributes significantly to the application of emerging technologies, as highlighted in the February 1996 FAA Aviation Safety Plan. The program is an integral participant and research provider under the FAA, Joint Aviation Authorities (JAA), and Transport Canada Aviation (TCA) Aircraft Cabin Safety Research Plan established in 1995 as a coordinated, living plan to maximize the cost-benefit of aircraft cabin safety research internationally.

International Civil Aviation Organization (ICAO) initiatives addressing the health of the aircraft occupant (crew and passenger) are developed under this program before final FAA recommendations are provided to ICAO. This program is the only research component of the FAA that can legally access confidential medical data about pilots for use in epidemiological research studies approved by FAA's institutional review board for use of human test subjects. Multi-year collaborative studies performed by the FAA and the National Institute for Occupational Safety and Health (NIOSH) into flight

attendant and passenger symptomatology and diseases are funded by this budget item to satisfy the mandate placed by Congress upon the agencies in the FY 1994 Appropriation Act.

Accomplishments: Based on aeromedical research at the Civil Aeromedical Institute, the FAA will shortly issue an advanced notice of proposed rulemaking concerning the usage and design of child restraints on aircraft. The output of this program's research is permitting the FAA and National Highway Traffic Safety Administration to revise the testing requirements in Federal Motor Vehicle Safety Standard 213, which covers the design of child restraints for use in aircraft. A prototype aircraft seat insert dramatically improves the safety performance of conventional forward-facing child restraints used in aircraft. Quantitative data were provided regarding various prototypes of aircraft-specific child restraints being developed as commercial products targeted for airlines. Specialized quantitative crashworthiness assessments for new types of restraint systems continued, inclusive of a review of airbag systems proposed for in-flight applications.

Data is continuously provided to the research sponsor on the role of toxicological and clinical factors associated with each aircraft accident and significant incident. Current findings indicate that about one of six pilots fatally injured in a civilian aircraft accident shows evidence of using a prescription drug; one of four has taken an over-the-counter drug, one of 25 has ingested significant positive alcohol, and 1 of 20 is using a significant controlled dangerous substance. Long-term aviation forensic and epidemiological research has helped the FAA to identify human factor roles in accident/incident causation. Specialized clinical evaluations were applied to cases associated with decompression of the aircraft. Probable seizures and other factors indicative of the pilot's inability to perform were evaluated.

R&D Partnership: Several of these partnerships (e.g., FAA/JAA/TCA; FAA/NIOSH) have been cross-referenced in the Customer/Stakeholder Involvement and Accomplishments sections above.

In addition, in each of the program area output categories, the FAA maintains direct cooperative research processes with all the manufacturers responsible for the safety products enumerated (seats, restraint systems, oxygen masks, evacuation slides, etc.). FAA investigators also maintain memberships on every Society of Automotive Engineers committee addressing safety research conducted under this program. The agency maintains a liaison with the American Society of Heating, Refrigeration, and Air Conditioning Engineers committee addressing aircraft cabin air quality status and research. Besides the active involvement in the FAA/JAA/TCA process of oversight for safety research, participants in this program are represented on appropriate subgroups of organizations such as the Aerospace Medical Association, the Civil Aviation Medical Association, and the Professional Aeromedical Transport Association. Appropriate liaison with the military is maintained either through direct project collaboration (e.g., crashworthiness, eye injury from lasers) or through the more global participation in the TriServices Aeromedical Research Panel or North Atlantic Treaty Organization aerospace medical advisory groups.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS

The following program results have been achieved or are expected to be achieved in FY 1998:

- Performed epidemiological assessment of toxicology factors from fatal civilian aviation accidents.
- Developed guidelines to reduce inflight sudden/subtle incapacitation.
- Evaluated autopsy data from fatal aviation accidents to determine protective equipment and design practices.
- Assessed flight attendant reproductive health hazards (congressionally-requested FAA-NIOSH study).
- Issued a report on the suitability of component tests for showing regulatory compliance with crashworthiness standards for aircraft.
- Published definitive evacuation escape slide angle and strength studies to minimize escape injuries and escape failures.
- Developed performance-based narrow- and wide-bodied aircraft cabin evacuation approval guidelines.
- Developed improved general aviation oxygen mask systems.

- Assessed operational hazards of inflight laser exposure.

KEY FY 1999 PRODUCTS AND MILESTONES

The following program results are being scheduled for FY 1999:

- Conduct epidemiological assessment of toxicology factors from fatal civilian aviation accidents.
- Compare toxicology findings at time of flight physical to post-accident data.
- Develop guidelines to reduce inflight sudden/subtle incapacitation.
- Evaluate autopsy data from fatal aviation accidents to determine protective equipment and design practices.
- Report on guidelines for aircraft cabin occupant health maintenance.
- Development of model disease transmission via aerosols in an aircraft cabin environment.
- Develop performance-based narrow- and wide-bodied aircraft cabin evacuation approval guidelines.
- Evaluate the suitability of analytical modeling as a substitute for evacuation tests in the certification of new passenger aircraft.
- Develop improved oxygen mask systems.
- Evaluate the effect of refractive surgery on vision tasks in aviation.

FY 1999 PROGRAM REQUEST:

The Office of Aviation Medicine encounters complex medical decisions during the initial and follow-up medical assessments of airmen who request special medical issuances (e.g., cardiac conditions, neurological deficits, etc.) to permit their continued flying. The prospective epidemiological assessment of special issuance methodology and medical outcomes in the airman population is required to ensure that medical issuances do not result in unexpected or increased aircraft accident or incident rates.

Ongoing research projects will:

- Develop safer aircraft cabin evacuation approval guidelines and safer field applications under operational conditions.
- Reduce head, neck, and extremity injuries in aircraft crash environments.
- Evaluate trends in toxicology and clinical findings from all major civil aviation aircraft crashes.
- Develop guidelines for aircraft cabin crew and passenger environmental management.

A08c - Aeromedical Research Product and Activities	Program Schedule FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
086-110 Aeromedical Research						
Cabin Health and Environmental Guidelines						
Assessment of Flight Attendant Reproductive Health Hazards	♦	◇	◇	◇	◇	
Report on Guidelines for Aircraft Cabin Occupant Health Maint.		◇	◇	◇	◇	◇
Development of a Model of Disease Transmission Via Aerosols in an Aircraft Cabin Environment		◇				
Human Protection/Survival in Civil Aviation						
Analyze the Suitability for Component Tests as an Alternative for Showing Regulatory Compliance with Crashworthiness Standard for Aircraft	♦	◇	◇	◇	◇	
Published of Definitive Evacuation Escape Slide Angle and Strength Studies to Minimize Escape Injuries	♦					
Develop Performance-Based Narrow and Wide Bodied Aircraft Cabin Evacuation Approval Guidelines	♦	◇	◇	◇	◇	◇
Report on Suitability of Aircraft Cabin Evacuation Modeling as a Partial Replacement for Evacuation Tests with Human Subject		◇	◇	◇	◇	
Implement Dual Aisle Evacuation Model						◇
Development of Improved Oxygen Mask System	♦	◇	◇			
Analyzed the Influence of Cabin Crew Duty Stations on Evacuation Performance of Passenger Aircraft in Panic Situations	♦					
Evaluate Cockpit Factors that Increase Glare Sensitivity of Flight Crews		◇				
Initiate Study of Combined Effects of New Antihistamines and Hypoxia		◇				
Medical/Toxicology Factors of Accident Investigations						
Perform Epidemiological Assessment of Toxicology Factors from Fatal Civilian Aviation Accidents	♦	◇	◇	◇	◇	◇
Develop Guidelines to Reduce Inflight Sudden/Subtle Incapacitation	♦	◇	◇	◇	◇	◇
Comparison of Toxicology Findings at Time of Flight Physical to Post-Accident Data		◇				
Evaluate Autopsy Data from Fatal Aviation Accidents to Determine Protective Equipment and Design Practices	♦	◇	◇	◇	◇	◇
Evaluation of Effects of Refractive Surgery on Vision Tasks in Aviation		◇				
Report on the Impact of the Drug Abatement Program on Aviation Accidents/Incidents		◇				

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	435	0	0	0	277
Personnel Costs	3,152	2,075	3,320	3,320	3,155
Other Costs	646	425	680	680	597
Total	**4,233**	**2,500**	**4,000**	**4,000**	**4,029**

2.6 Environment and Energy Program Area Description

Mission

Protecting the environment poses the greatest single challenge to continued growth and prosperity of the aviation system. The FAA must provide strong international leadership to reduce aviation's adverse environmental impact while not compromising the effectiveness of the aviation system. The agency has adopted the following strategies:

- Lead a cooperative development effort that balances noise reduction with adequate airport capacity.
- Manage FAA activities to understand and minimize adverse environmental consequences and comply with all Federal statutes.
- Stimulate private industry and government sponsored research to reduce noise, emissions, and energy consumption by the aviation sector.
- Harmonize international aircraft noise and engine emissions certification standards.

Intended Outcomes

The FAA must use its regulatory authority to serve as an advocate for both the environment and industry. Through an optimal mix of aircraft and engine certification standards, operational procedures, compatible land use, and abatement technology, the agency intends to:

- Reduce the impact of aircraft noise by 80 percent (based upon population) by the year 2000 and prevent any increase.
- Minimize the impact of aircraft emissions.

Program Area Outcomes

The findings of aviation environmental research produce:

- Noise and emissions standards for the certification of new and modified airframe and engine type designs.
- Technical guidance on certification procedures and practices for manufacturers and modifiers in the form of technical reports, handbooks, advisory circulars, training courses, and rules.
- Computer models and impact criteria for civil aviation authorities to use in the environmental assessment of proposed actions.

Program Area Structure

The Aviation Environmental Research Program is a single budget line item: Environment and Energy. It is composed of the following major disciplines:

- Aircraft noise reduction and control
- Engine emissions reduction and control
- Aviation environmental analysis

These disciplines form a cohesive focus of research projects to support Federal actions regarding noise and engine exhaust emissions. Together they identify, control, and mitigate environmental consequences of aviation activity.

Customer/Stakeholder Involvement

The FAA works closely with other Federal agencies, industry, and foreign governments to assess environmental concerns, plan R&D, shape technical requirements, identify feasible abatement technologies (or other mitigation actions), and implement aircraft and engine certification regulations. This unified approach to research-based regulatory actions mitigates potential adverse impacts. The FAA uses the following arenas for collaboration on aviation environmental issues:

- The Aviation Regulatory Advisory Committee (ARAC) - A formal standing committee, composed of representatives from aviation associations and industry. Established by the FAA, ARAC provides industry input in the form of recommendations, advice, and information to be considered in the full range of FAA rulemaking activities. The harmonization working groups under ARAC have been tasked to ensure that certification regulations impacting both domestic and foreign parties do not impose different international standards.
- The International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) - The FAA participates with representatives of other international civil aviation authorities and observers from the aviation industry. The purpose of CAEP is to assess the

adequacy of international aviation environmental standards, especially in the areas of aircraft noise and engine exhaust emissions.

- The Federal Interagency Committee on Aviation Noise (FICAN) - This committee provides forums for broad-based debate over needs for future aviation noise research and encourages new development efforts in this area. FICAN conducts annual public forums in different geographic regions to solicit general input on aviation noise impact, with the intent to better align research with public concerns.

Accomplishments

Since 1991, the program has:

- Simplified noise certification procedure for light helicopters. The new procedure, promulgated by FAA and ICAO, should save manufacturers and modifiers at least $24 million over 15 years.
- Prepared four reports to Congress on the annual progress of the FAA/NASA subsonic jet noise research program, and one report to Congress on quiet aircraft technology for light propeller-driven airplanes and helicopters. The findings of the latter report led to a joint FAA/NASA research project on general aviation noise.
- Developed a handbook on small airplane noise certification and published advisory circulars on the aircraft noise certification database used to improve efficiencies of manufacturers' measurement tests and the FAA's review and approval process.
- Developed a training course entitled "Fuel Venting and Exhaust Emissions Requirements for Turbine Engine Powered Airplanes," to help applicants and FAA engine certification personnel to improve the efficiencies of manufacturers' measurement tests and the FAA's review and approval process.
- Produced advances in the computer models used for airport and heliport noise analysis. Over 1000 copies have been sold around the world. In the U.S., these models have been used in over 150 airport studies involving more than $1 billion in airport noise compatibility grants.
- Conducted three public forums on aviation noise research in Atlanta, San Diego, and Seattle; three FICAN annual reports; one report on Federal aviation noise research projects; and one report to Congress on the effects of aircraft noise. The public participation has led to new Federal research projects on commuter airplane noise impact and the annoyance which ambient noise poses to communities.
- Enhanced the computer model used for airport air quality analysis, with formal acceptance by the Environmental Protection Agency (EPA) as a preferred guideline model (highest ranking); and developed a handbook on procedures for airport air quality analysis for use by civil and military aviation authorities. Standardized civilian and military analytical procedures to improve the quality of environmental assessments performed or reviewed by the Federal Government.

R&D Partnerships

Through a series of memorandums of understanding, the FAA works closely with NASA and U.S. industry under the NASA Advanced Subsonic Technology (AST) and the High Speed Civil Transport research programs. These efforts identify source abatement technologies. The FAA also participates in the Aviation Effects on the Atmosphere Project (AEAP) with NASA, industry, and academia to assess the potential global impact of aircraft engine exhaust emissions. The Volpe National Transportation Systems Center continues to provide substantial technical assistance in aircraft noise measurement and assessment.

FICAN is a forum for partnership, as are all Federal agencies concerned with aviation noise. Diverse interests are represented on the committee, including (in addition to the FAA); the U.S. Departments of Interior, Transportation, Housing and Urban Development; the U.S. Air Force, Army, and Navy; EPA and NASA. FICAN promotes expanded, coordinated, and cooperative research efforts among individual agencies, which results in more efficient use of Federal funds. Participating agencies signed a formal letter of understanding, defining FICAN's purpose, scope, membership, process, and products.

Long-Range View

Planning for environmental research needs beyond 2000 requires a look at key indicators. These indicators are generally described as driving forces for change, targets of opportunities, or future

(environmental) threats. The key indicators that may pertain to aviation environmental research include:

- Air transportation growth
- New aircraft designs
- New aviation technologies
- Scientific findings on environmental impact
- Increased globalization of aviation
- Reduced Federal resources

FAA predicts slow and steady growth in the demand for aviation services into the first decade of the next millennium. Continued growth translates into more aircraft operations and increased exposure to environmental impacts. The key to successful environmental planning is to identify operational mitigation options for those sectors of the growing aviation markets most likely to reach environmental critical mass. FAA needs to continually assess the situation to determine whether research supporting mitigation should be directed towards tour operations over national parks, urban vertiports, resurgent general aviation activity, large jet transport operations, or a new threat.

Several major NASA aeronautics research programs, most notably the AST program, will come to an end in the first few years of the next decade. Several new source technologies will emerge from NASA research programs to become, in 10-15 years, U.S. industry's next generations of aircraft. With the end of the AST program, FAA closes its companion research program on subsonic noise reduction. The agency will use its research findings to identify new environmental certification standards and procedures for the next generation of transport aircraft. The agency will also shift future environmental research in the field of new aircraft technology towards other research programs on rotorcraft and general aviation. The solution to controlling the environmental consequences of new aircraft technologies is through an approach in which FAA works closely with other Federal agencies (such as NASA) from the early stages of the technology research program through to the regulatory outcome.

Technologies like the Global Positioning System are already beginning to have a profound effect on the aviation system. As these innovations are introduced to improve efficiency in the system, a new FAA paradigm emerges under the general term, "free flight." As the FAA builds more user flexibility into the system, the question becomes: What are the environmental impacts and improvements? The FAA must commit funds to expand upon the current suite of environmental analysis tools to address present and future obstacles to total-domain free flight.

While behavioral research (human or animal) is not the duty or responsibility of the FAA, the agency must devote some resources to translating research findings regarding aviation's overall environmental impact into Federal guidance and policy. NASA's Atmospheric Effects of Aviation Project will conclude in 2003. Future regulatory benefits of this research might include protections from negative effects of subsonic aircraft cruise operations upon the ozone layer. Similarly, the project's final report on sleep disturbance might possibly form the basis of valuable new aviation environmental policy and guidance.

As stated in the 1996 Strategic Plan, "The globalization of aerospace is another factor driving FAA to change." What potential effect does expanding international and multinational manufacturing centers have on harmonizing international aircraft noise and engine emissions certification procedures and recommended practices? The FAA must plan for research efforts to support continued maintenance of international harmonization and standardization of the aviation environmental certification standards and procedures.

The prospect of reduced resources has driven FAA to operate more productively and to identify mission-critical services. Historically, environmental research has accounted for only 2 percent of the R,E&D budget. Funding constraints and further reductions are expected to continue to put a premium on identifying the research projects critical to FAA's environmental mission. The FAA continues to assess how to devote diminishing resources toward projects which fulfill one of its prime responsibilities, the promulgation of new, improved, more effective aviation environmental standards.

A09a Environment and Energy

GOALS:

Intended Outcomes: The FAA intends to reduce the impact of aircraft noise by 80 percent (based upon population) by the year 2000 and prevent any increase thereafter through an optimal mix of new aircraft certification standards, operational procedures, compatible land use, and abatement technology; define and minimize the impact of aircraft emissions, through an optimal mix of new aircraft certification standards, operational procedures, and abatement technology; and mitigate the environmental consequences of aviation operations.

Agency Outputs: The findings of aviation environmental research have resulted in the publication of significant standards, rules and technical guidance including:

- Standards for the certification of new and modified designs for the reduction of engine noise and exhaust emissions.
- Technical reports, handbooks, advisory circulars, training courses, and procedures for use by manufacturers and modifiers.
- Computer models and impact criteria for use by civil aviation authorities in the environmental assessment of proposed actions.

Customer/Stakeholder Involvement: The FAA uses a unified regulatory research and development (R&D) approach, working closely with other federal agencies, industry, and foreign government to guide R&D efforts into the impact of aviation upon the environment. Lessons learned from this research identifies and shapes technologies, regulations, and certification criteria with real potential to improve our present and future global environment.

The Aviation Regulatory Advisory Committee (ARAC) is a formal standing committee, composed of representatives from aviation associations and industry. Established by the FAA, ARAC provides industry input in the form of recommendations, advise, and information to be considered in the full range of FAA rulemaking activities. ARAC's harmonization working groups have been tasked to ensure that the aircraft noise certification regulations which impact both domestic and foreign parties do not impose different standards in each country involved.

The FAA represents the United States on the International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) along with representatives of other civil aviation authorities and observers from aviation industry. The purpose of CAEP is to assess the adequacy of the international aviation environmental standards, especially in the areas of aircraft noise and engine exhaust emissions standards.

FAA and other interested Federal agencies established the Federal Interagency Committee on Aviation Noise (FICAN) to provide forums for debate over needs for future aviation noise research and to encourage new efforts in this area. FICAN conducts annual public forums in different geographic regions to solicit general input on aviation noise impacts with the intent to better align research with the public's concerns.

The Aviation Environmental Research Program directly supports the General Aviation Action Plan in demonstrating noise abatement technologies for light propeller-driven airplanes.

Accomplishments: Through this program, FAA has produced a simplified noise certification procedure for light helicopters and promulgated it together with the ICAO. The new procedure should save manufacturers and modifiers at least $24 million over 15 years. FAA has also produced a handbook on small airplane noise certification and published advisory circulars on the aircraft noise certification database. These publications improve the efficiencies of industry's measurements of engine exhaust emissions as well as FAA review and approval in this area. A training course is available for FAA engine certification personnel and applicants that will improve the efficiencies of both the manufacturers' engine exhaust emissions measurement tests and the FAA's review and approval. Agency-sponsored advances in computer models used for airport and heliport noise analysis have resulted in over 600 copies of the model being sold around the world. In the United States, these models have been used in over 150 airport studies involving more than $1 billion in airport noise compatibility grants. FAA has conducted three public forums on aviation noise research in Atlanta, San Diego, and Seattle; three FICAN annual reports; one report on Federal aviation noise research projects; and one report to

Congress on the effects of aircraft noise. Public participation has led to new federal research projects on commuter airplane noise impacts and the influence of ambient noise on community annoyance.

R&D Partnerships: FAA works closely with NASA and the U.S. industry on NASA's advanced subsonic technology (AST) and the high speed civil transport research programs, through a series of memorandums of understanding, to identify source abatement technologies. FAA also participates in the Aviation Effects on the Atmosphere Project with NASA, industry, and academia to assess the possible global impact of aircraft engine exhaust emissions. The Volpe National Transportation Systems Center continues to provide substantial technical assistance in the areas of aircraft noise measurement and assessment. FICAN is also a forum for partnership as all Federal agencies concerned with aviation noise are represented on the Committee. FICAN has led to expanded coordinated and cooperative research efforts among the individual agencies and resulted in more efficient use of federal funds.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Aircraft noise reduction and control.

- Harmonized FAA subsonic jet airplane noise certification regulations with those of the European Joint Aviation Authorities that govern the procedures used by airframe manufacturers.
- Published revised Advisory Circular 36-4D, "Noise Certification Handbook" that will provide technical guidance to FAA field personnel, airframe manufacturers, designated engineering representatives, and aircraft modifiers.

Engine emissions reduction and control.

- With NASA and U.S. industry, continued comprehensive scientific assessment of the atmospheric effects of aviation.

Aviation environmental analysis.

- In cooperation with ICAO CAEP and the Society of Automotive Engineers, initiated the validation of the methodologies and data bases used in airport noise modeling.

KEY FY 1999 PRODUCTS AND MILESTONES:

Aircraft noise reduction and control.

- Continue the three cooperative FAA/NASA noise reduction research programs to identify feasible technologies for U.S. manufacturers to develop quieter subsonic jet transport airplanes, helicopters and light propeller-driven airplanes, respectively.
- Initiate the development of new supersonic airplane noise certification standard and certification procedures.

Engine emissions reduction and control.

- Develop simplified engine exhaust emissions measurement procedure to reduce manufacturers' test costs.
- Complete the upgraded global aviation emissions forecasting model for the evaluation of the atmospherics effects of aviation.

Aviation environmental analysis.

- Merge FAA's airport and heliport noise models for seamless fixed wing and rotorcraft noise analysis in the terminal area.

FY 1999 PROGRAM REQUEST:

Several major NASA aeronautics research programs (most notably, the AST program) will come to an end in the first few years of the next decade. Several new source technologies will emerge from NASA's research. This will be the basis, in 10-15 years, for the next generation of U.S. industry aircraft. With the end of the AST program, FAA will close its companion research program on subsonic noise reduction and will use its research findings to identify new environmental certification standards and procedures for the next generation of transport aircraft. FAA will shift future environmental research in the field of new aircraft technology towards other research programs for rotorcraft and general aviation.

A09a - Environment and Energy Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
091-110 Aircraft Noise Reduction & Control						
Airplane and Rotorcraft Noise Reduction Technologies, Noise Certification Standards & Procedures						
Harmonized FAA Noise Certification Regulations with European Joint Aviation Authorities	♦					
Final Assessment of FAA/NASA Subsonic Jet Noise			◇			
Final Assessment of FAA/NASA Light Propeller-Driven Airplane Noise Reduction Technology Research				◇		
Published Advisory Circular 36-4d	♦					
Develop Simplified Noise Certification Procedures or Requirements for Helicopters		◇				
Develop New Basis for Certification Standards and Procedures for High Speed Civil Transports				◇		
Initiate Development of Supersonic Noise Certification Standards and Procedures		◇			◇	
091-111 Engine Emissions Reduction & Control						
Engine Exhaust Emissions Reduction Technologies, Standards & Procedures, and Impact Assessments						
Develop Simplified Engine Exhaust Emissions Certification Procedures		◇				
Harmonize FAA Engine Exhaust Emissions Certification Regulations with European Joint Aviation Authorities			◇			
Release Upgraded Global Aviation Emissions Forecasting (GAEF) Model to Scientific Assessment Teams			◇			
091-113 Aviation Environmental Analysis						
Develop Noise & Air Quality Assessment Methodologies						
Initiated the Validation of the Methodologies and Databases Used in Airport Noise Modeling	♦					
Initiate Noise Modeling Validation		◇				◇
Merge FAA's Airport and Heliport Noise Models for Seamless Fixed Wing and Rotorcraft Noise Analysis in the Terminal Area				◇		

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	5,200	3,800	3,600	2,891	2,739
Personnel Costs	0	0	0	0	607
Other Costs	0	0	0	0	45
Total	**5,200**	**3,800**	**3,600**	**2,891**	**3,391**

2.7 R,E&D Program Management Program Area Description

Mission

The mission of the R,E&D Program Management program area is to provide for the effective and responsible stewardship of the funds entrusted by the users of the NAS to the FAA for research and development (R&D). The agency strives to gain the maximum benefit for the dollars invested in programs whose outputs and outcomes are important to a broad range of stakeholders.

Intended Outcomes

The R,E&D Program Management program area supports FAA strategic goals and objectives in global leadership, business practices, and communications. Specifically, work in this area is directed toward:

- Better serving the interests of the flying public through increased knowledge of the R,E&D Program by customers and stakeholders.
- Better serving the interests of the flying public by increased participation of customers and stakeholders in the formulation of the R,E&D Program.
- Better management of resources through more efficient and effective processes for developing and managing the R,E&D investment portfolio.
- U.S. leadership through international cooperation and harmonization in the development and implementation of Communication, Navigation and Surveillance (CNS)/Air Traffic Management (ATM) and other technologies that improve safety and efficiency.
- Achieving higher value and higher quality research projects for industry and the public though increased use of partnerships which enable access to the best academic and industrial R&D talent.

Program Area Outputs

Products of the R,E&D Program Management Program area include:

- The Federal Aviation Administration *Plan for Research, Engineering & Development.*
- R,E&D Advisory Committee reports.
- R,E&D budget.
- International conceptual and implementation planning to provide for worldwide harmonization and interoperability.
- Bilateral/multilateral agreements with foreign civil aviation authorities for cooperative research programs in aviation systems development.
- Cooperative research agreements with academia, other government agencies, and industry.

Program Area Structure

The R,E&D Management Program is structured to blend functional concerns with organizational responsibilities as follows:

- R,E&D Strategic Management
- R,E&D Cost, Benefit, and Risk Analysis
- R,E&D Financial Management
- R,E&D Advisory Committee
- International Cooperative Research and Development programs
- NASA Field Offices
- R,E&D Partnerships

Effective stewardship of the R,E&D program requires that NAS users receive the best possible program for their investment. Participants, whether FAA-internal, or from the broader community, must work together to ensure that the correct research is performed, necessary provisions are made in the budget and planning processes, and the highest standards of financial accountability are rigorously maintained. Additionally, the program must fund no research which duplicates work being performed elsewhere, particularly with NASA funding.

All but R,E&D Partnerships, the final item in the above list, are reflected in program narrative A01a, "System Planning and Resource Management." Program narrative A01b, "Technical Laboratory Facility," deals with concerns related to partnerships and cooperative research efforts.

Customer/Stakeholder Involvement

The FAA solicits guidance on its R&D programs through its R,E&D Advisory Committee (REDAC). The committee draws its membership from organizations that are customers or stakeholders of FAA products and services. Associations, individual users, corporations, other government agencies, universities and research laboratories are all represented. This group periodically reviews research commitments assists the agency in planning for its future.

Accomplishments

Recent accomplishments of the overall Program Management program area include:

- Published the 1997 FAA Plan for R,E&D - January 1997.
- Prepared the FY 1998 R,E&D budget - January 1997.
- Negotiated a bilateral agreement to install Wide Area Augmentation System reference stations in Mexico to augment existing U.S. WAAS network - August 1996.
- Established the CNS/ATM Implementation Plan to allow Canada, Mexico, and the U.S. to make realistic, coordinated use of new navigation technologies such as the Global Position System (GPS) - May 1996.
- Achieved International Civil Aviation Organization, Caribbean and South American Region, approval of the CNS/ATM Regional Implementation Plan - October 1995.
- Established ten GPS routes in the Eastern Caribbean (with Air Traffic and American Eagle) to provide an estimated cost savings of $160K per year, per route - ongoing.
- Achieved the signing of a Presidential decision directive to ensure GPS availability for civil aviation use - March 1996.
- Successfully completed FANS1 demonstration flights with United Airlines and Qantas Airlines - August 1995.
- Established R&D partnerships - ongoing.
- Technology transfer:
  - Negotiated and awarded Cooperative Research and Development Agreements.
  - Negotiated Patent Licenses.
  - Provided technical assistance to state, local and federal government departments.
- Small business innovation research:
  - Designed compressed video telecommunications network for ATM radar (installed by Delta Systems).
  - Sponsored compact neutron source development for explosives detection (produced by Accsys Technology).
- Cooperative research and development agreements:
  - Negotiated cooperative research agreement with U.S. Air Force Wright Laboratory to conduct joint research in advanced flight control systems and the improved reliability of aircraft engines - October 1996.
  - Negotiated cooperative research agreement with U.S Air Force Rome Laboratory to conduct joint research in advanced air-to-ground communications and communication architecture - August 1996
- University Research Program Group:
  - Developed a dripless bubbler, with Iowa State University, to provide immersion ultrasonic quality inspections for commercial aircraft.
  - Developed a high-speed tomography explosive detection system, with Imatron, to provide a higher throughput at a significantly lower cost than present systems.
  - Negotiated a savings to the Government of $6,000,000 in cost share through the award of grants and cooperative agreements - FY 1996.
- Joint University Program:
  - Presented 14 RTCA Jackson Awards for excellence in aviation electronics.
  - Presented two AIAA Major Field Awards (Aviation Meteorology), and one IEEE Major Field Award (Control Systems).

Recent REDAC accomplishments include:

- Published reports on the following:
  - Aviation Weather - October 1995.
  - Aircraft Safety Research - February 1996.
  - Aviation Security Research and Development - September 1996.
  - Human Factors program status and organization information - August 1996.
- Provided input to the FY 1999 Investment Portfolio - September 1996.
- Reviewed the proposed FY 1999 Target Area Team portfolios - February 1997.

R&D Partnerships

R,E&D Program Management partnerships in research and development include:

- Partnership with Federal Quality Consulting Group for process reengineering.
- REDAC partnerships for guidance on the R,E&D Program.
- 125 research and development agreements with 19 countries and one air traffic organization representing 17 member states.
- EUROCONTROL partnership for cooperative air traffic management research and development programs.

Long-Range View

Since the work is centered upon strategic management of the R&D program, the function will continue as long as the FAA performs research and development. Expected resource requirements in the outyears will remain at about 3-5 percent of the R,E&D budget.

A01a System Planning and Resource Management

GOALS:

Intended Outcomes: The FAA intends that its R,E&D programs more effectively meet customer needs, increase program efficiency, and reduce management and operating costs. The FAA also intends to facilitate increased use of U.S. standards and technology to meet worldwide aviation needs, thereby increasing customer and stakeholder involvement in its programs.

Agency Outputs: The agency prepares the annual R,E&D budget submission to Congress and publishes the *FAA Plan for Research, Engineering and Development.* The Agency hosts three R,E&D Advisory Committee (REDAC) meetings per year as well as a number of subcommittee meetings. The advisory committee produces reports providing advice and recommendations on the R,E&D program.

Customer/Stakeholder Involvement: The FAA presents annual program reviews to the Office of Management and Budget (OMB). REDAC reviews the agency's investment portfolio annually, and provides guidance for future R,E&D investments. REDAC members represent customer and stakeholder groups as well as subject matter experts from various associations, user groups, corporations, government agencies, and universities and research centers. The maximum REDAC membership is 30.

A prominent industrial spokesgroup, RTCA, offers the aviation community consensus-based recommendations on the NAS Architecture and attendant issues. It proposes consensus-based solutions to communications, navigation, and surveillance systems and air traffic management, e.g., global positioning system (GPS) implementation, data link, automatic dependent surveillance-broadcast (ADS-B), and decision support systems. The RTCA recommendations are important inputs to FAA policy and investment decisions. These recommendations serve as a basis for certification, and are referenced in FAA technical standard orders (TSO).

Accomplishments: The agency has consistently provided annual R,E&D program status information through the *FAA Plan for Research, Engineering and Development.* It has prepared and submitted the R,E&D budget requests to OMB and to Congress. REDAC has provided the FAA with an independent strategic view on the agency's investment portfolio. Recent Committee reports have reviewed the Aircraft Safety research program (February 1996), the Human Factors program (August 1996), the Aviation Security program (September 1996), the Air Traffic Services program area (March 1997), and the FAA's planned FY 1999 R,E&D investments (April 1997).

The RTCA has provided the agency the aviation community consensus needed to implement free flight and modernize the NAS. The RTCA Government/Industry Free Flight Steering Committee, through the efforts of its Select Committee, has provided recommendations to the Administrator to advance progress of the Free Flight Task Force Report and Action Plan. It has also provided operational concept and program plan input to the Flight 2000 initiative.

R&D Partnerships: The FAA's R&D partnerships are described in each budget line item.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

R,E&D plans and programs.

- Published the *FAA Plan for Research, Engineering and Development.*
- Prepared the annual budget submission to OMB.

REDAC.

- Completed Aircraft Safety Report.
- Completed Aviation Security Report.
- Completed Human Factors Report.
- Completed General Aviation and Vertical Flight Report.
- Completed Runway Incursion Report.
- Committee provided recommendations on FAA's planned R,E&D investments for FY 2000.

RTCA.

- Completed minimum aviation system performance standards (MASPS) for GPS Category I/II/III.
- Completed MASPS for airport surface surveillance.

- Completed minimum operational performance standards (MOPS) for very high frequency (VHF) digital radio.
- Prepared guidance on preparation and distribution of user-selectable navigation data bases.
- Completed MASPS/MOPS for Automatic Dependent Surveillance-B (ADS-B).
- Completed MASPS/MOPS for high frequency data link.
- Provided government/industry Free Flight Steering Committee involvement and recommendations for continued progress toward free flight.
- Provided government/industry Free Flight Steering Committee involvement and input to the Flight 2000 program initiatives.

KEY FY 1999 PRODUCTS AND MILESTONES:

R,E&D plans and programs.

- Publish the *FAA Plan for Research, Engineering and Development.*
- Prepare the annual budget submission to OMB.

R,E&D advisory committee.

- Prepare Air traffic Services Report.
- Prepare Airport Technology Report.
- Prepare Environment and Energy Report.
- Prepare recommendations on planned R,E&D investments for FY 2001.
- Prepare other reports as requested by the administrator.

RTCA.

- Complete MOPS/MASPS and/or changes to existing recommended standards for digital communications GPS, both wide- and narrow-area augmentation systems, ADS-B, decision support systems, and related activities.
- Update Free Flight Action Plan.
- Provide input to flight 2000 program activities.

FY 1999 PROGRAM REQUEST:

The FAA's R,E&D program strategic management encompasses four distinct steps to plan the program, and four steps to execute the plan. These steps are distinctly different from project level tactical planning and execution. They do not replace nor duplicate those efforts. These steps provide a structured program portfolio that unifies customer needs with limited available resources.

Step one - in the planning phase, identify specific FAA outputs to achieve desired outcomes. Include customer and REDAC participation to more accurately identify the research needed to meet product and service requirements.

Step two - group product and service requirements into six major service areas. Teams assigned to each of these areas study the requirements and devise an overall, integrated approach to satisfy the. The service areas provide a mechanism that groups similar requirements so that those related to a specific area, such as air traffic services, are considered as a group.

Step three - develop a set of research projects to support the strategy and provides the R&D products required to satisfy the mission of each service area. This step requires REDAC to provide input on the quality and potential of proposed research projects to achieve desired outcomes.

Step four - establish a cross-functional management team to review the work of the individual service area teams and to balance the work across the areas. This step ensures the most important work is accomplished with the available resources and REDAC participation in the decisionmaking process. This final step produces The R,E&D Investment Portfolio, the basis for the FAA's R,E&D budget submission to Congress.

The execution phase provides core, essential services across all the service areas. It provides:

- Financial management of the R,E&D program.
- Financial support for REDAC.
- Negotiation and execution of bilateral and multilateral agreements with international civil aviation authorities. These agreements establish cooperative R,E&D programs, system standards, and air traffic system procedures.
- Establishment of cooperative research and development agreements and technology transfer programs with industry and other government agencies. This ensures that the FAA establishes mechanisms to provide for the fair exchange of research talent and research results with entities outside the agency.

A01a – System Planning and Resource Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
011-130 R,E&D Plans and Programs						
R,E&D Plans and Programs						
Publish Annual *Plan for R&D*	♦	◇	◇	◇	◇	◇
Prepare Annual Budget Submissions to OST, OMB, and Congress	♦	◇	◇	◇	◇	◇
R,E&D Advisory Committee Reports						
Recommendations on FAA, RE&D Investments	♦	◇	◇	◇	◇	◇
Standing Subcommittee on Air Traffic Services		◇		◇		◇
Standing Subcommittee on Airport Technology		◇		◇		◇
Standing Subcommittee on Aircraft Safety	♦		◇		◇	
Standing Subcommittee on Aviation Security	♦		◇		◇	
Standing Subcommittee on Human Factors	♦		◇			◇
Standing Subcommittee on Environment and Energy		◇		◇		◇
Ad hoc Subcommittee on GA & Vertical Flight	♦					
Ad hoc Subcommittee on Runway Incursion	♦					
RTCA						
MOPS/MASPS and/or Changes to Existing Recommended Standards for GPS WAAS and LAAS CAT I/II/III	♦	◇		◇	◇	
Completed MOPS for High Frequency Data Link	♦					
MOPS/MASPS and/or Changes to Existing Recommended Standards for Decision Support Systems		◇		◇		◇
MOPS/MASPS and/or Changes to Existing Recommended Standards for New VHF Radios	♦	◇	◇			
MOPS/MASPS and/or Changes to Existing Recommended Standards for ADS-B	♦	◇		◇		
Update of Free Flight Action Plan Progress	♦	◇	◇	◇	◇	◇
Input to Flight 2000 Program Activities	♦	◇	◇			

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	1,247	0	200	1,164	1,369
Personnel Costs	1,972	1,660	1,378	0	685
Other Costs	404	340	282	0	94
Total	**3,623**	**2,000**	**1,860**	**1,164**	**2,148**

A01b Technical Laboratory Facility

GOALS:

Intended Outcomes: The FAA test beds located at the William J. Hughes Technical Center (WJHTC) support R,E&D program goals to: reduce the number of accidents and accident risk; increase airport capacity; reduce delays due to weather and system outages; reduce unnecessary flight restrictions; and reduce user costs.

The WJHTC maintains and operates agency test bed laboratories utilized by R,E&D programs in achieving the above goals. These centralized test beds consist of non-operational NAS systems, aircraft, simulation facilities, communication systems, and a Human Factors Laboratory.

Agency Outputs: FAA programs develop the technical characteristics for new systems and procedures. R,E&D programs require test beds to emulate and evaluate various field condition requirements. Human Factors projects require laboratories to perform human-in-the-loop simulations, measure human performance, and evaluate human factors issues. Airborne and navigation projects require "flying laboratories" that are specially instrumented and reconfigurable to support different projects. Developmental programs require simulation systems to recreate realistic scenarios.

Customer/Stakeholder Involvement: The test beds directly support agency projects and integrated product teams in the following areas:

- Capacity and air traffic management technology
- Communications, navigation, and surveillance
- Weather
- Airport technology
- Aircraft safety technology
- System security technology
- Human factors
- Environment and energy
- Traffic alert and collision avoidance system (TCAS)
- Flight 2000
- Global positioning system (GPS)
- Terminal instrumentation procedures (TERPS)
- Wide area augmentation system (WAAS)

Accomplishments: The technical laboratory facilities provide the test bed infrastructure to support R,E&D program goals and outputs.

R&D Partnerships: In addition to the R,E&D programs listed, WJHTC laboratories cooperate with the Canadian Ministry of Transport, NASA, U.S. Air Force, Aircraft Owners and Pilots Association, Experimental Aircraft Association, International Civil Aviation Association, and academia.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

The following programs have been supported by the laboratories:

- GPS
- WAAS
- TERPS
- Satellite communication
- Data link
- TCAS
- Vertical separation
- Automated Radio Terminal System IIIE
- Runway friction
- Aircraft deicing
- Aircraft security

KEY FY 1999 PRODUCTS AND MILESTONES:

- The test beds at the WJHTC provide the necessary infrastructure for R,E&D programs to achieve their goals. Specific milestones and products are contained within individual programs.

FY 1999 PROGRAM REQUEST:

Maintain and operate technical laboratories/facilities that support the R,E&D programs previously listed. The costs of these test beds/laboratories are prorated across the Facilities and Equipment, Operations, and R,E&D appropriations based on utilization.

A01b – Technical Laboratory Facility Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
011-140 Technical Laboratory Facility						
Systems Support Laboratory (En Route, Terminal, Automated Flight Station, Communications, and Scan Radars)						
Aviation System Capacity Planning	♦	◇	◇	◇	◇	◇
National Simulation Capability	♦	◇	◇	◇	◇	◇
Flight 2000		◇		◇	◇	◇
Research & Development Laboratory (Target Generator Facility, Cockpit Simulator, Auto Tracking, Tech Center Data)						
Aviation System Capacity	♦	◇	◇	◇	◇	◇
National Simulation Capability	♦	◇	◇	◇	◇	◇
GPS and Separation Standards	♦	◇	◇	◇	◇	◇
Flight 2000		◇		◇	◇	◇
WAAS	♦	◇	◇	◇	◇	◇
TERPS	♦	◇	◇	◇	◇	◇
Data Link	♦	◇	◇	◇	◇	◇
TCAS	♦	◇	◇	◇	◇	◇
General Support Laboratory (Aircraft)						
Satellite Communications and Navigation Programs	♦	◇	◇	◇	◇	◇
GPS and Separation Standards	♦	◇	◇	◇	◇	◇
Flight 2000		◇	◇	◇	◇	◇
WAAS	♦	◇	◇	◇	◇	◇
TERPS	♦	◇	◇	◇	◇	◇
Data Link	♦	◇	◇	◇	◇	◇
TCAS	♦	◇	◇	◇	◇	◇
Runway Friction	♦	◇	◇	◇	◇	◇
Aircraft Deicing	♦	◇	◇	◇	◇	◇
Aircraft Security	♦	◇	◇	◇	◇	◇
Airport Safety Technology	♦	◇	◇	◇	◇	◇
Human Factors Laboratory						
Air Traffic Control Human Factors	♦	◇	◇	◇	◇	◇
Flight 2000		◇	◇	◇	◇	◇
Data Link	♦	◇	◇	◇	◇	◇

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	5,800	4,202	3,435	3,341	3,268
Personnel Costs	0	3,152	2,627	3,905	6,462
Other Costs	0	646	538	800	0
Total	**5,800**	**8,000**	**6,600**	**8,046**	**9,730**

A01c Center for Advanced Aviation System Development (CAASD)

GOALS:

Intended Outcomes: The FAA intends to apply Center for Advanced Aviation System Development (CAASD) resources to air traffic service research to produce a safer, more efficient global air transportation system. CAASD is an essential component of the FAA's research program since it augments the agency's in-house resources in conducting research for the Air Traffic Services line of business.

Agency Outputs: The CAASD research program provides detailed reports, briefings, and concept demonstration systems used in the evaluation of new air traffic management (ATM) and control operating concepts and/or infrastructure replacements. These products are the beginning critical elements in the development of a more efficient, more available, and safer next-generation ATM and control system.

CAASD provides the necessary detailed, new technology research for applications for global air traffic management, including new developments in traffic flow management, navigation, separation assurance, surveillance technology, and system safety.

Customer/Stakeholder Involvement: The FAA is challenged to increase safety in the nation's civil aviation system while increasing capacity and efficiency. Outcomes within CAASD's work program span both FAA and system stakeholder issues and needs. Collaborative traffic flow management and NAS operational concepts are included among these important issues and needs.

The CAASD R,E&D effort supports the RTCA Free Flight Steering Committee. This committee provides the principal collaborative forum among industry, aircraft operators, and FAA representatives in developing plans and requirements for the NAS to evolve to free flight. It defines operational needs leading to free flight and identifies the required NAS Architecture that satisfies those needs affordably.

Additionally, the CAASD R,E&D effort supports International Civil Aviation Organization (ICAO) in its efforts to develop world-wide navigation capabilities: (1) wide area augmentation system; (2) local area augmentation system; and (3) world-wide, air-ground communication capability of very high frequency air-ground digital radio. ICAO is the principal venue for international standards development and validation.

Accomplishments:

- Assisted in defining a longer term evolution of decision support capabilities to move the ATM system closer to free flight objectives.
- Supported surveillance server prototyping, development, and implementation; and refined the architecture, transition plan, and decommissioning strategies based on test results.
- Investigated procedures, user needs, system requirements, and architecture implications for enhanced information systems.
- Assisted in developing an investment strategy to ensure high-level design decisions are based on an integrated evolutionary operational concept.
- Continued to provide the FAA with a strategic understanding of technology's role in developing the future ATM system.

R&D Partnerships: In accomplishing outcomes in the CAASD work program, extensive partnerships have been forged with industry suppliers, aircraft operators, operational FAA facilities, and other non-profit research institutions. For example, CAASD maintains a cooperative research relationship with ATN Systems, Inc. in order to refine and validate the technical characteristics of an aeronautical telecommunications network (ATN) router in a timely, cost effective manner.

CAASD maintains a cooperative research relationship with the Florida Institute of Technology to develop and validate the technical characteristics of flight information services broadcasts in a timely, cost-effective manner. Cooperating researchers have developed an air-ground prototype to disseminate weather information to NAS users in flight.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

- Developed a greater understanding of free flight concepts to potentially adapt technology and processes for system operations, thus providing flexibility and more efficient services.

- Continued investigating procedures, user needs, system requirements, and architecture implications for enhanced information systems.
- Made fullest use of global positioning system (GPS) and advanced avionics technology to reduce operating costs to NAS users.

KEY FY 1999 PRODUCTS AND MILESTONES:

- CAASD researches new ATM and control operating concepts evaluation and/or infrastructure replacements.
- CAASD continues to develop a greater understanding of free flight concepts and operating procedures needed to fully implement associated programs.
- CAASD continues to refine the architecture and transition plan, as well as strategies for planned FAA and user investment decisionmaking tools.

FY 1999 PROGRAM REQUEST:

Funding is requested for the following items:

- Develop free flight enhancements.
- Investigate the expanded use of GPS and advanced navigation systems.
- Integrate decision support system requirements with FAA and industry technology applications.

A01c - Center for Advanced Aviation System Development (CAASD) Product and Activities	Program Schedule					
	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
011-160 Center for Advanced Aviation System Development (CAASD)						
Navigation and Surveillance						
Developed Navigation Architecture for Timely and Cost Effective Transition to Satellite-Based Navigation Systems	♦					
Assessed Future Surveillance Alternatives Using Automatic ADS-B Capabilities	♦					
Researched Low Cost Avionics Benefiting Free Flight Paradigm	♦					
Define Relationships Among Safety, Separation Standards, & Operational Capability to Enhance Safety Management	♦	◇	◇	◇	◇	◇
Investigate the Expanded Use of GPS and Advanced Navigation Systems		◇				
Traffic Flow Management (TFM)						
Identified Enhancements to Current TFM System	♦					
Developed System Architecture for Implementation of Data Link Infrastructure	♦					
Develop/Integrate FAA Decision Support Systems (DSS) with FAA and Industry	♦	◇	◇	◇		
Develop Alternative Methods for Using GPS Technology Inclusion of Free Flight Concepts in Domestic Airspace	♦	◇	◇	◇	◇	◇
Incorporated GPS Technology into Ongoing Work in Area of Low Cost Avionics to Make Full Use of Traffic Alert and Collision Avoidance System (TCAS)	♦					
Continued Investigating Procedures, User Needs, System Requirements, and Architecture Implications for Enhanced Information Systems	♦					
Developed a Greater Understanding of Free Flight Concepts to Potentially Alter Technology and Processes for System Operations	♦					
Research New Air Traffic Management and Control Operating Concepts Evaluation and/or Infrastructure Replacements		◇				
Develop Free Flight Enhancements		◇				
Integrate DSS Requirements with FAA and Industry Technology Applications		◇	◇			

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	0	0	5,200	5,444	4,890
Personnel Costs	0	0	0	0	0
Other Costs	0	0	0	0	0
Total	**0**	**0**	**5,200**	**5,444**	**4,890**

A10a Innovative/Cooperative Research

GOALS:

Intended Outcomes: Through initiatives of its Innovative/Cooperative Research program, the FAA intends to channel the results of its R,E&D projects to contribute directly and cost-effectively to maintaining and improving our safe, reliable national air transportation system. To achieve these ends, the program will continue to partner with and help to improve the quality of results achieved by, other domestic and international, government and private, research organizations. Program-sponsored research will set the highest standards of effectiveness and economy, whether performed in-house or under contracts. The agency also intends to increase access to the current aviation research results by all interested parties through maintenance and improvement of its centers of excellence (COE) network.

Agency Outputs: Research products of the Innovative/Cooperative Research program generally are produced in conjunction either with industrial or academic institutions.

Industry Research Program Group

Technology transfer.

- Cooperative research and development agreements provide inexpensive way for new/innovative FAA R,E&D projects to get started.
- Government/industry conferences ("Industry Day") bring together the best academic and industry talent for cost effective research and development (R&D) partnerships.

Small business innovation research.

- Small business innovation research addresses congressional directive for FAA to maintain support for small business under acquisition reform legislation.

Independent research and development.

- Technical interchange meetings enable FAA to influence the direction of industry R&D for its own needs.

University Research Programs Group

Aviation research grants program.

- Grants and cooperative agreements with colleges, universities, non-profit institutions, or for-profits in the case of aviation security, leverage the agency's R&D investment.

Centers of excellence.

- The FAA leverages matching funds and supports long-term research by establishing research centers covering a broad scope of technical disciplines (operations research, aging aircraft structures, and airport pavement).

Joint university program.

- Quarterly technical review meetings at universities, FAA, and NASA provide customer/stakeholder review and input to FAA's research initiatives.

FAA fellowship program.

- FAA Fellows perform research on critical FAA needs at FAA, with university cost sharing, reducing FAA's R&D costs.

Customer/Stakeholder Involvement: Customer/stakeholder feedback is solicited via continuing interface with the FAA R,E&D Advisory Committee. The Committee has recently formed a subcommittee to advise the FAA on cooperative research ventures such as those supported by the R&D partnership program.

Accomplishments: Program accomplishments are generally achieved in conjunction either with industrial or academic institutions.

Industry Research Programs Group

Technology transfer.

- Cooperative research and development agreement (CRDA) with Boeing Corporation to jointly fund and operate a national airport pavement test machine.

Small business innovation research

- Design and installation, by Delta Systems, of an FAA compressed video telecommunications

network for air traffic management (ATM) RADARS.

- Commercial production of a compact neutron source, by Accsys Technology, developed for explosives detection.

University Research Program Group.

Aviation research grants program.

- Award of the first cooperative agreement to the Experimental Aircraft Association for joint research into state-of-the-art general aviation technologies.
- Development of a high-speed tomography explosive detection system with L3Communications (Lockheed), which will detect explosives based on chemical composition, shape, and other physical characteristics.
- Development of a high-speed tomography explosive detection system with Imatron, which will provide a higher throughput at a significantly lower cost than present systems.
- Publication of a brochure describing the grants program.
- Collaboration with Federal Railway and Transit Administrations in obtaining a $155,000 grant to test receipt of grant applications and payment of invoices over the world-wide-web.

Joint university program.

- First recipient of the FAA Excellence in Aviation Award (1997).
- 15 RTCA Jackson Awards for excellence in aviation electronics.
- Two major industrial field awards in aviation meteorology, one major industrial field award in control systems.
- Memo of agreement with NASA Ames for jointly funded research in a portfolio of civil aeronautics technologies.

FAA fellowship program.

- Partnership with Drexel University to advise PhD candidates working at the Technical Center on aging aircraft structural modeling

R&D Partnerships: The collective vision of this chapter is to provide safe and secure air transportation through partnerships which maximize the FAA R,E&D program investment. In effect, the programs of this chapter function as a clearinghouse for the major share of all partnerships occurring in the FAA R,E&D community.

MAJOR ACTIVITIES AND ANTICIPATED FY 1998 ACCOMPLISHMENTS:

Technology transfer/cooperative activities:.

- Issued new CRDAs and report results of completed CRDA projects.
- Obtained commercialization of results, products, and processes through CRDAs.
- Conducted joint seminars on FAA technology needs/requirements with program offices and other aviation related technical groups.
- Presented technology transfer awards.
- Provided FAA scientist, engineers, attorneys, and management with intellectual property and CRDA training.
- Negotiated licensing agreements.
- Negotiated FAA/NASA partnership for joint research in Air Traffic Management Technologies.
- Evaluated completed CRDAs and compiled report on successful partnerships.
- Proactively marketed FAA at technical meetings, conferences, and expositions, for licensing and partnership opportunities.
- Participated in interagency independent R&D program and information meetings to meet technology requirements in the FAA.
- Developed policy and procedures for donation of excess FAA computers to enterprise zone schools.

Small business innovation research.

- Solicited small business innovation research program (SBIR) proposals in response to identified FAA research needs.
- Issued annual solicitation for the SBIR.
- Awarded phase I SBIR contracts. Phase II and phase III contracts will be awarded leading to

industrialization and commercialization of research results obtained under phase I.

Aviation research grants program.

- Issued a national solicitation for research grant proposals.
- Published project reports of aviation research grants program.
- Continued to award aviation research grants/ cooperative agreements.

Centers of Excellence.

- Established a new COE worthiness assurance.
- Jointly conducted research at the COE in Operations Research at the University of California (Berkeley), the Massachusetts Institute of Technology, the University of Maryland, and Virginia Polytechnic Institute.
- Jointly conducted research at the COE in the computational modeling of aircraft structures at Rutgers University and Georgia Institute of Technology.
- Conducted an annual review for each COE and an audit of COE matching funds at the University of Illinois.

Joint university program.

- Held quarterly reviews and published annual report.
- Transitioned FAA/NASA joint university program to FAA/NASA Ames program sponsorship.
- Initiated long term research projects to compliment FAA R,E&D.

FAA fellowship program.

- Selected FAA Fellows, advisors, and awarded fellowships.
- Published reports on university fellowship topics of interest to the FAA.
- Held annual technical symposium.

KEY FY 1999 PRODUCTS AND MILESTONES:

University Research Programs

Aviation research grants program.

- Award grants and cooperative agreements (continuously); issue solicitation (2nd quarter annually).

Centers of Excellence.

- Start new center (bi-annually); hold annual review (one per center/year); conduct major symposium (one per program/year).

FAA fellowship program.

- Award fellowships (annually, 4th quarter); hold technical symposium (semi-annually).

Joint university program.

- Hold Quarterly Reviews (1998-2003).

Industry Research Programs

Technology transfer.

- Award CRDAs; produce technology assessments; make technology transfer awards; develop patents/licensing continuously.

Independent research and development.

- Participate in interagency IR&D program and meetings (1998-2003).

Small business innovation research.

- FAA-wide research topic survey; national SBIR solicitation; award SBIR contracts.

FY 1999 PROGRAM REQUEST:

Industry and University Research Programs Group

In FY 1999, the R&D partnerships program brings to fruition those intended outcomes enumerated above. Independent research and development receives increased emphasis. This will enable industrial R&D to influence and direct FAA research needs without expending R&D contract funds. Concurrently, cost sharing, cost matching, and leveraging of R,E&D funds will be increased under the aviation research grants and centers of excellence programs. Emphasis is placed on accelerating the search for higher return on investment cooperative research and development agreements. By promoting more widespread use of

these R&D partnership vehicles, the FAA increases the speed and efficiency of accomplishing R,E&D projects. This reduces the FAA's funding contribution and improves research results. Critical R,E&D projects and programs receiving reduced funding are able to achieve their R&D goals, while contributing directly to the goals of the FAA Strategic Plan.

A10a - R&D Partnerships Product and Activities	Program Schedule FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
101-210 Research & Development (R&D) Partnerships						
Industry Research Programs						
Technology Transfer/Award CRDAs						
Produce Technology Assessments	♦	◇	◇	◇	◇	◇
Make Technology Transfer Awards	♦	◇	◇	◇	◇	◇
Develop Patents/Licensing						
Small Business Innovation Research						
Perform FAA Wide Research Topic Survey	♦	♦	♦	♦	♦	♦
Issue National SBIR Solicitation	◇	◇	◇	◇	◇	◇
Award SBIR Contracts	◇	◇	◇	◇	◇	◇
University Research Programs						
Aviation Research Grants						
Award Grants and Cooperative Agreements						
Issue Solicitation	♦	◇	◇	◇	◇	◇
University Fellowship Program						
Award Fellowships	♦	◇	◇	◇	◇	◇
Hold Technical Symposium	♦	◇	◇	◇	◇	◇
Joint University Program						
Hold Quarterly Reviews	♦	◇	◇	◇	◇	◇
Centers of Excellence						
Establish New Center	♦		◇		◇	
Hold Annual Reviews	♦	◇	◇	◇	◇	◇
Conduct Major Symposium	♦	◇	◇	◇	◇	◇
101-220 NASA Field Offices						
Conduct Annual Reviews in Support of R,E&D Efforts Between FAA & NASA for Multiple Programs						
Provide Continuous Technical Liaison Support Between FAA & NASA Centers Cooperative R,E&D Programs						
Administer FAA's Portfolio of More Than 60 Memoranda of Agreement with NASA R,E&D Program Offices						

Budget Authority ($ in Thousands)	FY 1995 Enacted	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Request
Contracts	2,428	0	0	258	348
Personnel Costs	1,969	1,245	1,660	1,446	1,726
Other Costs	403	255	340	296	256
Total	4,800	1,500	2,000	2,000	2,330

Appendix A

Research, Engineering and Development (R,E&D) Advisory Committee

The FAA values the ongoing involvement of the R,E&D Advisory Committee in reviewing its current and planned R,E&D programs. A formal process has been established whereby the agency replies to the Committee's topical reports. This document summarizes recent Committee recommendations and FAA responses.

The Committee submitted six reports in 1996 and three in 1997. The FAA responded to two of the six 1996 reports within the same year and published these responses in the January 1997 *FAA Plan for R,E&D*. In the current plan, the agency is updating one of those responses as a follow up to the previously-circulated *Recommendations on FAA's Planned R,E&D Investments for FY 1998* (dating from the June 5-6, 1996, R,E&D Advisory Committee Meeting). The current plan also contains FAA's responses to the remaining four reports from 1996. These include: the *Final Report of the Aviation Weather Subcommittee;* the *Report of the Challenge 2000 Subcommittee;* the *Report of the Status and Organization of Human Factors within the FAA;* and the *Aviation Security Research and Development Report.*

Of the three reports submitted by the Committee in 1997, FAA responded to two within that year --the *Subcommittee Report of the NAS R&D Panel* and the Committee's *Recommendations on FAA's Planned R,E&D Investments for FY 1999.* FAA's responses for these reports are summarized below. The third report submitted in 1997, is the *Fight 2000 Evaluation,* dated June 3-4, 1997. This document was generated by the Subcommittee on Air Traffic Services (ATS) and approved by the Committee on September 9, 1997. FAA will continue to work with the Committee to respond to this report during 1998.

In total, this plan summarizes FAA responses to seven Committee reports:

- *Recommendations on FAA's Planned R,E&D Investments for FY 1998 (follow-up response)*
- *Final Report of the Aviation Weather Subcommittee*
- *Report of the Challenge 2000 Subcommittee*
- *Report of the Status and organization of Human Factors within the FAA*
- *Aviation Security Research and Development Report*
- *Subcommittee Report of the NAS ATM R&D Panel*
- *Recommendations on FAA's Planned R,E&D Investments for FY 1999*

The FAA expects specific 1998 products from the Committee, including subcommittee reports treating subjects such as runway incursions, General Aviation, and the Flight 2000 Program. Committee recommendations are scheduled regarding FY 2000 R,E&D investments. The agency appreciates the opportunity to obtain input and feedback from its customers and stakeholders on the Committee.

Follow-Up Response to the Committee's *Recommendations on FAA's Planned R,E&D Investments for FY 1998* (dating from the June 5-6, 1996, Committee Meeting)

The role of the Committee is to provide sustained, comprehensive involvement of customers, stakeholders, and subject-matter experts in R,E&D program reviews and investment decisions. In June 1996, FAA presented its planned investments to the Committee for review. The 1997 FAA *Plan for Research, Engineering and Development* provided the majority of Committee recommendations and FAA responses. The selected items which follow are drawn from the FAA's complete response to the Committee.

Recommendation: Do not fund the proposed project for back-up power systems with R,E&D funding.

Response: FAA will take this recommendation into consideration when formulating the FY 1999-2003 R,E&D investment portfolio. FAA needs to develop a viable research and development (R&D) activity for maintenance system development and looks to the ATS Subcommittee to provide recommendations in this area.

Recommendation: Provide a higher priority for weather research.

Response: In the FY 1997 R,E&D budget, FAA proposed a $5,446K Weather Research Program. Congress increased the FY 1997 program funding to

$11,047K. In the FY 1999-2003 R,E&D investment portfolio, FAA needs to decide the appropriate level of funding for weather research and looks to the ATS Subcommittee for recommendations.

Recommendation: Is FAA giving too high of a priority to security and aircraft safety?

Response: In the FY 1997 R,E&D budget, FAA proposed $36,045K for security. Congress increased this level to $57,055K. In the FY 1997 R,E&D budget for aircraft safety, FAA proposed $38,999K, and Congress reduced this amount to $36,504K.

Recommendation: Form a subcommittee to focus on the end-to-end certification process, including use of commercial off-the-shelf (COTS) systems in aircraft and in the ground system.

Response: FAA will refer this task to the ATS Subcommittee for consideration.

Response to the Final *Report of the Aviation Weather Subcommittee* (Report dated October 31, 1995)

The Aviation Weather Subcommittee was established on August 31, 1994. The purpose of the subcommittee was to identify and prioritize aviation weather R&D efforts and the related operational procedures and programs which FAA should pursue. Determinations were to be based on their potential payoff for the spectrum of users.

Recommendation: FAA's Aviation Weather System Architecture should be responsive to the information needs of all users and provide a mechanism to get the same information to all users.

Response: FAA has taken the following actions to address this recommendation:

- Formed the Aviation Weather Division to develop and manage the process of integrating internal and external user requirements.
- Developed the *National Aviation Weather Strategic Plan*. The plan is scheduled for publication in May 1997. [The plan was published in April 1997.]
- Initiated the incorporation of information needs into the NAS Architecture, Version 3.0.

Recommendation: Additional focus is needed to improve the FAA's decisionmaking process and ability and authority to fulfill approved weather requirements.

Response: FAA has taken the following actions to address this recommendation:

- Appointed the Associate Administrator for ATS to serve as the focal point for management of policy, planning, coordination, standards formation, evaluation, requirements generation and investment strategies for aviation weather services.
- Created the Air Traffic System Requirements Service with a direct reporting line to the Associate Administrator for ATS to strengthen FAA's requirements process.
- Improved liaison between the Aviation Weather Program Office, the integrated product teams (IPTs) and Regulation and Certification.

Recommendation: The FAA needs to do the following: coordinate R&D activities with other government agencies; provide an annual letter of requirements to the National Weather Service; tie R&D activities to real operational problems; and prioritize R&D activities within the limited R&D funding.

Response: FAA has responded to these recommendations with the following actions:

- Developed the *National Aviation Weather Strategic Plan*, which is scheduled for publication in May 1997. [The plan was published in April 1997.]
- Coordinated with the Office of Federal Coordinator for Meteorology for development of an interagency R&D project inventory and a cross-cutting budget report for aviation weather-related investments in government.
- Initiated (1997) submission of an annual requirements letter to National Weather Service.
- Tied R&D activities to operational problems for:
  - In-flight icing research: Aviation Weather Center (AWC), Kansas City
  - Water vapor sensing system: United Parcel Service and National Oceanic and Atmospheric Administration
  - Weather support to ground de-icing decisionmaking: Chicago O'Hare and LaGuardia Airports

- Turbulence: Northwest Airlines, United Airlines and AWC, Kansas City
- Storm growth and decay: Memphis Air Route Traffic Control Center
- Windshear: Juneau Internal Airport
- Ceiling and visibility: San Francisco International Airport

- Established R,E&D budget process to prioritize R&D activities based on external and internal users priorities.

Recommendation: The FAA needs to encourage private aviation weather enterprises through expedited acquisition.

Response: FAA has responded to this recommendation with the following ongoing activities:

- Developing strategic goals under the National Aviation Weather Strategic Plan to help focus private industry enterprises. An initial draft of the plan is available.
- Implementing acquisition reform to expedite acquisitions.
- Expediting technology transfer through cooperative R&D agreements.

Recommendation: The FAA must provide a clear and cohesive policy statement regarding the agency's role in the provision of aviation weather services.

Response: FAA is coordinating a policy statement that clearly establishes FAA's leadership in development and execution of the national Aviation Weather Program.

Recommendation: The FAA must clarify its mission relative to the provision of weather information that is needed to separate aircraft from weather.

Response: FAA is coordinating a separate policy that affirms FAA's resolve to improve timely dissemination of aviation weather information to users to enhance their decisionmaking process.

Recommendation: The FAA should set policies regarding training and certification of pilots and controllers.

Response: FAA is conducting an internal review of its existing assessments of the training needs of terminal controllers, en route controllers, and pilots. The review of terminal controller training needs is complete.

Response to the *Report of the Challenge 2000 Subcommittee*, (Report dated March 6, 1996)

BACKGROUND

The Subcommittee on Challenge 2000 was an ad hoc subcommittee formed at the request of Administrator Hinson in July 1995. Its mission was to re-examine FAA's fundamental approach to its certification function and its future operation. The review was to examine the use of new technologies, administrative techniques, and other means of improving safety, as well as the impact of future technologies on decreasing the accident rate.

The following responses to the Subcommittee's recommendations were returned to the Committee on September 10, 1997. In general, FAA agreed with all recommendations, and FAA's Regulation and Certification Administration (AVR) is working to accomplish them. Challenge 2000 is still under review by FAA, and no final decision has been made.

FAA RESPONSE

Recommendation 1: AVR should build on appropriate aviation industry initiatives to develop the capacity to more effectively utilize electronic data interchange technologies with electronic data warehousing; resulting capabilities to selectively call up and use digital technical data should be used to improve analysis, reliability, and engineering support to certification efforts, and to assist in aircraft lifetime accident prevention activities.

Response: The FAA is already working on initiatives like those suggested, e.g., Global Analysis and Information Network, Safety Performance Analysis System, Risk Analysis Decision Support, and Aviation Safety Accident Prevention. It is anticipated that, with Challenge 2000, an information center of excellence will be established to centralize and manage safety data processing within AVR.

Recommendation 2: AVR should make it a priority to upgrade the information systems and computer skills of its personnel to increase the numbers of resident experts with advanced knowledge of standards, electronic commerce, and advanced information processing systems.

Response: This has been done. The FAA has instituted the Avionics Systems Standardization Workshop to discuss emerging new technology and industry certification issues. AVR established the Avionics Systems Branch to centralize all the electronic design certification expertise, especially with respect to new communication, navigation, and surveillance (CNS) and air traffic management (ATM) technologies. We also expanded the National Resource Specialist (NRS) program into technical disciplines such as electro-magnetic interference, communications, human factors, and software quality assurance. Challenge 2000 is expected to establish a New Technology Office through which new technology will be evaluated and certification and operational criteria will be developed.

Recommendation 3: To accelerate the next phase of certification of ATM procedures for global navigation satellite system, CNS, and Free Flight, AVR should increase the use of statistical data sampling and simulation for flight procedures certification and thereby enable reduced-flight-check programs. A well-structured effort could encourage early aircraft equipage and save resources for the FAA.

Response: In AVR, the Avionics Systems Branch and the Technical Programs Division, are specifically focused on the CNS/ATM issues related to Free Flight and Flight 2000. Equipment certification is being discussed and appropriate system safety analysis is being proposed. A process is underway to address issues such as use of data sampling and simulation flight procedure certification. Similar issues would also come under the envisioned New Technology Office under Challenge 2000.

Recommendation 4: AVR should enhance its already-effective program of gathering data and enhancing certification for composite structures by working closely with other key agencies and industry to develop a detailed and accelerated, overall inter-agency "Master Plan" for verification and flight certification of composite technologies. This plan should include intensive data warehousing from all operating entities that fly aircraft with composite components.

Response: The FAA is expert in the certification of composite structures. All of the composite structures proposed to date for certification have been processed. The areas that need development are composite repairs, damage tolerance, probabilistic design methods, and material property test methods. The FAA employs an NRS who has been instrumental in developing its own composite program, as well as supporting those of other agencies. This is only one of many programs in the R&D Aircraft Safety Target Area that have been reduced to performing only the most essential activities, at a minimum rate, so that other areas can be funded.

Recommendation 5: AVR should investigate issues associated with upgrading commercial electronic equipment such as computers, displays, and automotive heads-up displays. It must be recognized that the potential benefits of adapting technologies which were originally developed for non-safety critical use on the ground for aviation use warrant a review and the development of possible guidelines for commercial avionics upgrades.

Response: The FAA is looking at other methods of certifying COTS software and equipment as part of its CNS/ATM development. The agency believes, however, that these actions must be taken without reducing the safety requirements for essential or critical software or equipment. Related standards are considered vital to sustaining the existing level of safety.

Recommendation 6: AVR should continue to emphasize technology advances such as new types of advanced sensors for their potential to improve reliability manufacturing, to provide intimate data on the state of equipment and aircraft, and to identify new techniques to extend pilot capabilities.

Response: The FAA is dealing with new technologies for design and production applications as demonstrated by the recent approvals of the Boeing 777. Ensuring that the FAA stays focused on technology development is the purpose of the New Technology Office envisioned in Challenge 2000.

Recommendation 7: The FAA should refine its capability to identify new technology areas that could have an important role in reducing future accidents (i.e. many of the means discussed in this report). AVR can assist by examining its regulatory process with the goal of creating a "compelling" process to help industry create "irresistible technical and business" incentives to develop and certify products to enhance safety in those identified areas.

Response: The Challenge 2000 concept includes the development of the New Technology Office, which is intended to focus directly on establishing the capability stated in this recommendation.

Recommendation 8: AVR, through the FAA R&D organization, should expand full simulation as well as "rapid prototyping" human factors studies targeted at areas identified with "high accident potential" and associated with equipment and procedural certification. This effort should be worked jointly with the National Aeronautics and Space Administration (NASA) and the Department of Defense (DOD).

Response: The AVR NRS for Human Factors is working closely with the Human Factors Division and other agencies to establish a Human Factors Implementation Plan.

Recommendation 9: In conjunction with other civilian and government agencies, vitally interested in human factor research, AVR should support R&D to explore new simulation support software. Together, the cooperating agencies should help mature the best tools to deal with safety, certification, and support prevention efforts for "near zero accidents."

Response: AVR hired an NRS in Flight Deck Human Factors and is assessing requirements to hire human factor experts at the aircraft certification offices, directorates, and headquarters. Our NRS will provide focus to AVR human factor initiatives, coordinate them with other entities, and ensure that the best tools for safety, certification, and accident rate reduction are developed.

Recommendation 10: Together with FAA R&D efforts, with NASA, DOD, industry, and academia, AVR should expand the use of interviews and opinion polls throughout the aviation industry to create a better means of projecting future accidents. The data should be combined with simulation and selectively used through data warehousing.

Response: The FAA participated fully in the work of the NASA Aeronautics Safety Investment Strategy Team (ASIST). NRS and members of the policy staffs participated in ASIST meetings with industry, NASA, DOD, and academia. FAA will continue to follow through as the ASIST program closes and the Aviation Safety Program begins. Aircraft Certification Service is also conducting risk and Praedo analysis with industry to identify the "critical few" areas on which to focus their safety initiative in order to net the most return. Flight Standards is using the Safety Performance Analysis System to focus their resources and is developing improvements with the assistance of the FAA Office of Aviation Research.

Recommendation 11: FAA should utilize every opportunity to develop and use computer based training (CBT) for its own people, and should encourage its use throughout the aviation community. AVR should find ways to use CBT to disseminate critical human factor lessons to help avoid accidents.

Response: The FAA agrees that CBT should be considered as a potential training vehicle. AVR has developed CBT and continues to consider it for varied training applications. The FAA views this training approach as a tool, and as with all tools, there is a proper place and time for its use.

Recommendation 12: AVR should increase the use of IPT management of certification and safety enhancement functions.

Response: AVR is increasing the use of the IPT, which is an integral part of the Challenge 2000 concept. Since this recommendation was made, AVR has increased its engagement and participation with the agency's other IPTs.

Recommendation 13: AVR should hire more National Resource Specialists to increase in-house technical expertise to deal with the rapid acceleration of aeronautical technology.

Response: This has been done. The FAA has just completed hiring ten NRS personnel in the Aircraft Certification Service. The new disciplines affected are flight deck human factors, flight environmental icing, metallic structural materials and processes, propellers, aeronautical communications, advanced control systems, propulsion control systems, electromagnetic interference, manufacturing and quality assurance technology, and software quality assurance. AVR is presently looking for qualified applicants for engine dynamics and safety.

Recommendation 14: Recommendations from the COTS Non-Developmental Item (NDI) report. The FAA should conduct an in-depth analysis of processes within the FAA which are affected by COTS/NDI technologies. There are 19 items which the Committee recommends for consideration.

Response: AVR is addressing the use of COTS/NDI in the new NAS Plan and will agree to its use where it is appropriate. Again, the FAA is open-minded to considering other methods for demonstrating

compliance to requirements provided they meet the safety required for the certification of essential and critical software and equipment.

Response to the *Report of the Status and Organization of Human Factors within the FAA* (Report dated August 5, 1996)

The Human Factors Subcommittee was formed in September 1994 as an ad hoc group to investigate, assess, and report on the status and organization of human factors in the FAA and make recommendations for change.

Recommendation: The FAA needs to create a centralized responsibility for human factors.

Response: The FAA will distribute a memorandum by March 31, 1997 that outlines a concept of operations for the relationships among organizational elements for the planning and execution of human factors. [The date for the memorandum was changed from March 31 to June 30 due to a change of personnel, specifically, a new Chief Scientist for Human Factors. Accomplished on November 17, 1997.]

Recommendation: The FAA needs to assign resources and people to this central responsibility structure, define the expectations of the agency, and hold the participants accountable.

Response: The FAA will publish an order in 1997 that defines the following responsibilities and expectations: [A memorandum signed by the Administrator dated November 17, 1997, accomplishes the underlying philosophy and framework of this recommendation and response.]

- Designating the Associate Administrator for Research and Acquisition (ARA) as the lead organization for developing a unified FAA human factors program.
- Designating the Human Factors Division as the central focal point:
  - For representing, communicating, coordinating, advocating and centrally managing FAA human factors within and outside the agency.
  - With responsibility and authority for human factors related R,E&D budget programming, planning and management.
- Identifying the roles and responsibilities and organizational relationship with the central focal point for the following organizations:
  - Agency providers for human factors including FAA Headquarters, the Civil Aeromedical Institute (CAMI), and the William J. Hughes Technical Center.
  - FAA lines of business.

Recommendation: The FAA needs to provide a lead organization for human factors.

Response: ARA and the Human Factors Division (along with the Associate Administrators for Regulation and Certification, Air Traffic Services, and other lines of business) will accomplish the following by June 30, 1997: [The Action Plan for Goal 2 in ARA's Performance Plan addresses these issues. FAA plans to update the Committee on the Action Plan at the January 1998 meeting. Implementation of the Action Plan is scheduled to begin in February 1998.]

- Jointly establish a human factors requirements identification and prioritization process.
- Jointly establish a human factors program planning and execution process.
- Jointly revise the human factors coordinating committee as a forum to define and support coordination and interface requirements.
- Cooperatively identify, acquire and align resources to address agreed upon agency human factors requirements.
- Jointly establish a process for and conduct regular feedback and review sessions to assess the FAA human factors program.
- Jointly develop and execute an advocacy plan to communicate agency human factors objectives.
- The Human Factors Division will reorganize internal staff structure to enhance the support of research program management and serve as the human factors focal point for the following:
  - Assisting lines of business in (1) identifying human factors staffing and resource requirements, (2) acquiring qualified providers, and (3) allocating human factors resources effectively.

- Presenting and advocating the agency human factors program within and outside of the FAA.
- Providing the platform for the cooperative development of the total agency human factors program and managing human factors resources to address cooperatively-identified research priorities.
- Providing linkages that support agency human factors activities such as the following:
  - translation of operational requirements
  - research sponsorship
  - coordinated resource allocation
  - policy development
  - program (vs. project) development
  - program reviews
  - strategic planning
  - quality assurance

Response to the *Aviation Security Research and Development Report* (Report dated September 1996)

In direct response to the 1998 terrorist bombing of Pan Am Flight 103 over Lockerbie, Scotland, Congress passed the Aviation Security Improvement Act of 1990 (Public Law 101-604). This legislation included a requirement that the FAA Administrator establish a scientific advisory panel as a subcommittee of its R,E&D Advisory Committee. Under its charter the Aviation Security Research and Development Subcommittee is tasked to review the progress of the agency's R&D program and related activities for countering terrorist threats against commercial aviation.

Recommendation: The FAA should require phased deployment of advanced technologies beginning in 1998. Consider cost and effectiveness analysis, incorporate procedures like profiling, and provide a forum for feedback.

Response: FAA agrees. An IPT was formed to include air carrier and airport personnel. The IPT will procure equipment, determine deployment strategy, and coordinate deployments as well as gather cost and effectiveness data that will be applied to future deployment decisions.

An automated profiling system is being developed and will be available by the end of 1997. [Many airlines will begin using the profiling system by December 31, 1997. Some airlines will implement the system in the spring of 1998.]

FAA is co-sponsoring a CTX 5000 users conference on February 13, 1997, to collect and share feedback. The Aviation Security Research and Development Subcommittee may also function as a forum for feedback from stakeholders. [The conference was accomplished on schedule.]

Recommendation: The FAA should develop rapid deployment capability of enhanced security systems by 1998.

Response: FAA did this for the 1996 Summer Olympics with a small inventory maintained at the Technical Center. FAA will continue to maintain and make this equipment available; however, the recommendation is overcome by events based on wide-scale IPT procurements and deployments.

Recommendation: The FAA should reallocate FY 1997 R&D security funds to increase long-term R&D counter measures for emerging threats.

Response: This has been completed. Security program requirements are being modified to include more long-term research objectives. The hardening program will be expended for narrow-body aircraft. The emerging threats (CBR, SAMs, etc.) are being addressed.

FY 1997 funding increases included adding $5.5 million to the Aircraft Hardening program for a total program value of $6.3 million including $0.5 million for threat analysis of HERF. Also, there was an increase to Chemical Weapon Detection of $190,000 for a total program value of $250,000. FY 1998 funding levels include maintaining the $6.3 million level of funding in the Aircraft Hardening program. The program includes an additional $300,000 for procedures for MANPADS and $2.0 million to initiate an assessment of hardening techniques for next-generation aircraft. Also, funding in FY 1998 for mitigation techniques for CBR is increased by $1.0 million.

FAA Response to the *Subcommittee Report of the NAS R&D Panel Report* (Report dated March 25, 1997)

BACKGROUND

The National Airspace System (NAS) Research and Development (R&D) Panel was an ad hoc subcommittee chartered to review the content and management of FAA's current R&D program against the proposed NAS Architecture. The purpose of the review was to identify issues that require resolution in order to complete the architecture and to explore opportunities for increasing the program's effectiveness in enhancing the NAS.

The Subcommittee's report was approved by the Committee on April 9 and provided by letter to the Administrator on April 17. The report provided recommendations in six areas: management, advanced ATM, software engineering, aviation weather, system capacity, and leveraging. The following response was presented to the Committee on September 9, 1997.

FAA RESPONSE

MANAGEMENT

Recommendation: Establish a Deputy Administrator for NAS Development, Operation and Maintenance.

Response: FAA will review the National Civil Aviation Review Commission (NCARC) report, which is due out this week, prior to responding to this recommendation. [DOT is preparing a legislative proposal in response to the Commission's recommendations.]

Recommendation: Elevate the systems engineering function to a higher reporting level.

Response: Again, FAA will review the NCARC report, which is due out this week, prior to responding to this recommendation.

Recommendation: Reverse the loss of technically competent people.

Response: ARA is developing an Intellectual Capital Investment Plan to foster more effective recruitment, development, and retention of its workforce.

Recommendation: Plan for and fund continuous insertion of new technology into the NAS, especially computing and communications capability.

Response: The NAS Architecture provides for continuous technology insertion over the lifecycle of systems.

ADVANCED ATM

Recommendation: Develop operational concept, architecture, and transition plan for Free Flight.

Response: The following documents have been developed: FAA 2005 Ops Concept draft version 1.3, dated 27 July, 1997; RTCA Free Flight Select Committee 2005 ops concept, signed August 1997; NAS Architecture version 3.0, scheduled to be published in December 1997. [Publication is scheduled for February 1998.]

Recommendation: Pursue Free Flight human performance issues.

Response: A human factors working group has been established to support Flight 2000 operational evaluation.

Recommendation: Evaluate safety and environmental impacts of Free Flight.

Response: The FAA and NASA collaboration on Free Flight addresses safety and environmental issues.

Recommendation: Improve benefits analysis capability.

Response: FAA recognizes the need for improved benefits analysis capability and has developed some capability in this area. Funding is a problem.

Recommendation: Ensure that NASA contributions are directed toward the intended evolution of the NAS.

Response: The integrated FAA/NASA ATM research program is focused on the 2005 operational concept and longer-term research. A revised inter-agency plan is expected this year.

Recommendation: Develop international consensus on ATM evolution.

Response: FAA has a number of bilateral R&D agreements with foreign civil aviation authorities for this purpose.

SOFTWARE ENGINEERING

Recommendation: Establish a chief scientist for software.

Response: Dr. Art Pyster, Chief Scientist for Software Engineering, reports to the FAA Chief Information Officer.

Recommendation: Elevate importance of information security engineering.

Response: Dr. Feisal Keblawi, from the System Architecture Group, and the NAS Information Security Group have developed an action plan for information security.

Recommendation: Establish a software engineering laboratory.

Response: Dr. Art Pyster and Dr. Herman Rediess, Chief Scientist for Test and Evaluation, are collaborating on an FAA Center of Excellence at the William J. Hughes Technical Center.

Recommendation: Undertake a number of specific software engineering and R&D initiatives.

Response: FAA agrees with the recommendations and is developing a program in collaboration with universities and other government agencies, but funding is a problem.

AVIATION WEATHER

Recommendation: Establish a single weather research IPT in the Office of Communication, Navigation, and Surveillance Systems (AND).

Response: Weather research is vested in a single IPT in FAA's Office of Air Traffic Systems Development (AUA). Wake vortex research is performed in the Office of AND.

Recommendation: Consider hazardous weather as an aviation safety issue in FAA policy statements and plans.

Response: The Aviation Policy Statement drafted recently by the Associate Administrator for ATS addresses weather both as a safety and a capacity issue.

Recommendation: Establish a weather architecture.

Response: NAS Architecture version 3.0 includes an integrated weather architecture.

Recommendation: Develop and implement a number of specific weather products.

Response: FAA agrees and has plans in place to develop and implement these weather products; however, funding is a problem.

AVIATION SYSTEM CAPACITY

Recommendation: The subcommittee made 21 recommendations to provide priorities for specific system improvements. There were also four recommendations that concerned management of airports.

Response: The response to this section of recommendations will be deferred until January [1998].

LEVERAGING

Recommendation: Recognize necessity and potential of FAA suppliers to undertake a greater level of R&D than in the past through the following means:

- Policy
- Performance specifications
- Hardware and software standards
- National resource specialists
- Cooperation and collaboration with industry

Response: FAA is placing a greater R&D burden on industry through a number of program-specific initiatives:

- Acquisition Management Systems
- Coordinating specification with industry
- Performance specifications and standards
- NAS architecture
- Cooperative R&D agreement

FAA Response to Committee *Recommendations on FY 1999 R,E&D Investments* (From the meeting minutes dated April 8-9, 1997)

BACKGROUND

The objective of the R,E&D process is to develop an R&D investment portfolio for FY 1999-2003 that best applies resources to meet the needs of the agency's customer community. The role of the Committee is to provide sustained, comprehensive involvement of customers, stakeholders and subject-matter experts

in R,E&D program reviews and investment decisions.

Each year, the Committee will conduct an investment portfolio review to determine whether or not FAA is pursuing appropriate R&D investments, effectively allocating resources among priorities, and accounting for the market environment. Here are the resulting recommendations from the Committee's review of FAA's FY 1999 planned R,E&D investments.

At the April 8-9, 1997, Committee meeting, the Committee reviewed FAA's planned FY 1999-2003 R,E&D Investment portfolio with special emphasis on FY 1999. The Committee provided feedback to FAA in an April 17 letter from the Committee Chairman Mr. Ralph Eschenbach to the Acting Administrator Mr. Barry Valentine. There were three major areas of Committee recommendations. FAA responded to those recommendations in two letters dated June 10 and August 18, 1997. The response was presented to the Committee on September 9, 1997.

FAA RESPONSE

Recommendation: The Committee recommends that FAA set the specific objectives and detailed operational concepts for Free Flight. This should include a plan and system architecture for the transition from the current NAS to Free Flight. In support of verifying the Free Flight operational concept and transitioning to Free Flight, FAA should develop a detailed plan, operational concept and architecture for the Flight 2000 demonstration and validation. In particular, the FY 1998-2003 R,E&D program should include a comprehensive, large-scale simulation effort to develop and validate the operational concepts. In order to meet the objectives of live operational testing starting in FY 2000, these simulation efforts must start in 1998. The ATS Subcommittee has been asked to evaluate the 1998 and 1999 research allocations and determine if any adjustments need to be made. This report will be submitted in September 1997.

The Committee strongly supports the Flight 2000 demonstration program. To accomplish Flight 2000 and the transition to Free Flight by the 2005 date suggested by the Gore Commission, FAA must provide strong leadership within the Aviation Community to ensure stakeholder support and dedicate its R,E&D investments in air traffic services and related areas to achieving Free Flight and Flight 2000.

Response: FAA concurs with these recommendations. FAA has developed an operational concept for Free Flight. The draft version 1.3 is dated June 27, 1997. A copy of this document has been provided to each committee member. In addition to FAA's effort, the (RTCA) Free Flight Select Committee has developed a 2005 operational concept, which was signed in August 1997. With respect to Flight 2000, FAA published an initial program plan for Flight 2000 on July 16, 1997. FAA will provide a copy of this document to each committee member. FAA plans to publish the NAS Architecture version 3.0 in December 1997. [Publication is scheduled for early 1998.] Finally, efforts are underway in FAA to establish an operational concept validation activity.

- FAA 2005 operational concept:
  - http://www.faa.gov/ATS/ATO/wcome400.htm
- NAS Architecture:
  - http://asd.orlab.faa.gov

Recommendation: The FAA should place more emphasis on the NRS program. We recommend that FAA fill vacancies with well-qualified people who understand the role of the NRS. Furthermore, FAA should utilize the NRS to guide its R&D investments in aircraft safety and related areas including collaborative efforts with NASA.

Response: The NRS program in the Aircraft Certification Service has more than doubled from eight NRS personnel to 19. The agency worked on this expansion to ensure that the best candidates would apply. The recruiting and selection processes were managed personally by members of the senior executive staff because of the level of importance placed on the NRS program. FAA believes that it has assembled a credible panel of experts representing a broad spectrum of technology.

The FAA agrees with the recommendation to utilize the NRS to guide FAA R&D investment. Recently, during the NASA ASIST process, the FAA and NASA were directly involved with the NRS. Within the FAA's own process and on NASA's initiative, the NRS are working closely with the policy offices to ensure that the research being sponsored by FAA is technically credible and appropriate. NRS also

consult and advise senior management on emerging technology and safety concerns. These examples show how the NRS are guiding the research investment of FAA.

More information on the NRS program, including background information on each NRS in the Aircraft Certification Service, is available on the NRS home page at the following address:

http://www.faa.gov/avr/air/air100/nrshome.htm

Recommendation: The Committee recommends that FAA consider diverting 20 percent of its planned investments in aviation security to high priority requirements for air traffic services research. We do not believe that the money is being misused, but that it would be more in the national interest to support the Flight 2000 program and the transition to Free Flight.

Response: Although FAA agrees that air traffic services research requires additional funding, we do not agree that the additional funding should come at the expense of aviation security. The additional funding provided to aviation security is a result of the Gore Commission and national concern over security. We will continue to work with the Administration and Congress with the objective of ensuring that we have adequate funding for all areas of the R&D program.

Recommendation: The Committee strongly endorses the FAA's collaborative R&D activities with NASA. In the collaboration, NASA's role should be focused strongly on basic research that provides a technology base in FAA mission areas. FAA's role principally should be in applied R&D in support of its regulatory and air traffic services responsibilities.

Response: The FAA agrees with this recommendation and believes that its existing collaborative activities generally abide by this guideline. The joint FAA and NASA ASIST is now under development. We will continue to involve the Committee in reviewing activities in this area, in particular, our research efforts with NASA in aviation safety and ATM.

Appendix B

Alphabetical Listing of R,E&D Budget Line Items

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Appendix C

Numerical Listing of R,E&D Projects

Project Number	Project Title	Budget Item
011-130	R,E&D Plans and Programs	A01a
011-140	Technical Laboratory Facility	A01b
011-160	Center for Advanced Aviation System Development (CAASD)	A01c
021-110	Advanced Traffic Management System	A02a
021-140	Oceanic Air Traffic Automation	A02b
021-200	Surface Automation Research and Development	A02c
021-250	Runway Incursion Reduction	A02c
022-110	Traffic Alert & Collision Avoidance System (TCAS)	A02e
022-141	Low-Cost Avionics	A02f
022-142	Rotorcraft Instrument Flight Rules (IFR) Procedures	A02f
023-120	Separation Standards	A02d
024-110	Aviation System Capacity Planning	A02d
025-150	Flight 2000 Operational Evaluation	A02g
028-110	Operations Concept Validation	A02h
028-130	Software Engineering R&D	A02i
031-110	Aeronautical Data Link (ADL) Communications	A03a
031-111	Aeronautical Data Link (ADL) Applications	A03a
032-110	Satellite Navigation Program	A03b
033-140	Automatic Dependent Surveillance-Broadcast (ADS-B)	A03c
041-110	Aviation Weather Analysis and Forecasting	A04a
051-110	Airport Planning and Design Technology	A05a
051-120	Airport Pavement Technology	A05a
051-121	National Dynamic Airport Pavement Test	A05a
051-130	Airport Safety Technology	A05a
060-110	Aviation Safety Risk Analysis	A06g
061-110	Fire Research & Safety	A06a
062-110	Structural Safety	A06b
062-111	Advanced Materials Structures	A06b
063-110	Propulsion Systems Research	A06c
064-110	Flight Safety	A06d
064-111	Atmospheric Hazards	A06d
065-110	Aging Aircraft	A06e
066-110	Aircraft Catastrophic Failure Prevention Research	A06f
071-110	Explosives/Weapons Detection	A07a
073-110	Airport Security Technology Integration	A07b
075-110	Aircraft Hardening	A07d

Project Number	Project Title	Budget Item
076-110	Aviation Security Human Factors	A07c
081-110	Flightdeck/Maintenance/System Integration Human Factors	A08a
082-110	Air Traffic Control/Airway Facilities Human Factors	A08b
086-110	Aeromedical Research	A08c
091-110	Aircraft Noise Reduction & Control	A09a
091-111	Engine Emissions Reduction & Control	A09a
091-113	Aviation Environmental Analysis	A09a
101-210	Research & Development (R&D) Partnership	A10a
101-220	NASA Field Offices	A10a

Appendix D

Glossary of Acronyms

A	
AANC	Aging Aircraft Nondestructive Inspection Validation Center
AC	Advisory Circular
ACAS	Airborne Collision Avoidance System
ADL	Aeronautical Data Link
ADS	Automatic Dependent Surveillance
AEAP	Aviation Effects on the Atmosphere Project
AGATE	Advanced General Aviation Transport Experiment
AGFS	Aviation Gridded Forecast System
AIA	Aerospace Industries Association
AIAA	American Institute of Aeronautics and Astronautics
AIP	Airport Improvement Program
AMASS	Airport Movement Area Safety System
AOC	Airline Operational Control
AOPA	Aircraft Owners and Pilots Association
APMS	Automated Performance Measurement System
AQP	Advanced Qualification Program
ARAC	Aviation Regulatory Advisory Committee
ARTCC	Air Route Traffic Control Center
ASDE	Airport Surface Detection Equipment
ASDI	Aircraft Situational Display for Industry
ASRA	Aviation Safety Risk Analysis
AST	Advanced Subsonic Technology
ASTI	Airport Security Technology Integration
ATA	Air Transport Association
ATC	Air Traffic Control
ATCS	Air Traffic Control Specialist
ATM	Air Traffic Management
ATS	Air Traffic Services
ATSP	Air Traffic Service Plan
AWT	Area Work Team
C	
CAASD	Center for Advanced Aviation System Development

CAEP	Committee on Aviation Environmental Protection
CAMI	Civil Aeromedical Institute
CASR	Center for Aviation Systems Reliability
CBT	Computer-Based Training
CDM	Collaborative Decision Making
CDTI	Cockpit Display of Traffic Information
CIS	Cockpit Information System
CNS	Communication, Navigation, and Surveillance
COE	Center of Excellence
COTS	Commercial-off-the-Shelf
CRDA	Cooperative Research and Development Agreement
CRDA	Converging Runway Display Aid
CTAS	Center TRACON Automation System

D

DOD	Department of Defense
DOE	Department of Energy
DSS	Decision Support System

E

EARTS	Enroute Automated Radar Tracking System
EDD	Explosives Detection Device
EDM	Expert Decisionmaking
EDS	Explosives Detection System
EMS	Emergency Medical Service
EPA	Environmental Protection Agency

F

F&E	Facilities and Equipment
FAA	Federal Aviation Administration
FANG	FMS-ATM Next Generation
FAST	Final Approach Spacing Tool
FEM	Finite Element Model
FICAN	Federal Interagency Committee on Aviation Noise
FIS	Flight Information Service
FSM	Flight Schedule Monitor
FTE	Full Time Equivalent
FY	Fiscal Year

G	
GA	General Aviation
GAMA	General Aviation Manufacturers Association
GAO	General Accounting Office
GDP	Ground Delay Program
GICB	Ground Initiated Comm B
GNSS	Global Navigation Satellite System
GPRA	Government Performance and Results Act
GPS	Global Positioning System
GWS	Graphic Weather Service
H	
HAI	Helicopter Association International
HSI	Human Systems Integration
HUMS	Health/Usage Monitoring System
I	
ICAO	International Civil Aviation Organization
IDACS	Intelligent Damage Adaptive Control System
IEEE	Institute of Electrical and Electronics Engineers
IFR	Instrument Flight Rules
IPT	Integrated Product Team
J	
JAA	Joint Aviation Authorities
L	
LAAS	Local Area Augmentation System
M	
MANPADS	Man Portable Air Defense Systems
MASPS	Minimum Aviation System Performance Standards
MOA	Memorandum of Agreement
MOPS	Minimum Operational Performance Standards
MOU	Memorandum of Understanding
N	
NAS	National Airspace System
NASA	National Aeronautics And Space Administration

NATCA	National Air Traffic Controllers Association
NAWCAD	Naval Air Warfare Center Aircraft Division
NCARC	National Civil Aviation Review Commission
NDI	Non-Developmental Items
NEXRAD	Next Generation Weather Radar
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NPRM	Notice of Proposed Rulemaking
NRS	National Resource Specialist
NSTB	National Satellite Test Bed
NTSB	National Transportation Safety Board
NWS	National Weather Service

O

O&M	Operations and Maintenance

P

P3I	Pre-Planned Product Improvement
PDC	Pre-Departure Clearance
PPBM	Positive Passenger Baggage Matching

R

R&D	Research and Development
R,E&D	Research, Engineering and Development
REDAC	R,E&D Advisory Committee
RF	Radio Frequency

S

SAE	Society of Automotive Engineers
SAMA	Small Aircraft Manufacturers Association
SARPs	Standards and Recommended Practices
SATORI	Systematic Air Traffic Operations Research Initiative
SBIR	Small Business Innovative Research
SDTF	Surface Development and Testing Facility
SEIPT	Security Equipment Integrated Product Team
SICAS	Secondary Improvements and Collision Avoidance System
SMA	Surface Movement Advisor
SOIT	Satellite Operational Implementation Team
SPAS	Safety Performance Analysis System

SPEARS	Screener Proficiency Evaluation and Reporting System
STARS	Standard Terminal Automation Replacement System
SUA	Special Use Airspace
T	
TCA	Transport Canada Aviation
TCAS	Traffic Alert and Collision Avoidance System
TDLS	Tower Data Link System
TERPS	Terminal Instrument Procedures
TFM	Traffic Flow Management
TMA	Traffic Management Advisor
TMS	Traffic Management System
TOGAA	Technical Oversight Group On Aging Aircraft
TRACON	Terminal Radar Approach Control
TWIP	Terminal Weather Information for Pilots
U	
USAF	U.S. Air Force
V	
VHF	Very High Frequency
VNTSC	Volpe National Transportation Systems Center
W	
WAAS	Wide Area Augmentation System
WFD	Widespread Fatigue Damage
WJHTC	William J. Hughes Technical Center
WSDDM	Weather Support to Deicing Decision Making