National Aviation Research Plan

Federal Aviation Administration
April 2001

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

1.0 OVERVIEW

1.1 The FAA Mission and R&D

The American public and their elected officials rely upon the Federal Aviation Administration to provide a safe, secure, efficient, and environmentally responsible National Airspace System (NAS). The FAA has committed to reducing the U.S. rate of fatal aviation accidents by 80 percent, based on 1996 levels, by the year 2007. In an increasingly mobile and complex world, innovative solutions are vital to meeting these expectations. The importance of the FAA's research and development (R&D) will grow with the expanding demands placed upon it.

FAA R&D develops technologies, systems, and procedures to fulfill the agency's principal operational and regulatory responsibilities: air traffic services, certification of aircraft and aviation personnel, operation and certification of airports, civil aviation security, and environmental standards for civil aviation.

1.2 Increased Demands on FAA R&D

The job of safely managing air traffic in the United States is becoming increasingly complex. In May 2000, the FAA's Technical Center reported: "Our air transportation system has over 17,000 landing facilities, 226,000 registered aircraft, 700,000 pilots, 8000 tower controllers, a multitude of terminal buildings and access roads, and 500 million passenger enplanements each year." FAA forecasts predict major growth in demands upon the system.

- *Between 2000 and 2010:*
  - Domestic passenger enplanements will increase at an average annual growth rate of 3.4 percent.
  - Regional/commuter passenger enplanements will increase at a yearly growth rate of 5.4 percent.
  - The commercial air carrier jet fleet will increase at an annual rate of 4.0 percent or 260 aircraft per year.
  - The active general aviation fleet will come to total 220,800.
  - Total civil aircraft activity at towered and non-towered airports will reach 129.4 million operations.
- *By 2015:*
  - The numbers of passengers carried on our commercial aircraft will reach one billion.
- *By 2025:*
  - Domestic passenger enplanements will slow somewhat to an average annual rate of 2.9 percent.
  - Regional/commuter passenger enplanements will slow to a yearly rate of 3.6 percent.
  - The regional/commuter fleet (60 seats or fewer) will grow from 2,039 aircraft (1998) to 3,800.
  - The active general aviation fleet will expand to 248,800.
  - Total civil aircraft activity at towered and non-towered airports will reach 142.8 million.
  - The total pilot population will grow to 849,200.

1.3 Civil Aviation and the Nation

The technologies and procedures resulting from FAA R&D contribute heavily to our domestic economy and fuel the nation's largest export sector. Estimates recently updated by Wilbur Smith Associates (see Figure 1) indicate that nearly one dollar in every twenty in the U.S. Gross Domestic Product is generated by aviation and related industries. A wide range of economic activities including the airlines, travel industries, food services, construction, and communications provide nearly 11 million American jobs, create $278 billion in annual earnings, and pump $976 billion into the domestic economy.

Increased foreign competition is threatening to erode our preeminent international position in aviation. Although U.S. aircraft manufacturers expect to deliver over 14,000 transport aircraft valued at $1 trillion world-wide in the next 20 years, aviation research and development is accelerating in other nations and improving their commercial aviation products. Effective R&D is a major factor in protecting our leadership and market share in the vibrant and crucial aviation industry.

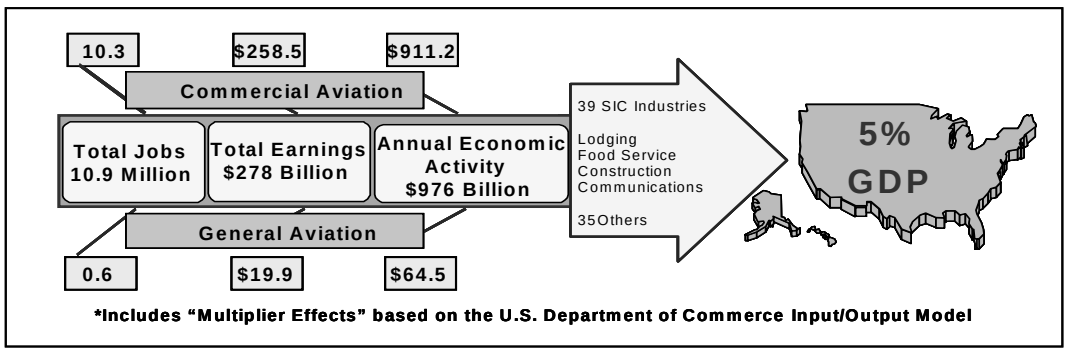


Figure 1. Aviation Impact on the Economy

1.4 FAA R&D Program

Most of the research described in the "Program Information" portion of this plan is funded through the agency's Research, Engineering and Development (R,E&D) appropriation. Except for the Weather Program (A04a), all Air Traffic Services research is funded through the Facilities and Equipment (F&E) appropriation.

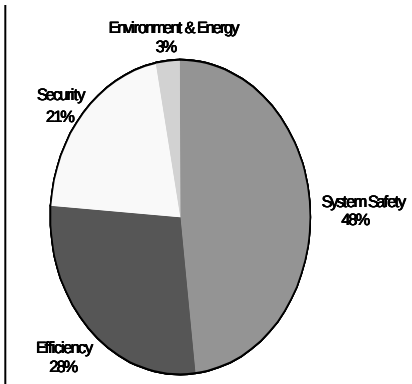
Figure 2 shows the relative percentages of FY 02 R&D funding to be directed toward meeting the following major FAA goals:

System Safety: By 2007, reduce U.S. aviation fatal accident rates by 80% from 1996 levels.

Security: Prevent security incidents in the aviation system.

Efficiency: Provide an aerospace transportation system that meets the needs of users and is efficient in the application of FAA and aerospace resources.

Environment & Energy: Prevent, minimize, and mitigate environmental impacts.



Applicable Goal	FY 02 Level	Appropriation(s)
System Safety	$123,249	R,E&D, F&E, AIP
Efficiency	$ 71,885	R,E&D, F&E, AIP
Security	$ 53,392	R,E&D
Environment & Energy	$ 7,602	R,E&D
Total:	$256,128	

Figure 2. FY 02 R&D Funding Percentages by Goals

The FAA R&D program is functionally divided into the eight areas described below:

- *Air Traffic Services*—R&D focuses on increasing system safety and capacity and enhancing the flexibility and efficiency of air traffic management operations. Improved decision support tools are key to enabling FAA air traffic specialists to collaborate with the user community in managing traffic flows as efficiently as possible.
- The R&D program is also working to reduce occurrences of runway incursions, midair collisions, and aircraft encounters related to the effects of wake vortices and hazardous weather. Research is helping to develop new technologies that will improve navigational accuracy and 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 FAA is introducing new technologies to support a Free Flight system, in which aircraft operators can vary their speed and flight path to increase efficiency, while air traffic controllers can still ensure safe operations.
- *Airport Technology*—R&D develops and evaluates technologies and materials designed to ensure safe and efficient airport operations. Research focuses on 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. Research results 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&D focuses on ensuring the safe design, manufacture, and maintenance of aircraft. It addresses the hazards to 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 and nonstructural problems associated with degradation, damage, fatigue, and corrosion. New aircraft with digital flight control and avionics systems and associated imbedded software are more susceptible to disruption from external electromagnetic interference. Research focuses on developing technologies and standards for maintenance and modification of inservice aircraft to ensure continued airworthiness. This work includes studies in structural integrity of airframes and engines, maintenance and repair of composites, atmospheric hazards, crashworthiness, fire safety, and forensics capabilities to support accident investigations.
- *Aviation Security*—R&D develops technologies and standards that counter the threat of terrorism and criminal acts targeted at aviation. Research focuses on developing and evaluating 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 inflight explosion; human factors aspects of threat 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 that have minimal impact on airport and airline operations.

- *Human Factors and Aviation Medicine*—R&D programs described in this Overview directly support the needs of the FAA's lines of business and NAS users, as identified in the National Plan for Civil Aviation Human Factors. These Civil Aeromedical Institute (CAMI) initiatives address major human factors areas affecting the flight deck, Air Traffic Control, flight deck/ATC system integration, airway facilities, aircraft maintenance, as well as aeromedical issues related to the safe operation and forensic investigation of aircraft cabin environments.
- *Environment and Energy*—R&D develops technical information, standards, and procedures to mitigate the environmental impact of aircraft operations, particularly upon noise and air pollution emissions. The program seeks to identify and balance technology, operations, and land-use measures with special emphasis on developing assessment methodologies that give insight into the system-wide consequences of alternative courses of action.
- *Commercial Space Transportation*—The overall mission of Commercial Space Transportation (AST) is to protect public health and safety, protect the safety of property, and protect U.S. foreign policy and national security interests; to encourage, facilitate, and promote U.S. commercial space launches; to enhance the international competitiveness of the U.S. commercial space transportation industry; to ensure compliance with international obligations of the U.S., and to facilitate new or improved U.S. space transportation infrastructure.
- *National Aviation Research Plan Program Management*—includes the management, planning, control, and support activities associated with formulating the FAA R&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.

The cross-cutting emphases just described ensure outside assessment of the FAA R&D investments. NARP Program Management also facilitates research partnerships with industry, universities, and other government agencies that enable the FAA to leverage its research dollars.

1.5 The Need for Modernization

In the course of the 1990s, the FAA often has been called on to do business differently. Sometimes these calls have come from outside the DOT/FAA ranks, and sometimes from within. The advocates of change about to be described have contributed to a growing spirit of modernization both in systems and in the operating "culture" of the agency.

1.5.1 External Motivators

Government Performance and Results Act of 1993

The FAA emphasizes GPRA concepts throughout the National Aviation Research Plan. Figure 3 relates the workings of agency's research programs within a GPRA framework. The most forceful **suppliers** of the requirements that shape FAA research are direct mandates from Congress and the Administration. In response to these directions, the FAA partners with interested **stakeholders**, public and private, to formulate specific research budgets and programs. The Research, Engineering and Development Advisory Committee (REDAC) is a permanent conduit, instituted by Congress, to bring the expertise and experience of industry, academia, and the full aviation community into the planning and implementation of FAA research. Implementation of improved systems and regulations, the physical **outputs** of FAA aviation research, results in **outcomes** that increase aviation safety, efficiency, security, and environmental compatibility.

White House Commission on Aviation Safety and Security

The Commission on Aviation Safety and Security was established in August 1996. The group reviewed the current status of NAS modernization efforts and found that, in the interest of safety and efficiency, improvements to the program should be accelerated "to achieve full operational capability by 2005."

President's Commission on Critical Infrastructure Protection

The President's Commission on Critical Infrastructure Protection was established in July 1996 to find current and viable means to protect critical infrastructures, including aviation, from physical and cyber threats. An advisory committee of industry leaders supported the main body, and a steering committee of cabinet-level officials reviewed the final report, "Critical Foundations." The agency has accordingly heightened its emphasis on combating threats to the security of information deemed vital to the safe performance of the NAS.

National Science and Technology Council

The National Science and Technology Council (NSTC) was established on November 23, 1993. This Cabinet-level Council is the principal means to coordinate science, space, and technology among the diverse parts of the Federal research and development enterprise.

A key NSTC objective is to establish clear national goals for Federal science and technology investments that can strengthen and improve areas ranging from information technologies and health research to transportation systems and fundamental research. The NSTC Committee on Transportation Research and Development has developed the rationale and framework for guiding Federal initiatives that will make the transportation system safer, more productive, and more efficient.

In its report titled "National Research and Development Plan for Aviation Safety, Security, Efficiency, and Environmental Compatibility" (1999), the Council provides a description of the coordinated long-term research initiatives needed to bring about the advances in aviation for the opening decades of the next century.

The FAA is a highly visible member of the transportation community. Continuing investments in its research activities are critical to meeting the national goals and sustaining the prosperity of the national economy.

The FY 2002 FAA R&D budget supports the strategic goals for transportation outlined in the NSTC plan. These goals include:

- Providing a safer transportation system.
- Achieving a high level of transportation system security.
- Improving environmental quality and energy efficiency.
- Fostering economic growth and productivity through more effective and flexible global passenger and freight services.

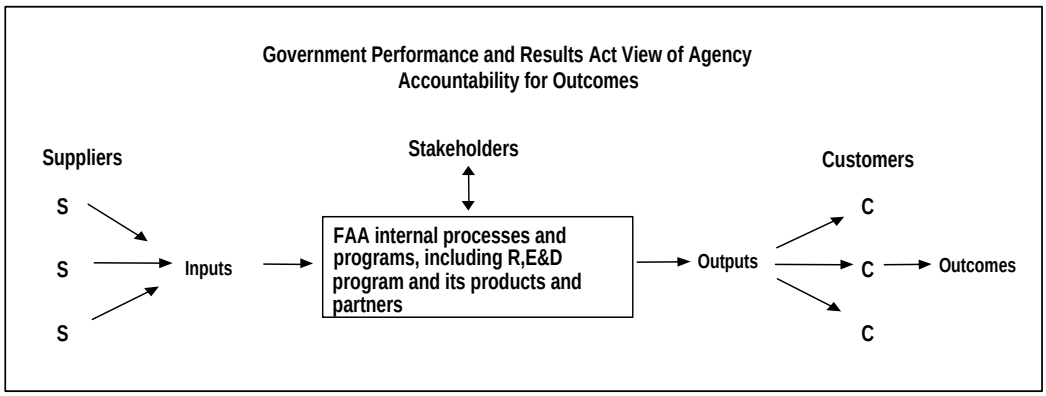


Figure 3. FAA R&D Program and GPRA Terminology

- Ensuring improved access to and increased mobility on the nation's transportation system.

The NSTC report is available on the internet at: http://www.volpe.dot.gov/resref/strtplns/nstc/aviatrd.

R,E&D Advisory Committee

Established by Congress in 1989, the FAA's R,E&D Advisory Committee (REDAC) reports to the Administrator on research and development issues and provides a liaison between the FAA R&D program and similar efforts of industry, academia, and other government agencies. The committee considers aviation research needs in air traffic services, airport technology, aircraft safety, aviation security, human factors, and the environment.

Up to thirty members may hold two-year terms on the committee. They represent corporations, universities, associations, consumers and other government agencies. The FAA's Director of Aviation Research, serves as the executive director of the committee. The REDAC meets two times during the year, typically in April and in September.

NASA's Aerospace Technology Advisory Committee and FAA's REDAC now conduct joint meetings to establish a framework allowing them to provide better support to inter-agency R&D modernization goals in the areas of safety, efficiency, and Environment and Energy.

Recent REDAC recommendations appear in Appendix A of this Plan.

1.5.2 DOT/FAA-Internal Motivators

DOT Flagship Initiatives

One hundred and eighty senior leaders from all components of the Department of Transportation met for two days in February of 1999 as the DOT's first-ever expanded Senior Leadership Team. Their charter was to identify ways to improve overall cooperation among the various departmental components and ensure consensus on crosscutting issues. DOT "Flagship Initiatives," a two-year "intermodal" strategic agenda with roots in the department's Strategic and Performance Plans, was the result.

Flagship Initiatives generally involve more than one major DOT component and cluster around five strategic goals: safety, mobility, economic growth and trade, human and natural environment, and national security. FAA programs included in previous "Flagships" have included: Safer Skies, Free Flight Phase 1, research relying upon GPS technologies, Aircraft Noise Standards, and a number of physical security efforts.

FAA Administrator

The FAA Administrator has firmly supported recent NAS modernization and related activities. The following remarks from Ms. Garvey's speeches and congressional testimony further illustrate this continuing commitment:

> "It cannot be business as usual. Let me rephrase that — it will not be business as usual. Our job is too important."
>
> — March 12, 1998
>
> "What drives us to work so hard and so well together is that we all know that Safer Skies is absolutely the right approach. This data-driven, prioritized, and measured approach is the best way to enhance aviation safety. Safer Skies is the right thing to do."
>
> — April 15, 1999
>
> "I believe that we have put into place a structure for information system security that is vigilant; and will continue to seek all ways and means to provide the greatest level of protection for our information systems."
>
> — September 27, 2000

R&D Executive Board

The nine-member R&D Executive Board (REB) was established during the past year to provide a high level of FAA-internal R&D management support to the Executive Director, Office of Aviation Research (AAR-1). The REB advises the Executive Director regarding three key program planning and implementation stages: 1) it guides the initial R&D portfolio planning and preparation phase, 2) it oversees the integration of budget requests from various projects and funding sources into one comprehensive R&D program, and 3) it helps to adjust program impacts during

the culminating phases of the annual budget deliberation process.

Membership on the REB includes senior representatives from the following organizations:

- ABU - Financial Services
- ACS - Civil Aviation Security
- API - Policy, Planning, International Aviation
- ARA - Research and Acquisition
- ARP - Airports
- ATS - Air Traffic Services
- AVR - Regulation and Certification
- AIO - Chief Information Officer
- AST - Commercial Space Transportation

The REB has taken an active role in the past year in a baseline appraisal of selected R&D management actions. This effort is part of an agency-wide initiative to document, evaluate and improve overall management processes through application of a unique integrated Capability Maturity Model (iCMM).

1.6 Ongoing Aviation Community Initiatives

All FAA initiatives described in this section relate directly to the agency's pragmatic approach to NAS Modernization. In their planning and execution, they are "benefits-driven," involve all facets of the user community, minimize implementation risk, and link to past, current, and future R&D efforts. In philosophy, they are consistent with the Free Flight operational concept: "…a safe and efficient flight operating capability, under instrument flight rules, in which the operators have the freedom to select their path and speed in real time."

All are based on the FAA's three essential goals of modernization:

- Sustain the integrity and reliability of the system.
- Improve on our Nation's excellent safety performance.
- Increase flight efficiency and flexibility.

1.6.1 NAS Architecture

The NAS Architecture responds to the requirements of the Government/Industry Operational Concept for the Evolution of Free Flight (CONOPS). The most recent version culminates an intensive effort of the FAA, DOD, industry representatives, and pilot and owners' organizations to define a comprehensive system architecture that can realistically meet the infrastructure needs of 21st-century air transportation. The NAS Architecture Version 4.0 document, approved by the FAA Joint Resources Council on September 14, 1998, was published in February 1999.

The Architecture incorporates the needs and requirements of NAS users through an incremental, benefits-driven approach to achieving the capabilities of Free Flight. It covers the transition from the current NAS through three distinct phases, respectively ending in: 2002; 2007; and the year when mature Free Flight is anticipated, 2015. The concept forms the basis for various FAA and user community plans calling for procedural, financial, and architectural decisions regarding capabilities needed for Free Flight.

Before the full Architecture was announced, a NAS Modernization model was used to validate all current and proposed R&D initiatives within the Air Traffic Services (ATS) area. New requirements were identified, and some ongoing research activities were restructured. Details of how ATS research activities map to NAS Modernization appear in the NAS Architecture Version 4.0. As system managers continue to prepare to meet future needs, they will continue to assess architecture options against the NAS Modernization model and existing capabilities.

1.6.2 Free Flight Initiatives

Free Flight enhances the aviation community's ability to collaboratively share data and to view and optimize all phases of flight - from planning and surface operations to en route flight paths. In collaboration with the aviation community, Free Flight is introducing new technologies and procedures. Free Flight is the industry-endorsed strategy that calls for the deployment of selected capabilities with potential to benefit users of the National Airspace System. Deployed systems are

integrated into the traffic management system with operational procedures and training to minimize risk and achieve greater user satisfaction.

Free Flight Program

The partnerships, systems, and regulations that will make Free Flight safe and efficient are being developed in phases through extraordinary consensus between the FAA and the full aviation community. Free Flight Phase 1 (FFP1) was begun in July of 1998 and will be completed at the end of calendar year 2002. FFP1 has deployed its "core capability" prototype systems to selected sites, in specific configurations, to demonstrate the potential of adapting known research vehicles to meet the steep capacity and efficiency demands of the Free Flight environment.

The deployed FFP1 capabilities are:

- *Traffic Management Advisor (TMA)* – A tool that aids the en route controller in making decisions regarding sequencing and spacing of en route arrival aircraft approaching selected airports.
- *passive Final Approach Spacing Tool (pFAST)* – A tool that aids the controller in making decisions regarding sequencing and runway assignment for terminal arrival aircraft.
- *User Request Evaluation Tool (URET)* – A tool that aids the controller in managing en route traffic, supporting user request decisions, and identifying potential conflicts.
- *Collaborative Decision Making (CDM)* – A collection of tools that allows the FAA and participating airlines to exchange NAS status information including weather, equipment and delays.
- *Surface Movement Advisor (SMA)* – A data distribution capability that provides aircraft arrival information to airline ramp towers and permits data exchange to support efficient surface movement.

Concerned that the momentum would be lost upon the scheduled completion of FFP1, RTCA formed the 2003-2005 capabilities working group to: define which FFP1 capabilities should be further implemented; nominate sufficiently mature capabilities for post-FFP1 implementation; identify flexible airspace and procedural initiatives that could alleviate en route congestion; and, select and prioritize a set of research projects for possible implementation within the 2003-2005 timeframe.

The FAA has selected RTCA-recommended capabilities for direct inclusion in the Free Flight Phase 2 (FFP2) program. Four of these continue and build upon FFP1 capabilities, specifically URET, TMA (used in conjunction with a single air traffic control center), pFAST, and CDM. An additional FFP2 capability, Collaborative Routing Coordination Tools (CRCT) has been added to provide improved system-wide problem prediction to controllers. The FAA also has included Controller Pilot Data Link Communications (CPDLC) Builds 1 and 1A as an FFP2 component.

The agency has opted to address FFP2 airspace and procedural recommendations through the Air Traffic Airspace Management (ATA) program and the Air Traffic Planning and Procedures (ATP) organization, respectively. These ongoing FAA management resources will develop and implement national plans to fulfill the RTCA recommendations and report their progress to the aviation community.

RTCA also recommended that certain research projects be prioritized for FFP2. These have been categorized into two groups according to the maturity level of the technologies involved:

These items are sufficiently mature to implement within the 2003-2005 timeframe:

- *Direct To (D2)* – Will aid the controller in establishing priorities by placing all aircraft eligible to fly directly to a destination airport in an ordered sequence.
- Surface Management System (SMS) – Will support the safe, prioritized movement of aircraft on the airport surface in order to increase the efficiency of arrivals and departures.
- Problem Analysis Resolution and Ranking (PARR) – Will improve upon the URET capability to provide planning and conflict detection information to controllers.
- Equitable Allocation of Limited Resources – CRCT does not currently provide this RTCA-recommended capability; therefore, the working group recommended the high priority

R&D development of automation to work toward this goal.

- Traffic Management Advisor-Multi Center (TMA-MC) – FFP1 TMA technology works best for airports located approximately 200 nautical miles from an air traffic control center boundary. The envisioned FFP2 capability will improve the efficiency of sequencing aircraft for descent through airspace controlled by more than a single center.

Development of these items will be accelerated as opportunities emerge within the 2003-2005 timeframe:

- active Final Approach Spacing Tool (aFAST) – Will improve upon the pFAST capability by adding the benefits of vector and speed data to improve the safe sequencing of aircraft on final approach.
- Advanced Vortex Spacing System (AVOSS) – A ground-based system that will dynamically provide safe spacing for aircraft in trail to a single runway.
- En Route Descent Advisor (EDA) – An en route decision support system that will aid the efficient control of en route and arrival traffic in transition airspace.
- Expedite Departure Path (EDP) – A decision support system that will assist controllers in managing unrestricted climbs into the en route system and safely merging other departure operations involving multiple aircraft.

Free Flight Phase 2 is currently working with the Joint Resources Council (JRC) to determine the appropriate funding profile for the program. Once that is established, more information will be available regarding the numbers and locations of sites to be implemented for each of the selected capabilities.

Safe Flight 21

Safe Flight 21 is a high-priority three-year activity designed to demonstrate and validate, in a real-world environment, the capabilities of advanced surveillance systems and air traffic procedures associated with free flight. The program uses Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Services-Broadcast (TIS-B) as enabling technologies. With the collaboration of the aviation industry, the program has targeted nine communications, navigation, and surveillance operational enhancements of high potential to deploy in strategically selected locations. The results will provide a basis for future FAA policies and decisions regarding the selected technologies and procedures.

The FAA is working with air carriers in the Bethel, Alaska region through the "Capstone" initiative, to improve aviation safety while offering greater efficiencies to operators. The initiative will concentrate on the evaluation and implementation of operational enhancements in the region to improve the quality of weather and other information to pilots, provide affordable means to avoid the dangers of Controlled Flight Into Terrain (CFIT), and enhance pilots' ability to see and avoid adjacent traffic.

Another Safe Flight 21 initiative pools the resources of the FAA with the Cargo Airline Association (CAA) to conduct an operational evaluation of ADS-B capabilities in the Ohio Valley. The CAA began equipping its aircraft in late 1998 in preparation for in-flight evaluations of the air-air use of promising see-and-avoid technologies. Subsequent operational evaluations have resulted in the addition of operational enhancements to the original systems and capabilities.

1.6.3 Ongoing Safety and Security Initiatives

Safer Skies

In 1997 the President's Commission recommended the FAA launch a concentrated effort to reduce accidents dramatically over the next decade. The National Civil Aviation Review Commission (NCARC) concurred and further advised that the FAA work with industry on safety data analysis. Later that year, Administrator Garvey committed the agency to developing a plan to focus its resources on the accident prevention steps that hold the greatest potential. "Safer Skies" was the result. The essence of the initiative was to look at available accident and incident data and develop intervention strategies to mitigate the major causes of fatal accidents—a pointed, pragmatic research emphasis.

The new initiative, "Safer Skies—A Focused Agenda," was announced on April 14, 1998. Under this agenda, the FAA pledged to review available data on all major causes of aviation accidents

and, where necessary, refocus its safety priorities. Just a year and a day later, Administrator Garvey was able to report to a conference of industrial participants that 230 aircraft of 13 types were collecting Flight Operations Quality Assurance (FOQA) data and 350 additional aircraft were being equipped for FOQA.

Safer Skies continues to focus on commercial and general aviation accident prevention. Accomplishments to date include:

- Published 23 final rule Advisory Directives for the inspection of high- and priority low-pressure turbine engine components capable of preventing uncontained engine failures.
- Published a final rule to reduce Controlled Flight into Terrain (CFIT) accidents by requiring Terrain Awareness and Warning System (TAWS) equipment in all air carrier aircraft.
- Published the FOQA Notice of Proposed Rulemaking and prepared related Advisory Circulars and Handbook Bulletins.
- Instituted Air Carrier programs to train pilots in the use of comprehensive Standard Operating Procedures; incorporated a CFIT training aid as part of these training programs.
- Provided special CFIT training for air traffic controllers through publication of an Air Traffic Bulletin.
- Conducted checks to ensure that by-products associated with ground-based radar provide terrain avoidance protection.
- Developed plans, procedures, and techniques for flying stabilized approaches and producing the full range of precision instrument approaches.
- Issued policy for Required Navigation Performance (RNP) procedures and operational approvals.

Research is making a valuable, direct contribution in the form of developing low cost analytical tools for FOQA and Aviation Safety Program (ASAP) data, developing synthetic vision technology, and developing data link capabilities and systems. Additional interventions are being developed and will be implemented in the near future.

Aging Aircraft Systems

In 1997, the White House Commission on Aviation Safety and Security requested that the FAA institute regulatory and research programs to address aging nonstructural systems issues not at that time covered by the FAA's Aging Aircraft Program and Aging Aircraft Research Program. In response, the FAA released the Aging Transport Nonstructural Systems Plan (ATNSP) in October 1998. The initial intent of the ATNSP is to evaluate the effectiveness of current practices for design, maintenance, and repair in preventing or mitigating aircraft accidents precipitated by degradation or damage to aircraft nonstructural systems. Based on these evaluations, recommendations will be made for changes to the current processes under which systems are designed, maintained, and repaired.

The ATNSP calls for the FAA to add the following five specific tasks to the Aging Aircraft Research Program:

- To assess the degradation of airplane electric wiring and determine the point at which wiring degradation may present a hazard to safe flight.
- To establish the condition of aging aircraft wiring components and validate the adequacy of visual inspection.
- To develop nondestructive testing tools for inspection and testing of wiring systems.
- To develop an arc-fault circuit interrupter for transport aircraft.
- To perform destructive testing of flight control linkages.

Current research initiatives related to aging systems include: the development of an aging systems test and validation infrastructure; an assessment of the condition of aging wire components; an assessment of the adequacy of visual inspection; the development of wire inspection and testing technologies and techniques; and the development, test, and validation of aircraft arc-fault circuit breakers.

One of the program's first initiatives is the development of a systems test and validation capability at Sandia National Labs. This effort will draw upon the existing infrastructure of the FAA Aging Aircraft Nondestructive Inspection Validation

Center (AANC), including its three retired aircraft: a Boeing 737, a McDonnell Douglas DC-9, and a 1971 Boeing 747 with over 100,000 hours of service. The B-747, recently added to the FAA AANC, will be subjected to an intensive visual inspection of its electrical and mechanical systems. Selected electrical and mechanical systems on both the B-747 and DC-9 testbed aircraft will also be baselined using state-of-the-art test and inspection techniques. In addition to yielding valuable insight regarding the state of aged aircraft systems, this initiative will provide two testbed aircraft for the test and validation of current and emerging maintenance technologies and procedures.

The FAA and U.S. Air Force Office of Productivity, Reliability, Availability, and Maintainability (PRAM) jointly sponsored a short-term effort to enhance an automated wire test system. The state-of-the-art equipment will be used to help baseline AANC's test aircraft and test articles and to establish a benchmark for future testing equipment developed and tested in aging systems.

The FAA is working with the U.S. Navy's Office of Naval Research and the Naval Air System Command, Aircraft Division (NAVAIR) to develop aircraft arc-fault circuit breakers. An arc-fault is the undesired, momentary discharge of current (a spark) from a conductor. This type of short circuit is particularly destructive because the high temperature of the sparks it generates, and the absence of current excursions, might trip standard thermal circuit breakers typically used on aircraft. Arc-fault circuit interrupter technology has the potential to mitigate the consequence of wire failure without requiring the redesign of aircraft circuitry. The execution plan for this initiative calls for a device sensitive to arc faulting while still meeting all performance and design specification of existing circuit breakers.

Fielding of Security Equipment

Since the early 1990s, the FAA Aviation Security R&D Program has been highly responsive to congressional mandates to expedite the passage from research to the field of less costly, more reliable aviation security technologies. To date, the FAA Security Equipment Integrated Product Team has advanced the protection of the traveling public by deploying over 531 explosive trace detection devices to U.S. airports. The team already has completed 92 installations of one vendor's advanced Explosives Detection System (EDS) installations. Another competitor's EDS was certified in October 1998. The FAA will begin phasing in new a technology at Checkpoints called Threat Image Projection (TIP). The technology applied to X-ray systems inserts fictional threats such as gun, knives, and explosives devices into the images as they are presented to screeners. This strategy increases the awareness of the screeners and allows for the evaluation of their performance. The agency works closely with its industry partners to encourage constructive competition, to decrease the costs, and to increase the reliable capabilities of field-worthy systems.

Various types of systems are in, or are nearing, prototype stage to mitigate the security threats involving the full range of aviation facilities and situations. Examples include checked baggage screening technologies, checkpoint technologies, cargo screening technologies, and systems designed for small volume vs. large volume airports and other facilities. While automated solutions are preferred, standards and training programs are being developed to screen and train the airport and airline employee operators of systems.

1.7 Cooperative Research

1.7.1 FAA/NASA Collaborative Research

FAA/NASA Safety Program

Technology has always held the key to maintaining commercial aviation's impressive safety record, but in an increasingly complex world, the search for technologies requires increasing discipline. The wrong technologies, employed in the wrong ways, could introduce more problems than they solve.

In August 2000, NASA and FAA signed the "FAA-NASA Integrated Safety Research Plan." This plan is significant in that it builds on existing relationships between the two agencies to accomplish the following important objectives:

- Builds upon the national plan for research described in the *National Research and Development Plan for Aviation Safety, Security, Efficiency and Environmental Compatibility.*
- Introduces the ability to analyze the combined research portfolios in a simple, clear format, including making needed programmatic adjustments.
- Describes how NASA and FAA will achieve ongoing communication and coordination with respect to safety research in pursuit of common safety goals.
- Establishes a strategy for the FAA and NASA to make complementary, coordinated research investment decisions.

The foundation for this plan was established on October 9, 1998, when FAA Administrator Jane Garvey and NASA Administrator Daniel Goldin signed a formal agreement to articulate and achieve specific joint goals enabling the NAS to meet its future challenges. The agencies have worked together through Memoranda of Understanding on specific topics such as human factors, aging aircraft, aircraft icing, airworthiness of new classes of aircraft, crashworthiness, energy efficiency, and noise reduction. Since 1980, each of the agencies has provided members to a common R&D coordinating committee. With the 1998 agreement, that committee was restructured into a new "FAA/NASA Executive Committee" and charged with the coordination of all joint R&D efforts.

According to the 1998 agreement, the role of NASA in our national aviation R&D is to perform research, development, verification and transfer activities upon technologies with advanced potential for long and short-term NAS improvement. The FAA's complementary R&D role is to prepare these identified technologies for introduction into the NAS. The FAA sponsors research to develop and field regulations and procedures to control the operation of new systems, as well as research to refine the systems themselves. The results of FAA R&D have provided operational benefits in direct support of the agency's key goals in safety, security, efficiency, and environmental compatibility.

The NSTC National R&D Plan provides an "Aviation Safety Roadmap" of the inter-agency plan to achieve the national goal for safety. The initiative encompasses the following research issues:

- **Accident Precursor Identification and Safety Risk Management** — Accidents rarely have a single cause. The detection and mitigation of anomalous operating conditions can actually avoid many accidents. Jointly, the FAA and NASA are working to develop the Aviation Performance Measuring System (APMS) to help all segments of the aviation community draw safety improvement from normally collected data.
- **Accident prevention** — Together with DOD, the FAA and NASA are working to improve the effectiveness of their long-term commitment to the Aging Aircraft Program. FAA is working closely with industry in aviation safety areas including the improvement of propulsion and fuel systems, the prevention of aircraft catastrophic failure, the elimination or containment of in-flight fires, and the creation of safer airport materials and systems. NASA research is developing new technologies to afford better visibility to pilots and flight crews experiencing adverse conditions, to improve the overall health of pilots and crews, and to allow pilots to regain control of their aircraft when engines or systems fail in flight.
- **Accident Mitigation** — When aviation accidents do occur, their effects can be lessened through attention to factors such as aircraft crashworthiness, occupant protection, fire safety, evacuation equipment and procedures, and airport emergency services. The FAA is conducting detailed and innovative aeromedical research to improve the chances that more passengers and crew members will survive aviation accidents. The agency also works to improve airport systems to provide better materials, methods and equipment to increase survival rates. NASA partners with the FAA on research to improve the structural crashworthiness and the fire resistance of aircraft and fuels.

Integrated Plan for Air Traffic Management for Research and Technology Development

In 1995, the FAA and NASA formed the FAA/NASA Interagency Air Traffic Management

(ATM) Integrated Product Team (IAIPT) to coordinate research into air traffic control technologies and the development of procedures for their safe and efficient use. This relationship was broadened three years later through an agreement enlisting the cooperation of the Department of Defense.

The IAIPT is comprised of the major stakeholders in the planning, execution, and outcome of ATM R&D programs, throughout the FAA and NASA. The IAIPT is structured as follows to facilitate communications and the resolution of issues:

- Co-Leads, who formulate R&D policy and goals.
- The Interagency Integrated Management Team (IAIMT), which targets R&D outputs to the needs of customers and stakeholders.
- Area Work Teams (AWT), which execute research activities in these research areas:
  - System/Cross-Cutting — System-wide initiatives, including the initial definition of concepts and assessment methodologies and demonstrations of cross-domain system(s) integration (e.g., en route, terminal, and surface decision support systems).
  - *Traffic Flow Management* — Strategic resource allocation and flow management.
  - *Surface* — Operations on an airport's surface.
  - *Terminal* — Operations in airspace surrounding one or more closely spaced airports where a TRACON or a comparable military facility provides services.
  - *En Route* —Operations in airspace between airports where an ARTCC provides services, and transition airspace between the en route and terminal environments.
  - *Oceanic* — Operations in airspace over international waters where an oceanic ARTCC provides services.

IAIPT receives guidance from the FAA R,E&D Advisory Committee (REDAC), its Subcommittee on Air Traffic Services, the NASA Aeronautics and Space Transportation Technology Advisory Committee, and the NASA Air Traffic Management Research and Development Executive Steering Committee. The IAIPT also maintains collaborative partnerships with federally-funded research and development centers, industry, academia, Department of Defense, EUROCONTROL, the Center of Excellence in ATM and Operations Research, the National Weather Service, and research contractors.

The IAIPT periodically reports to the FAA Associate Administrator for Research and Acquisitions and the NASA Associate Administrator for Aerospace Technology through the FAA/NASA Coordinating Committee. Specific program direction and control comes through internal program management mechanisms in both agencies.

IAIPT research is accomplished at the following research facilities: FAA William J. Hughes Technical Center, NASA Ames Research Center, NASA Langley Research Center, MITRE CAASD, MIT Lincoln Laboratory, Volpe National Transportation Systems Center, and NASA North Texas Research Station. Joint ATM research is described in Joint Research Project Descriptions (JRPD), as shown in the IAIPT Integrated Plan, available on the Internet at: ftp://www.faa.gov/ara/iaipt.

All of FAA's Free Flight Phases 1 and 2 capabilities have been transitioned from former IAIPT products.

1.7.2 Technology Transfer

Technology Transfer addresses the need for Government-private sector cooperation by enabling companies, institutions of learning, and Federal laboratories to work together to develop innovative technologies and marketable products.

The FAA has tailored its Technology Transfer program to meet the objectives of the Stevenson-Wydler Technology Innovation Act of 1980, the Bayh-Dole Act of 1980, the Federal Technology Transfer Act of 1986, and Executive Orders 12591 and 12618: Facilitating Access to Science and Technology.

Current projects overseen by the Technology Transfer Program Office, at the FAA William J. Hughes Technical Center include:

- Effective use of meteorological measurement and sensing equipment at airports with terrain-induced turbulence and in regions prone to inflight icing.

- Development of a generic model for predicting the transport and validating the dispersal of glycols.
- Industrial validation of an acoustic emissions technology system prototype for use with onboard hazardous materials containers.
- Development and evaluation of internationally applicable alternative user interface display options and requirements for a next generation voice communication system.
- Test and evaluation of an unleaded high octane fuel formulation for general aviation piston engines.
- Measurement of the interaction/interference between a selected set of personal medical electronic devices and the magnetic fields emitted by walk-through metal detectors.

Cooperative Research and Development Agreements (CRDA) have proven highly effective in meeting congressionally mandated technology transfer requirements where little or no funding has specifically been available to meet those needs.

Marketing is a critical component of the FAA Technology Transfer Program. The agency maintains membership in a wide range of professional organizations and on high-visibility committees that include private industry as well as all levels of government participants.

The Technology Transfer Program Office is also responsible for the Small Business Innovation Research (SBIR) program. After eligible small business contractors complete the second phase of the SBIR cycle, the office encourages them to enter into CRDAs with the FAA to strengthen their ability to perform well in Phase III, as well as to attract and negotiate successfully with venture capitalists.

1.7.3 Centers of Excellence

Air Transportation Centers of Excellence (COE) are established through cooperative agreements among academic institutions, their affiliate partners, and the FAA. COEs are established to assist the FAA in the pursuit of mission-critical research in technologies that are pertinent to developing and maintaining a safe and efficient national air transportation system. Centers may be funded in 3 phases over a period of three to ten years. Thereafter, they are expected to be self-supporting.

Center of Excellence in Airworthiness Assurance

The Center in Airworthiness Assurance was established with Ohio State University and Iowa State University as leads and seven additional core members. There are more than 100 academic, industry, and government affiliate partners. The center, established in September 1997, conducts research in the areas of:

- Maintenance, inspection, and repair
- Crashworthiness
- Propulsion and fuel systems performance
- Safety
- Advanced materials

Funded through contracts and grant awards, this center has a $100M contract cap over the next ten years and is making a $500K per year minimum commitment to fund basic and advanced research through a cooperative agreement.

Center of Excellence in Operations Research

The FAA-selected team of the University of California (Berkeley), Massachusetts Institute of Technology, Virginia Polytechnical Institute, and the University of Maryland (College Park) are the leads for the Center of Excellence in Operations Research. This team includes ten university affiliates and twenty industrial partners. The COE program uses a new funding vehicle blending grant and sole-source contracting authority to award a wide range of contracts. The center's areas of research involvement include traffic management and control, human factors, system performance and assessment measures, safety data analysis, scheduling, workload management and distribution, navigation, communications, data collection and distribution, and aviation economics.

Center of Excellence for Airport Pavement Research

The Center of Excellence for Airport Pavement Research was established with the University of Illinois (Urbana-Champaign) in April 1995 and is supported by Northwestern University. Pavement research focuses on new technologies to handle

the estimated stress loads foreseen in the next generation of high-volume, commercial aircraft, such as the Boeing 777. The COE also supports the test design and analysis work at the FAA's Pavement Test Facility at the William J. Hughes Technical Center.

1.7.4 International Activity

Global harmonization of Communication, Navigation, Surveillance, and Air Traffic Management (CNS/ATM) technologies and standards holds the key to the future success of all aviation systems. The United States (through the FAA) continues to position itself to be a leader in international efforts to maintain the safety, security, efficiency, and environmental compatibility of civil aviation. Progress towards a globally harmonized CNS/ATM system has accelerated since the adoption of the Global Plan for CNS/ATM Implementation by the International Civil Aviation Organization's (ICAO) Tenth Air Naviion Conference.

The FAA has continued to support CNS/ATM implementation by participating in ICAO technical panels, committees, study groups, and regional planning groups as well as by entering into numerous bilateral cooperative research and development agreements with countries and civil aviation organizations in every region of the world. These ICAO forums and international agreements provide the FAA opportunities to work directly with key research, engineering, and development organizations and decision makers in order to make significant contributions toward international coordination of air traffic services.

The FAA works closely with internationally recognized standards developing organizations such as RTCA and the European Organization for Civil Aviation Equipment (EUROCAE) to reach consensus with industry and the user community on standardizing and certifying evolving aviation technologies.

The FAA is also working with the Joint Aviation Authorities (JAA) and Transport Canada Civil Aviation (TCCA) to encourage international cooperation in identifying and developing technologies needed to support safety regulatory activity. The pilot program, begun in FY2000, is designed to encourage technical cooperation in limited areas through exchange of information. Continued airworthiness and regulatory concerns, exchange of information among the research communities on safety-related research, identifying areas for collaborative research will focus initially on cabin safety, flight deck human factors, and aircraft icing issues.

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 that is "unlikely to result in a final rulemaking action within five years, or in the initial installation of operational equipment within ten years after the date of the commencement of such project."

The FAA's R&D is principally associated with applied research: that is, leveraging off new technologies identified by research programs in space, aeronautics, communications, computer science, and other related fields of exploration. Developmental activities beyond this stage are found in the Engineering, Development, Test, and Evaluation activity of the FAA's Facilities and Equipment (F&E) appropriation.

Of the $186,589M appropriated for R&D efforts in FY 2001, 26% of these funds are earmarked for long-term research, with the remainder devoted to developmental/near-term efforts. Similarly, the $187,781M FY 2002 congressional budget submission for R&D designates 23% of the total request for long-term research. These percentages are significantly in excess of the congressionally mandated 15% level.

1.9 Permanent FAA Research Facilities

The FAA maintains two permanent, world-renowned research centers, The Civil Aeromedical Institute, located in Oklahoma City, Oklahoma, and the William J. Hughes Technical Center, lo-

cated adjacent to the Atlantic City International Airport in New Jersey.

Civil Aeromedical Institute

The Civil Aeromedical Institute (CAMI) is a unique, internationally recognized aeromedical facility located at the Mike Monroney Aeronautical Center in Oklahoma City, Oklahoma. CAMI maintains a cadre of in-house scientific specialists whose safety research thrusts are all distinctively human-centered and include:

- *Advanced ATC Systems Research* — Using rapid prototyping techniques with advanced real-time ATC simulation capabilities, scientists analyze advanced ATC system designs and their effects on workload and performance, develop metrics of performance and workload, assess the applications of innovative control and design concepts, and identify and evaluate the applications of intelligent systems to enhance aviation safety.
- *Behavioral Stressors Research* — Human factors researchers investigate variables that could compromise safety by impairing both air traffic controller and pilot job performance levels (e.g., shift management, age, fatigue, drug and alcohol-induced impairment, color perception) and assess the effectiveness of policies, procedures, individual coping strategies, and countermeasures to reduce performance decrements and enhance individual performance.
- *Organizational Effectiveness Research* — Through field research, analytic information is developed to measure progress toward achieving agency change goals and for agency guidance on the relative merits of various innovations intended to enhance safety, efficiency, effectiveness, workforce health and satisfaction, and system performance. Relationships between psychological characteristics (e.g., work attitudes, organizational perceptions) and the work environment (e.g., business practices, organizational climate) are explored.
- *Flight Crew Performance Assessment* — General Aviation research emphasizes design of flight deck controls and displays related to emerging technology, development and validation of performance-based criteria for use in certification and regulation, and the successful integration of training devices into existing instructional systems to enhance flight crew performance and reduce accidents and incidents.
- *Selection, Validation, Research, and Team Performance* — Researchers use laboratory and field studies to develop scientific evidence of the job validity of criteria within aviation selection and training systems. Cognitive strategies and processes underlying aviation skill acquisition through training are identified and assessment measures of individual and team performance developed to determine effects of advancing technologies on individual and workteam safety, efficiency, and effectiveness.
- *Aircraft Accident Research* — CAMI scientists maintain comprehensive databases and conduct extensive analyses involving the human factors, medical, physiological, and pathological aspects of aviation mishaps. Preventive measures and proactive interventions that will enhance aviation safety in the next millennium are rigorously investigated.
- *Forensic Toxicology Research* — Impeccable procedural integrity and robust toxicological and biochemical analyses of human samples from fatal aircraft accidents are required in support of the National Transportation Safety Board to ensure continuous safety of the NAS. Scientists evaluate the underlying human basis for mishaps to prevent future tragedies in our transportation systems. State-of-the-art analytical and molecular biological techniques, including DNA analyses, are developed to assist in identifying human causes or influences associated with aviation fatalities.
- *Biodynamics Research* — When failures do arise in aviation, occupant survival may depend directly upon the design of the seating and restraint systems in the aircraft. Evaluating the design of these systems, and ensuring their protective characteristics, requires both scientific and engineering talents.
- *Cabin Safety Research* — The ability to survive following aircraft-related emergencies

depends upon the systems, structures and procedures that are developed and investigated in CAMI's aircraft evacuation facility where researchers conduct occupant evacuations from current aircraft configurations and develop evacuation research for larger, more complex aerospace vehicles of the future.

- *Aviation Environment Safety Research* — Breathing and oxygen delivery systems for all aircraft occupants in normal and emergency situations are investigated. Threats to visual integrity and pilot performance from intense light emitters and ground-based lasers are defined. Improved measures of galactic cosmic radiation levels at various altitudes are developed by CAMI scientists to ensure that those who work and travel in the aviation system are not at a disproportionate risk for health problems from radiation exposures.

William J. Hughes Technical Center

The FAA William J. Hughes Technical Center (WJHTC) is one of the world's leading engineering, research, development, and testing facilities for nearly every aspect of aviation. Representative areas of involvement of this diverse and extensive facility include:

- *NAS Modernization* — The center uses currently fielded and newly developed systems to perform R&D encompassing every aspect of air traffic operations. Its laboratories contain current and advanced radar display systems capable of intricate simulations for the testing, development, and evaluation of both air and ground traffic procedures and en route operational concepts.
- *Services and Operations* — Every NAS service provided by the FAA is either on-site or accessible at the center. The Integration Interoperability Facility (I2F) allows staff to simulate actual operating conditions, including adverse weather, to test and evaluate systems without impacting air traffic operations or ARTCC site personnel.
- *Air Traffic Management* — The powerful capability of the Traffic Flow Management Laboratory allows for a "fast-tracked" development approach ideal for meeting escalating NAS modernization needs without extensive, traditional prototyping.
- *Human Factors* — The multiple "what if" capabilities of the Research, Development and Human Factors Laboratory apply principles derived from the behavioral sciences to plan and test the deployment of next generation NAS capabilities such as displays and workstations. As NAS modernization will increasingly rely on the automation of suitable tasks, improved and reliable computer-human interfaces are critical to the avoidance or mitigation of system-induced operator errors.
- *Navigation and Surveillance* — WJHTC scientists conduct flight tests with actual GPS signals and prototype ground stations to maximize GPS accuracy in connection with existing and projected communications capabilities. Similarly, they perform tests and evaluations of Automatic Dependent Surveillance — Broadcast capabilities to provide reliable aircraft position data to airborne and ground-based users.
- *Communications* — Simulation and live research is being performed to improve the reliability of both voice and digital data (data link) transmission.
- *Terminal Areas* — The improvement of airports' capacity is a difficult problem facing NAS modernization. Center staff work with simulation tools and test environments to refine proposed changes in takeoff and landing patterns, improvements in lighting and visual aids, and new procedures.
- *Security* — The Aviation Security Laboratory conducts extensive simulated and live testing in the areas of explosives and weapons detection, aircraft hardening, human factors, and security technology integration to provide the civil aviation system with maximum security while minimizing the adverse impacts on airline and airport operation.
- *Safety* — The Airport and Aircraft Safety R&D Division conducts research in continued airworthiness using some unique, world-class facilities. Fire and accident testing on aircraft, components, and engines requires very specialized facilities and experienced people. The center's facilities in these and ar-

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2.0 PROGRAM INFORMATION

2.1 Air Traffic Services Program Area Description

Mission

The purpose of Air Traffic Services (ATS) is to ensure the safe and efficient operation, maintenance, and use of the air transportation system today and to increase tomorrow's system safety, capacity and productivity. The ATS R&D program is an overt initiative to provide a structured, evolutionary improvement of services that keeps pace with the global growth in aviation. R&D within the program is intended to develop technology, practices, and procedures that ensure continued improvement in the delivery of air traffic services.

Intended Outcomes

The ATS R&D program is part of an integrated strategy to increase the value of the air traffic services delivered. It provides a vehicle for making long-term investments in improving services, procedures and infrastructure, as well as integrating new concepts and technology able to meet the increasing demands of safety, capacity, efficiency, and productivity. Human factors considerations are central to all outcomes of the program for a totally effective solution.

The ATS R&D program contributes to the performance outcomes contained in the Air Traffic Service Plan (2000-2002) as well as to the strategic goals of the Government Performance and Results Acts (GPRA). The program is also consistent with the goals delineated in the FAA Strategic Plan, Research and Acquisitions Performance Plan, and Regulation and Certification Performance Plan.

The ATS R&D program contributes to the four performance outcomes described below and represents increased value to the users of the system and the American public.

Improve Quality and Availability of Weather Information — Weather has a continual impact on the safety of aircraft in flight as well as the efficiency of operations throughout the National Airspace System (NAS). Weather and resultant decision making, factors in approximately 23% of all aviation accidents, annually cost the country an estimated $3 billion for accident damage and injuries, delays and unexpected operating costs. The ATS R&D program is striving to improve both the accuracy, display, and timeliness of weather information and the ability of controllers and pilots to use that information safely and efficiently. Aviation weather capabilities in the NAS must undergo major changes to improve decision making and to reduce the number of weather-related accidents. To achieve these ends, today's weather sensors must be networked to allow all NAS providers and users to receive the same weather information simultaneously.

The ATS R&D program is pursuing an aggressive schedule to develop and implement a variety of technologies that can improve the accuracy, timeliness, and usefulness of weather information in combination with extensive training for pilots and ATS personnel on the use of new weather systems.

Research is focused on increasing accurate aviation weather forecasts from their present one-hour "look-aheads" to providing reliable four-hour predictions of storms and fog. Related ATS research is currently collecting and analyzing data to demonstrate the capability of new weather technologies to decrease the rate of weather delays in the NAS.

Reduce Delays — Attested delays are traditionally used to measure ATM system efficiency. Delay occurs in the aviation system when an activity does not happen within the planned, expected, or scheduled time. Delays to commercial aviation are estimated to cost the airlines over $3 billion per year. The inconvenience of delays directly affects passengers in terms of missed flight connections and business meetings, and loss of personal time. But not all delays are avoidable. Adverse weather, for example, can close a runway or whole airport, making it impossible to land at the scheduled time.

Service improvements during the 2000-2002 timeframe will focus on Free Flight Phase 1 tools, airport expansion, and critical infrastructure

replacement programs. Airspace and airport capacity will be enhanced to improve throughput and allow aircraft to operate with minimal delay in congested areas.

Continuing to involve users in decisions affecting the flow of air traffic across the nation will reduce the impact of weather on flight schedules. While weather-related delays are harder to influence, the ATS R&D program is continuing to support Collaborative Decision Making and the implementation of automated detection and forecasting tools to mitigate the negative impact of these delays.

Improve System Predictability — System predictability allows users to plan and manage their resources efficiently. Most system users rely on schedules that define when aircraft takeoff and aircraft land. These schedules are central to the operations of commercial flights, driving crew scheduling, ground service operations, and other operational components. Near-term decisions such as scheduling and planning flights—as well as longer-term decisions such as fleet sizes, airframe types and hubbing options—are all impacted by day-to-day variation in NAS performance. Scheduled operations are highly dependent on total system predictability, and ripple effects of relatively small deviations from scheduled operations can cause widespread and drastic impacts.

The ATS R&D program is working toward increasing information flow to system users, a key ingredient to improved system predictability. Collaborative planning between ATS and all NAS users is a strategy being pursued during the 2000-2002 timeframe. As weather is a main contributor to the uncertainty in the ATM system, improvements are being undertaken to obtain and disseminate better weather products. These improvements will supply consistent information to pilots and controllers alike so that they can realize the same degree of situational awareness.

Improve System Flexibility — Measuring the flexibility of the ATM systems allows ATS to evaluate its own ability to permit users to adapt their operations to changing conditions. Users want the capability to optimize their operations in the face of objectives and constraints that can vary flight-by-flight and user-by-user.

ATC-preferred routes are important tools that help air traffic controllers to organize traffic flows around major airports and minimize conflict in congested airspace. These routes are generally not the most direct alternatives, and often differ significantly from the routes that pilots or flight planners would normally propose between two cities.

Due to the constraints of ATC-preferred routes, users sometimes experience inflexibility during the flight planning process, especially when planning flights along heavily traveled corridors. Flexibility in flight planning offers users significant benefits. Once an aircraft is airborne, the conditions for which a route and altitude were originally chosen may change. For example, winds may shift to make another route more desirable. The parameters that affect an optimal flight are highly dynamic, and ATS options must be equally flexible.

For increased flexibility of flight operations in the NAS, the ATS R&D program will continue to evolve its services toward the free flight concept of operations and work with aviation users in the review and redesign of the national airspace.

Program Area Outputs

The developmental outputs of the ATS R&D program vary in composition from operational prototype equipment to operational concepts, modeling and simulation studies, emergent technology evaluations, and procedures, standards, and guidance. Some specific examples of expected outputs for the ATS R&D program follow:

- Uplink of guidance information that will give aircraft and controllers the same situational awareness.
- Timely delivery of high-resolution information for icing, winds, temperature, and turbulence to improve aviation advisories and forecasts used by the National Weather Service.
- Human factors guidelines for shared information displays in air-to-ground communications.
- Selection criteria and training methods for operators and maintainers that reflect changes

in the operational environment and automation.

- Support to industry development of advanced avionics for small airplane and rotorcraft single pilot Instrument Flight Rules (IFR) to meet FAA requirements.
- Improved processes and practices in software development for the aviation industry and the FAA.
- Validation of Free Flight Operation Concepts.
- Prototypes of controller and Air Traffic Management decision support tools.
- Operational demonstrations of Automatic Dependent Surveillance – Broadcast (ADS-B) applications.

Program Area Structure

The ATS R&D program has been structured to support the following intended outcomes:

- Improve Quality and Availability of Weather Information
- Reduce Delays
- Improve System Flexibility
- Improve System Predictability

The ATS R&D program addresses these outcomes and strives to make the most efficient and effective possible use of R&D resources, with the objective of adding value to benefit NAS users, operators, and the public.

Customer and Stakeholder Involvement

The ATS R&D program extends to and supports the interests of a broad spectrum of the NAS user community. These involvements include those reflected in the Aviation Safety Plan, the RTCA Free Flight Action Plan, the NAS System Architecture, and the 2005 Concept of Operations documents for both ATS and the Commercial Space Transportation Program. Specific examples of customer and stakeholder involvement include:

- The R,E&D Advisory Committee (REDAC) provides guidance on the FAA's ATS investments. The REDAC Subcommittee for ATS reviews the ATS program and recommends ATS R&D investments. This program has seriously considered the Subcommittee's recommendations and has adopted much of their advice.
- The National Plan for Aviation Human Factors represents a cooperative effort between the FAA, NASA and DOD to establish a coherent national agenda for human factors research and development to improve the safety and efficiency of the NAS.
- The National Aviation Weather Users' Forum provides a process to develop a federal/industry consensus on the needs and priorities for aviation weather information and serves as a basis for seting priorities for research and development. Forum attendance includes representatives from:
  - The Airline Pilots Association (ALPA)
  - Airline Dispatchers Federation (ADF)
  - Air Transport Association of America (ATA)
  - Aircraft Owners and Pilots Association (AOPA)
  - Experimental Aircraft Association (EAA)
  - Helicopter Association International (HAI)
  - National Air Transportation Association (NATA)
  - National Association of State Aviation Officials (NASAO)
  - National Business Aircraft Association (NBAA)
  - Regional Airline Association (RAA)
  - American Airlines
  - Delta Airlines
  - Other facets of industry

Accomplishments

The following represents a partial listing of recent past accomplishments of the ATS R&D program:

- Developed prototype methodology to evaluate the impact of technological and Concept of Operations change on controller selection requirements.
- Completed Weather Support to Deicing Decision Making (WSDDM) technology transfer to commercial vendor for operational implementation.

- Implemented in-situ turbulence algorithm on multiple airframes.
- Completed convective weather forecast algorithm commercial technology transition.
- Completed national implementation of Next Generation Weather Radar (NEXRAD) Tornado Detection algorithm.
- Completed Standard Terminal Automation Replacement System (STARS) Early Deployment Capability Human Factors evaluation.
- Evaluated Enhanced Terminal Voice Systems (ETVS).
- Conducted Data Link Evaluation Simulations and Studies.
- Commenced design of a sensor for parallel runway wake turbulence sensing.
- Integrated terminal area weather products with automatic updates for airborne aircraft through use of Flight Information Service (FIS) broadcasts.

R&D Partnerships

The ATS R&D program continues to establish partnerships with U. S. Government agencies, international organizations, academic institutions, the airline industry, industry and industry user groups, and non-profit organizations. A listing of some of the current partnerships follows:

- 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
  - Direction Generale de L'Aviation Civile (DGAC)
  - International Civil Aviation Organization
- Academic Institutions
  - Embry Riddle Aeronautical University
  - Massachusetts Institute of Technology
  - Pennsylvania State University
  - San Jose State University
  - University of Maryland
  - University of Oklahoma
  - University of Quebec at Montreal
- Non-Profit Organizations
  - Advanced General Aviation Transport (AGATE) Consortium
  - RTCA
- Airline Industry
  - America West
  - American
  - Continental
  - Delta
  - Northwest
  - Southwest
  - Trans States
  - TWA
  - US Airways
  - United
- Industry and Industry User Groups
  - ALPA
  - ATA
  - Small Aircraft Manufacturers Association (SAMA)
  - AOPA
  - NBAA
  - Commercial Space Transportation Advisory Committee (COMSTAC)

Long-Range View

The essence of the ATS R&D program is to maintain a long-term view of the research requirements for the continued safe and efficient operation, maintenance, and use of the air transportation system today and to increase system safety, capacity and productivity.

Although the composition of the R&D program portfolio will change over time as some efforts transition to full-scale development or operational environments, continued investment in ATS R&D will ensure that the FAA stays current with the ever-increasing demands on the air traffic system.

The ATS R&D program is an ongoing effort with continuing funding expectations at or beyond the

current level. A continued investment in the ATS R&D will ensure the FAA has an effective risk identification/mitigation strategy for the high-risk areas of the future NAS architecture.

F&E 1F01 Runway Incursion Reduction

GOALS:

Intended Outcomes: With the Runway Incursion Reduction program (RIRP), the FAA intends to develop technologies and other solutions that minimize the chance of injury, death and damage, or loss of property due to runway accidents/ incidents within the civil aviation system. In addition, the program will improve safety and reduce the potential for accidents on the airport surface through increased pilot/controller situational awareness.

Agency Outputs:

- Develop low-cost airport surface detection equipment.
- Develop secondary surveillance capabilities for the airport surface.
- Develop a conflict-alerting and data fusion platform.

Investigate alternative options such as visual aids (lights and signs), education, training, and advisory circulars.

Customer/Stakeholder Involvement: The Air Traffic Requirements Office has been actively involved in developing requirements to meet objectives of reducing runway incursions. Additionally, the FAA Administrator has made runway incursion a priority within the Agency. Reducing runway incursions is second on the National Transportation Safety Board's (NTSB) "Most Wanted List" of safety improvements.

Accomplishments: The following R&D projects were accomplished in FY 2000:

- Completed initial multilateration/ADS-B, data fusion, and LOOP technology evaluation at Dallas, TX.
- Completed Phase II testing of LOOP technology system at Long Beach, CA.
- Completed informal evaluation of Airport Surface Detection Equipment Model X (ASDE-X) radars at Milwaukee, WI.

R&D Partnerships:

- Memorandum of Agreement (MOA) with NASA for Low-Visibility Landing and Surface Operations (LVLASO) demonstration in Dallas-Ft. Worth.
- Sensis (Vehicle Automatic Dependent Surveillance–Broadcast [ADS-B] and Aircraft Target Identification System [ATIDS]).
- CACI (safety algorithms).
- General working agreement with Volpe National Transportation Systems Center (VNTSC).
- Contract with Aircraft Owners and Pilots Association (AOPA) Air Safety Foundation.
- Memorandum of Agreement with National Air Traffic Controllers Association (NATCA).

Runway incursion reduction technologies—including low-cost radar, secondary surveillance systems, conflict alerting systems, and other alternatives with various contractors—are currently being researched. After system evaluation is completed, specifications will be developed for soliciting competitive bids for production of successfully demonstrated systems. Periodic briefings will also be conducted during the Research, Engineering and Development (R,E&D) phase to inform industry of FAA's requirements for runway incursion reduction solutions.

The FAA recently awarded a contract to produce and install an ASDE-X system at 25 airports. The system will include a radar, multilateration system, and surveillance server.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Continue evaluation of data fusion technology and surface technology risk reduction activities at Dallas-Ft. Worth, TX.
- Conduct LOOP technology operational assessment (Phase III) at Long Beach, California.
- Develop final test requirements document and select test site for evaluation of runway status lights.
- Initiate Broad Agency Announcement (BAA), awarding 10 to 15 contracts to ven-

dors, allowing them to demonstrate new and emerging surface technologies.

- Develop surface technology roadmap.
- Initiate demonstrations resulting from BAA and draft reports relating feasibility of applications to the surface technology roadmap.
- Continue testing other technology prototypes including low-cost radar, conflict alerting systems, and other potential runway incursion reduction alternatives.
- Begin Runway Safety Blue Print Initiatives.
- Evaluate airport surface marking and painting technologies.
- Evaluate Advanced Taxiway Guidance System (ATGS) and Radio Frequency Identification (RFID) system.
- Improve operational procedures and educational awareness.
- Identify solutions to improve runway safety on airport surfaces.
- Conduct data collection and analysis.

KEY FY 2002 PRODUCTS AND MILESTONES:

- BAA technology demonstrations.
- Runway status lights technology demonstration.
- Runway Safety Blue Print initiatives, including controller training, simulator/markings, education and awareness program, technology continuations, human factors studies, and industry conferences.

FY 2002 PROGRAM REQUEST:

In FY 2002, funding will provide for:

- Continuing BAA demonstration and evaluation efforts in preparation for sponsor decisions.
- Conduct of a runway status lights technology demonstration and related analysis of results and findings.
- Information sharing with air traffic controllers, pilots, and vehicle operators.
- Continuation of ATGS/RFID system demonstration and evaluation activities.
- Simulation tools for training, modeling and measuring improvements/impacts of technology on runway safety.
- Conduct of education, training, and awareness programs.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$5,168
FY 2001 Enacted	11,500
FY 2002 Request	6,533
Out-Year Planning Levels (FY 2003-2006)	23,400
Total	$46,601

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Runway Incursion Reduction	0	* 2,269	2,000	11,500	6,533
Personnel Costs	0	899	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**3,168**	**2,000**	**11,500**	**6,533**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	3,168	2,000	11,500	6,533
Total	**0**	**3,168**	**2,000**	**11,500**	**6,533**

*** In FY 1999 $900K of contract funds were allocated to Free Flight Phase 1 Atlanta GA**

Runway Incursion Reduction Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
021-250 Runway Incursion Reduction							
Runway Incursion Plan	$3,700						
Phased Array Radar (Milwaukee)		◆	◇	◇	◇		
Data Fusion/ATIDS/ADS-B/Loops (DFW)		◆	◇	◇	◇	◇	◇
Loop Technology (Long Beach)		◆	◇				
FAA/NASA Evaluation (DFW)		◆					
Systems Selection for Full-Scale Validation Testing		◆	◇				
Continuous Research on Additional Technologies		◆	◇	◇	◇	◇	◇
Multi Lateration-Demo	$833		◇	◇			
Runway Incursion Non-Technical Solutions	$2,000						
Develop Procedures		◆	◇	◇	◇	◇	◇
Develop Educational Process		◆	◇	◇	◇	◇	◇
Develop Training Guidelines		◆	◇	◇	◇	◇	◇
Total Budget Authority	**$6,533**	**$11,500**	**$6,533**	**$5,700**	**$5,700**	**$5,700**	**$6,300**

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 System Capacity, Planning and Improvements

GOALS:

Intended Outcomes: System Capacity Improvement (SCI) research directly supports three of the FAA's strategic goals: 1) Safety - reducing fatal accident rates in support of Safer Skies goal; 2) Efficiency - reducing system delays, operational criteria development time, and significantly reducing implementation risks for NAS Architecture 4.0; and 3) Global Leadership - providing global leadership in capacity and aviation simulation research.

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, and problem solving methodologies addressing such issues as the identification and development of solutions to the planned introduction of New Large Aircraft (NLA) and Smart Aircraft Transportation System (SATS) in the National Airspace System (NAS). It also includes developing an ATS performance measurement system to measure FAA progress against customer expectations and relate that performance to relevant costs. This strategy coordinates across budgetary lines allowing programs and projects to improve investment decision making and 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 workload, 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: This program will, for the first time, integrate the performing elements of the FAA necessary to gain near term safety and capacity benefits. SCI provides an ongoing problem solving research capability. This need for a highly adaptive, rapid response capability is expected to exist until NAS Modernization is complete.

SCI establishes a dedicated set of resources, set aside specifically to respond to identified problems, agreed by the performing, regulatory and consuming interests to share some or all of the following characteristics:

- Maintains or enhances aviation safety.
- Offers the potential for immediate or near-term solutions.
- Offers significant relief at locations of transportational significance.
- Employs creative applications of existing or near-term technology.
- Requires "corporate" solutions.
- Either will not interfere with or may be superceded by national solutions when they become available.

To comply with GPRA, ATS has developed four areas of capacity-related outcomes: flexibility, predictability, access, and delay. These outcomes provide guidance and a framework to enable any ATS investment 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 each year operators experience a minimum of $558 million in inefficiencies in the terminal and en route airspace. 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 Las Vegas terminal and en route arrival procedures.

- New departure routes from Los Angeles International Airport.
- Airspace suggested changes to Phoenix departure procedures.
- New dual arrival procedures into San Francisco.
- Annual savings to the aviation industry at airports and en route facilities estimated at a minimum of $450 million annually.

Predictability:

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

- Reductions in the approach minima, ensuring an average capacity gain of 30 arrivals per hour.
- Fundamental increases in the predictability of the system.
- Use (anticipated) of the Global Positioning System (GPS).
- Combined savings (estimated) to the air carriers of $40 million 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 include:

- Precision Runway Monitor—for closely spaced parallel runways with center lines separated by 3,000 feet (reduced from 4,300 feet).
- Reduced separation of 2.5 nmi on final approach (reduced from 3.0 nmi).
- Dependent staggered approaches to closely spaced parallel runways using 1.5 nmi diagonal separation.
- Offset Approach Course guidance for simultaneous operations at San Francisco, Newark, St. Louis, Cleveland, Seattle and other candidate airports.
- Converging approach standards at Chicago O'Hare, Dulles, and Dallas-Ft. Worth International Airports.

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. By 2008, 21 of the top 29 large hub airports are projected to exceed an average of five minutes of delay per operation. 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 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.
- Airfield improvements such as new runways and runway extensions, improved approach procedures, and new facilities and equipment such as the Precision Runway Monitor are being investigated.
- The improvements producing the greatest capacity increases, estimated delay reductions, and delay 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 1995, based on recommendations, 20 new runways have been constructed at major airports.
- Efforts are underway to accommodate New Large Aircraft into the operational environment.

The FAA's airport and airspace design programs have the dual objectives of addressing tactical improvements, in response to industry requirement shifts, and facilitating large-scale investment analysis and optimization planning. Securing active cooperation at the local (regional) level, and the high degree of coordination needed among affected facilities and user groups, pose process problems.

Various solutions to these problems have been proposed and simulated. The results have then been compared to make intelligent investment decisions. A detailed example follows:

Problem: On the Dallas-Ft. Worth Metroplex project, which involved substantial Airports Improvement Program (AIP), F&E, and operational investment, the effects on the system of several airspace structures, including a "do nothing" scenario, were compared.

Solution: Given the industry's plan to expand operations at Dallas-Ft. Worth, 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.

Result: This approach enabled the community to construct a new runway and ground infrastructure. It also enabled the industry to schedule growth and capital investment.

Comment: 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. The cumulative 20-year (1997–2016) estimated aircraft operating cost savings based on the Dallas-Ft. Worth Metroplex, East Runway, and New West Runway in 2003 is $13 Billion.

Customer/Stakeholder Involvement: Although the FAA directs the entire capacity program, 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.

The System Capacity Improvement Program will be established within the Office of System Capacity and will be responsible for the establishment of a government/industry communication mechanism that will ensure an effective dialogue on the subject of NAS infrastructure improvement. This outreach system may be in the form of a formal advisory committee, a series of informal seminars, or individual meetings with relevant industry elements. Specific responsibilities of the System Capacity Improvement program office are:

- Serves as a single focal point for industry driven capacity enhancement projects (one stop shopping).
- Generates, coordinates and maintains work plans for capacity enhancement projects at least two years into the future.
- Reports on resource requirements, allocations and shortfalls to both FAA management and its industry outreach mechanism.
- Reports project status to both FAA's senior management and industry representatives.

The capacity program annually publishes the Aviation Capacity Enhancement Plan to keep the aviation world informed of progress and advancements in the capacity arena. Members of the international aviation community regularly request this document. Requestors in this country include Congress; scholars and students, who use it for their aviation studies; and aviation groups, who use it to develop congressional budget justifications.

As previously stated in "Goals," the overall capacity program parallels 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 because the improvements, either combined or treated individually, are a direct cause of the constant increase in traffic. The program has recently accomplished the following:

- Prototyped and tested initial system performance measures.

- Completed more than 50 major airport studies—some of which have been updated due to growth. Estimated annual savings $75–$100 million per airport.
- Completed four major terminal/en route airspace redesigns: (1) Las Vegas approach procedures; (2) Los Angeles terminal procedure and ZLA Sectors; (3) Phoenix departure procedures; and (4) Dual arrival procedures into San Francisco.
- Completed aircraft ground movement analysis studies at Las Vegas and Salt Lake City International Airports.
- Completed Pales Verdes airspace environmental initiative.
- The program's achievements reach beyond U.S. airspace. Inquiries about our modeling and design methods and requests for assistance have been received from countries in Asia and Europe (e.g., Frankfurt am Main International Airport, Germany, and the new Kimpo 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, GPS, the Flight Management System, the Precision Runway Monitor, and other emerging technologies.
- The FAA will partner with major air carriers and business aviation aircraft in developing financial management systems approaches.
- The FAA will partner with NASA to further develop and demonstrate the Small Aircraft Transportation System (SATS), and continuance of wake turbulance efforts.
- The FAA will partner with NASA in using performance measures developed by the capacity program for ATS in compliance with the Congressional mandate for GPRA. The FAA will participate in joint computer simulation modeling for TRACON systems including the Center Tracon Automation System (CTAS) and the Standard Terminal Automation Replacement System (STARS).
- NASA Short Haul Civil Tiltrotor simulation of proposed Simultaneous Non-Interfering (SNI) Approach procedure.
- The FAA will partner with aircraft manufacturers Boeing and Airbus, avionics manufacturers, Municipal Airport Authorities, Airports Council International – North America, Air Transport Association, and the Airlines Pilots Association for proposed New Large Aircraft (NLA).
- Wide Area Augmentation System/Local Area Augmentation System (WAAS/LAAS) for Minimum Vectoring Altitude (MVA) and Automatic Dependent Surveillance – Broadcast (ADS-B) for closely spaced parallel runway analysis for Airports Council International – North America (ACI-NA).

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Conducted Continuous research to develop, refine, and/or enhance high-level outcome performance metrics that were then integrated into processes supporting GPRA requirements and investment decision making.
- Initiated Offset Approach Course guidance for simultaneous operations at San Francisco.
- Developed new Instrument Flight Rules (IFR) approach and departure concepts for improving the safety and efficiency of operations at capacity constrained airports.
- Identified the impact and developed proposed solutions to the planned introduction of New Large Aircraft in the NAS.
- Initiated converging approach standards at Chicago O'Hare International Airport.
- Initiated Airport Design Studies at John F. Kennedy, La Guardia, and Portland airports.
- Completed ground analysis at Phoenix Sky Harbor International Airport.
- Initiated efforts to accommodate New Large Aircraft into the operational environment.
- Completed Newark and Tampa Airport Design Studies.

- Participated in airport design study at Dulles International Airport and Baltimore-Washington International Airport.
- Developed procedural alternatives for increased capacity in Anchorage area.
- Completed experiment on civil tilt rotor operations into Newark.
- Explored 250 knot departure route restriction at Houston.
- Initiated and completed the Aviation Capacity Enhancement (ACE) Plan.
- Initiated NAS integration studies at 11 major airports.
- Completed airport capacity improvement demonstrations at Houston and Memphis airports.
- Conducted demonstration of Aviation System Capacity Improvement (ASCI) program at Houston and Memphis airports.
- Completed Anchorage Airport Design study.
- Completed Phoenix Airport Ground movement analysis.
- Initiate Seattle Airport Ground movement analysis.
- Completed NAS integration study of regional jets at LaGuardia and Dallas Ft. Worth.
- Completed NAS integration studies at six major airports.
- Completed capacity analysis for Runway 14/32 at Boston International Airport.
- Initiate Airport Design studies at Portland, Pittsburgh, and Boston.
- Continued solution development for introduction of New Large Aircraft (NLA) into the NAS.
- Completed analysis of the obstacle free zone – flight deck model for accommodation of NLA into the National Airspace System (NAS).
- Conducted wake turbulence separation standards reduction research at San Francisco and Boston.
- Participated in the development of Simultaneous Offset Instrument Approach (SOIA) procedures at San Francisco, Newark and St. Louis.
- Facilitated the development of Along Track Separation (ATS) procedures for operations at St. Louis and Minneapolis St. Paul.
- Supported development of domestic and international Required Navigation Performance (RNP) operational standards and procedures.
- Supported the development of enhanced departure and arrival procedures at Chicago O'Hare and Midway airports.
- Supported the development of triple approach procedures to new runways at Atlanta and Detroit.
- Completed the installation of NAS performance measurement analysis equipment at ATC System Command Center and Air Traffic Western Pacific Region and begin analysis.
- Expanded facility level metrics analysis capability to Air Traffic Southwest Region.
- Identified facilities level metrics program requirements for Airway Facilities.
- Developed En Route Balance Scorecard and conduct cost performance benchmarking and causal analysis.
- Completed 2000 Aviation Capacity Enhancement (ACE) plan.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Continue to develop new IFR approach and departure concepts and support ATP efforts for proceduresdevelopment.
- Transition offset approach course for simultaneous operationsn technologies at St. Louis and Newark.
- Continue to develop proposed solutions to integrate New Large Aircraft into the NAS.
- Complete airport design study at JFK, terminal area airspace study at Anchorage, and ground analysis at Phoenix Sky Harbor International Airport.
- Continue analysis of new and/or additional performance measures for the national airspace system.

- Conduct demonstration of the ASCI program at Atlanta, Philadelphia, Cleveland and Detroit airports.
- Support the development of parallel runway wake turbulence separation standards.
- Support fast and real time simulation of SOIA for site specific airports.
- Complete SOIA procedure development at San Francisco airport.
- Continue development of SOIA procedures at Newark, St. Louis, and initiate programs to support the development of procedures for operations at Cleveland and Boston airports.
- Finalize the Along Track Separation (ATS) recommendations for implementation at St. Louis, Minneapolis St. Paul and initiate programs to support the development of procedures for operations at Newark, Atlanta and Los Angeles airports.
- Support Multi-Lateration Procedures Development (MLPD) for operations at Memphis.
- Support the completion of converging approach standards (CASTWG) and departure procedures at Dallas-Fort Worth and Dulles Airports.
- Support efforts to analyze wake turbulence spacing at Seattle Airport.
- Complete the installation and development of NAS performance measurement analysis capability for Air Traffic's Western Pacific and Southwest Regions.
- Initiate NAS performance measurement analysis capability at Air Traffic Northwest Mountain and Central Regions.
- Initiate Airway Facilities NAS Performance measurement analysis capability and metrics development.
- Develop ATS Balance Scorecard for Flight Service and Terminal SDPs.
- Continue ATS Cost and Performance benchmarking and causal analysis.
- Continue analysis of new and/or additional performance measures for ATS.
- Initiate and complete a NAS integration study of new NAS technology.
- Complete Airport Design Studies at Portland, Pittsburgh and Boston airports.
- Initiate Airport Design Studies at Cincinnati, Memphis, and Los Angeles airports.
- Complete Aircraft Ground Movement Analysis at Seattle Airport.
- Initiate Charlotte New Runway Ground Movement Analysis and multi-lateration experiments.
- Complete 2001 Aviation Capacity Enhancement (ACE) Plan.
- Initiate capacity impact analysis of equipment location priorities in the NAS architecture.
- Initiate capacity impact analysis of selected NAS architecture capabilities.
- Initiate and complete study of Airport design for accommodation of New Large Aircraft (NLA) into the NAS by FY2006.
- Identify the impact and develop solutions to NASA's Small Aircraft Transportation System (SATS) Demonstration Program planned for FY2003 implementation.
- Identify constraints on the SATS proposal caused by existing ATC procedures and support the development of solutions.
- Support simulations (testing) of SATS procedures for safety and system efficiency impacts.
- Coordinate procedures for SATS with relevant facilities.
- Validate performance of NASA's SATS airframe/avionics package with testing to ensure adequate back-up procedure capabilities.
- Monitor efforts at enhancing ceiling and visibility forecasting for LAX.
- Participate in and support concept validation and application of ATC/ATM decision support tools to enhance arrival and departure management.
- Integrate ATC/AF Human Factors into capacity enhancements
- Initiate capacity analysis and safety assessment of domestic RVSM.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program will continue to focus on capacity enhancement at all major airports as well as on terminal and en route airspace. Primary focus areas are: (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 will continue to fine tune air traffic system performance measures. These efforts will concentrate on reducing the cost of service delivery by targeting and coordinating investments across appropriations.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$3,055
FY 2001 Enacted	5,300
FY 2002 Request	5,300
Out-Year Planning Levels (FY 2003-2006)	26,300
Total	$39,955

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
System Capacity, Planning and Improvements	0	228	1,200	5,300	5,300
Personnel Costs	0	1,627	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**1,855**	**1,200**	**5,300**	**5,300**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	1,855	1,200	5,300	5,300
Total	**0**	**1,855**	**1,200**	**5,300**	**5,300**

Note: FY 1999 funding for this budget line item included the allocation for Separation Standards.

System Capacity, Planning and Improvements	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Capacity Improvement Initiatives	$1,500						
Demonstration Projects							
Houston/Memphis		◆	◇				
Atlanta, Philadelphia, Cleveland, Detroit			◇				
Architecture Deployment Support	$900						
Conduct Analysis of System Impact of Potential New Separation Criteria							
Along Track Separation (ATS) St. Louis Lambert, Minneapolis-St. Paul, Newark, Los Angeles, Atlanta		◆	◇	◇			
Simultaneous Offset Instrument Approach (SOIA)							
San Francisco, St. Louis Lambert, Newark, Boston, Cleveland		◆	◇	◇			
Develop Required Navigational Performance (RNP) Operational Standards and Procedures for Air Carrier Aircraft		◆	◇				
NAS Performance Measurement	$1,500						
Installed NAS Performance Measurement Equipment at ATCSCC and Air Traffic AWP region		◆					
Air Traffic and Airways Facilities metrics Development and Analysis		◆	◇				
Develop ATS Balance Scorecard for SDP's		◆	◇				
Conduct ATS Cost & Performance Benchmarking and Causal Analysis		◆	◇				
Expand facility level metrics equipment analysis to AAT Regions			◇	◇			
Regional NAS Performance Measurement Implementation				◇	◇	◇	◇
Airport Development	$600						
NAS Integration – Regional Jets/Additional New Runways/Major Airports		◆					
Boston Procedures Tactical Analysis for Runway 1432		◆					
Ground Movement Analysis at Phoenix, Seattle, Charlotte, Portland		◆					
Airport Design Study at Anchorage, Portland, Pittsburgh, Boston		◆	◇				
NAS Integration – New NAS Technology		◆	◇				
Kansas City Parallel Runways Tactical Analysis				◇			
Airport Analysis and Development Studies				◇	◇	◇	◇
NAS Architecture/ACE Plan Integration	$800						
Aviation Capacity Enhancement (ACE) Plan Development		◆	◇	◇	◇	◇	◇
Equipment Location Priority Analysis			◇	◇	◇	◇	◇
Capacity Impact Analysis of NAS Architecture Capabilities			◇	◇	◇	◇	◇
Total Budget Authority	**$5,300**	**$5,300**	**$5,300**	**$5,600**	**$5,900**	**$7,100**	**$7,700**

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 General Aviation and Vertical Flight Technology Program

GOALS:

Intended Outcomes: The General Aviation and Vertical Flight (GA & VF) Technology Program supports GA demands for Communications, Navigation And Surveillance (CNS) technologies through applied research and development. These technologies support cost-effective air traffic services, improve safety, and expand NAS capacity and efficiency – especially where CNS services are not currently available to GA users. GA & VF program products are integral to NAS modernization.

The GA & VF Technology Program supports research and development across the full spectrum of GA operations. The program's research areas align with the most critical components for GA participation in the NAS-terminal operations: enroute communications and navigation, landing facilities, airmen and controller training, and low-cost avionics.

Vertical flight Terminal Instrument Procedures (TERPS) efforts support the terminal and enroute flight environment. Low-altitude CNS research provides critical data and evaluations for future low-altitude enroute infrastructure to support Free Flight. TERPS capabilities facilitate implementation and use of advanced technology in the cockpit and controllers' workstations for GA needs. These efforts are interrelated and support mutual requirements without duplication or added costs.

Agency Outputs: The GA & VF Technology Program helps generate design criteria, publish Advisory Circulars (AC) 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 project creates the following types of products and engages in the following activities related to rotorcraft Instrument Flight Rules (IFR) procedures and infrastructure:

Terminal Airspace

Criteria and design parameters for instrument approaches to hospital, corporate, and business district heliports. This development effort supports TERPS criteria, aircraft and avionics certification standards, IFR, Emergency Medical Service (EMS) procedures and training guidance, as well as Minimum Aviation System Performance Standards (MASPS), Minimum Operational Performance Standards (MOPS), and Technical Standard Orders (TSO).

Rotorcraft Air Routes

Procedures and test systems designed in an operational environment to work with Global Positioning System (GPS) navigation, surveillance and terrain avoidance technology developed by other projects. Resulting experience and information helps to integrated newer, safer, and more efficient rotorcraft routings into the NAS including the Gulf of Mexico, and can be useful to other GA systems operating at low altitudes.

Avionics and Cockpit Technology

Avionics, equipment, procedures, and related testing to enable the safe, efficient integration of GA aircraft into the NAS. These efforts have become particularly important with the introduction of GPS navigation/landing and surveillance systems, Free Flight, and other advanced concepts.

Low Altitude CNS Infrastructure

Route system guidelines, cockpit display guidelines, noise abatement procedures, and terminal and enroute system integration plans for low altitude CNS operations.

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 the VF community's direct needs related to helicopters and tiltrotors. Stakeholders include:

- Helicopter Association International (HAI)
- American Helicopter Society (AHS)
- National Business Aircraft Association (NBAA)

- Experimental Aircraft Association (EAA)
- Aircraft Owners and Pilots Association (AOPA)
- General Aviation Manufacturers Association (GAMA)
- Small Aircraft Manufactures Association (SAMA)
- National Association of State Aviation Officials (NASAO)
- Association of Aeronautical Medical Services
- National Emergency Medical Services Pilots Association
- Airborne Law Enforcement Association

Accomplishments:

- Completed evaluation of current technology to support precision IFR approaches to heliports and vertiports.
- Developed Vertical Flight Satellite Navigation (SATNAV) Road Map.
- Developed an operations concept plan to provide enhanced weather data and Flight Information Services to helicopter operations in the Gulf of Mexico as part of the next generation CNS technology.
- Developed a strategic plan and operations concept for vertical flight operations using advanced technology.

R&D Partnerships: Historically, the GA & VF Technology Program has maintained a unique R&D collaboration with industry. Partnerships, existing or planned for the near future, include:

- Experimental Aircraft Association in advanced technology avionics – for single pilot GA aircraft.
- Helicopter manufacturers and user organizations – to focus development of IFR procedures (including approaches) as well as systems and equipment to meet user identified and validated operational needs.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Developed criteria for the publication of mountain pass waypoints on Vertical Flight Rules charts.
- Supported the development of procedures and standards to enable Simultaneous Non-Interfering (SNI) operations between fixed-wing and vertical flight aircraft.
- Conducted flight tests and data analysis to investigate the potential improvement in efficiency for time-critical VF operations, such as law enforcement and emergency medical service.
- Evaluated helicopter performance through flight tests and data analysis to define aircraft and avionics requirements for steep angle approaches (greater than three degrees) to a heliport/vertiport.
- Identify lighting requirements to support helicopter Instrument Landing System (ILS) instrument approaches to 100-foot height-above-touchdown decision altitudes.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Enhance fixed wing/rotorcraft vertical flight rule procedure technology application standard by continuing research that supports use of advanced avionics (including GPS navigation, dependent surveillance, and cockpit display of traffic and weather information).
- Establish lighting requirements for heliports and vertiports to support instrument landing system and capabilities for vertical flight aircraft.
- Initiate efforts to use non-radar surveillance system in the Gulf of Mexico for FAR 135.79 Flight Locating Requirements.
- Initiate research to support steep angle IFR approaches and missed approach guidance for helicopters and tiltrotors.
- Continue research leading to establishing improved low speed GPS precision approach TERPS criteria for vertical flight aircraft operations.
- Improve the distribution of weather information in the Gulf of Mexico to pilots operating helicopters at low altitudes.
- Develop procedures and standards for vertical flight simultaneous non-interfering VFR and IFR operations in terminal areas.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program continues to focus on the areas listed at the beginning of the GOALS section above. Specific areas are simultaneous non-interfering operations in the terminal area and precision approaches to heliports and vertiports.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$3,402
FY 2001 Enacted	900
FY 2002 Request	1,000
Out-Year Planning Levels (FY 2003-2006)	5,600
Total	$10,902

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
General Aviation and Vertical Flight Technology Prog	0	1,462	500	900	1,000
Personnel Costs	0	1,440	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**2,902**	**500**	**900**	**1,000**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	2,902	500	900	1,000
Total	**0**	**2,902**	**500**	**900**	**1,000**

General Aviation and Vertical Flight Technology Program Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
General Aviation	$200						
Developed Criteria for the Publication of Mountain Pass Waypoints on VFR Charts		◆					
Enhance Fixed Wing/Rotorcraft VFR Procedures Technology Applications Standards by Continuing Research Supporting Use of Advanced Avionics			◇	◇	◇	◇	◇
Vertical Flight	$800						
Evaluate Helicopter Performance Through Flight Tests and Data Analysis to Define Aircraft and Avionics Requirements for Steep Angle Approacher (Greater Than 3 Degrees) to a Heliport/Vertiport		◆	◇	◇	◇	◇	◇
Conducte Flight Test and Data Analysis to Investigate the Potential Improvement in Efficiency for Time-Critical Vertical Flight (VF) Operations, Such as Law Enforcement and Emergency Medical Service		◆	◇				
Develope Procedures and Standards to Enable Simultaneous Non-Interfering (SNI) Operations Between Fixed-Wing and Vertical Flight Aircraft		◆	◇	◇	◇	◇	◇
Identified Lighting Requirements to Support Helicopter Instrument Landing System (ILS) Instrument Approaches to 100' Height Above Touchdown Decision Altitudes		◆					
Initiate Efforts to Use Non-Radar Surveillance in the Gulf of Mexico for FAR 135.79 flight Locating Requirements			◇	◇			
Initiate Research to Support Steep Angle IFR Approaches and Missed Approach Guidance for Helicopters and Tiltrotors			◇	◇	◇	◇	◇
Improve the Distribution of Weather Information in the Gulf of Mexico to Pilots Operating Helicopters at Low Altitudes			◇	◇	◇		
Total Budget Authority	$1,000	$900	$1,000	$1,200	$1,400	$1,500	$1,500

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

Safe Flight 21

GOALS:

Intended Outcomes: Safe Flight 21 is a government/industry initiative to demonstrate and validate, in an operational environment, the capabilities of advanced communications, navigation, surveillance, and air traffic procedures designed to improve flight safety and to increase capacity and efficiency. The program will be a step in implementing capabilities that prove to be beneficial. Specifically, Safe Flight 21:

- Addresses pilot and controller human factors issues.
- Develops and assesses new operational procedures and associated training.
- Streamlines certification processes and procedures.
- Develops a cost-effective avionics and NAS infrastructure.
- Defines a realistic NAS transition path supported by the user community.

Agency Outputs: Safe Flight 21 is essential to the risk mitigation and evolution of emerging technologies into the NAS. The program will address the risks and challenges of fielding advanced communications, navigation, and surveillance systems, such as Automatic Dependent Surveillance – Broadcast (ADS-B), Controlled Flight Into Terrain (CFIT) avoidance, Flight Information Services -- Broadcast (FIS-B), and the Traffic Information Service – Broadcast (TIS-B).

These objectives will be achieved through the following:

- Evaluating the three ADS-B links (1090MHz, Universal Access Transceiver (UAT), and VHF Datalink (VDL) Mode 4).
- Conducting operational evaluations of the following nine operational enhancements identified by RTCA:
  - FIS-B for Special Use Airspace (SUA) status, weather, wind-shear, Notices To Airmen (NOTAMs), and Pilot Reports (PIREPs).
  - Cost-effective Controlled Flight Into Terrain (CFIT) avoidance through graphical position display.
  - Improved terminal operations in low-visibility conditions.
  - Enhanced see-and-avoid.
  - Enhanced enroute air-to-air operations.
  - Improved surface surveillance and navigation for pilots.
  - Enhanced airport surface surveillance for controllers.
  - ADS-B surveillance in non-radar airspace.
  - Establishing ADS-B-based separation standards.

Customer/Stakeholder Involvement: The Safe Flight 21 program resulted from inputs that the FAA Administrator requested from the RTCA Select Committee on Free Flight Implementation. It is a jointly developed program strongly endorsed by the RTCA Free Flight Steering Committee. The Safe Flight 21 Steering Committee is the focus for ongoing coordination between stakeholders and the Safe Flight 21 program, and includes RTCA Select Committee representatives from the FAA, the Aircraft Owners and Pilots Association (AOPA), the Airline Pilots Association (ALPA), the Air Traffic Control Association (ATCA), the Cargo Airline Association (CAA), the MITRE Corporation, U.S. Airways, and the Alaska Capstone Program Office.

Accomplishments in FY 2000:

- Published the operational evaluation (OpEval) final report from the first OpEval in Wilmington, Ohio, conducted in FY 1999.
- Established an OpEval Coordinating Group (OCG) to accomplish the detailed planning for a second evaluation (OpEval-2) in Louisville, Kentucky to be conducted 1st quarter, FY 2001.
- Established or modified operational concepts and procedures required to support the Safe Flight 21 applications to be evaluated in OpEval-2, specifically:
  - Approach spacing

  - Departure spacing
  - Runway and final approach occupancy awareness
  - Airport surface situational awareness
- Began preliminary analysis for NAS-wide implementation of ADS-B.
- Acquired and installed a "single stack" Common ARTS automation system at the Louisville Terminal Radar (TRACON) facility, to be evaluated by air traffic controllers for the airborne ADS-B applications.
- Developed and installed two Safe Flight 21 color displays at the Louisville TRACON for evaluation of ADS-B applications by controllers.
- Acquired and installed ADS-B avionics and displays with moving map capability in three WJHTC (FAA Technical Center) aircraft, to be used in OpEval-2.
- Coodinated avionics requirements with industry avionics manufacturers.
- Acquired and installed a multilateration/ ADS-B surface surveillance system at Memphis, Tennessee in preparation for an FY 2001 OpEval focusing on surface management.
- Conducted evaluation of ADS-B link characteristics based on established criteria.
- The following has been accomplished under the Safe Flight 21 Capstone Program in Alaska:
  - Seventy-four aircraft have been equipped with certified Capstone avionics.
  - Three operational remote ADS-B ground stations have been installed at Bethel, Cape Romanzof, and Cape Newenham, Alaska.
  - ADS-B surveillance capability has been established at Anchorage Center.
  - New, standalone GPS approaches have been published for six remote village airports.
  - Additional Automated Weather Observation Systems (AWOS) with weather cameras have been installed, with the first site operational at Mountain Village, Alaska.
  - Over 100 pilots and associated personnel have been trained on Capstone avionics though the University of Alaska.

R&D Partnerships: The Safe Flight 21 program is based on the principle that government and industry will share in the development and implementation of new communications, navigation, and surveillance technologies as the nation enters the Free Flight era.

The FAA will partner with the aviation industry in supporting Safe Flight 21. This will allow the FAA to build on ongoing industry initiatives. It will also allow industry and the FAA to fund avionics and ground systems. Safe Flight 21 will build on Alaska Capstone and Ohio River Valley activities by:

- Identifying and resolving ADS-B technology issues.
- Developing ADS-B operational concepts.
- Focusing data collection activities during OpEvals to answer as many operational and avionics certification issues as practical.
- Focusing on cockpit human factors issues.
- Exploring the use of TIS-B and FIS-B data link messages to receive traffic, weather, and other information in the cockpit.
- Developing, in conjunction with industry partners, an integrated cockpit display of terrain, traffic, and weather information.
- Ensuring that organizations representing controllers and commercial and general aviation pilots are included in Safe Flight 21 planning and in the evaluation of operational enhancements and data link alternatives.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

The FAA anticipates accomplishing the following activities in support of Safe Flight 21 in the Ohio River Valley and Alaska in FY 2001:

- Completed preliminary analysis for NAS-wide implementation of ADS-B, begun in FY 2000.
- Conducted OpEval-2 at Louisville, Kentucky, in 1st quarter FY 2001, to demonstrate applications and gather data on approach spacing, departure spacing, runway and final approach occupancy awareness, and airport surface situational awareness.

- Conducted detailed data analysis and publish OpEval-2 final report.
- Optimized Memphis multilateration/ADS-B system in preparation for OpEval-3 at Memphis.
- Conducted OpEval-3 phase I at Memphis in 3rd quarter FY 2001, focusing on system integration of multilateration system and real-time data collection using the Dynamic Runway Occupancy Measurement System.
- Continued air traffic procedure development for terminal and enroute environment.
- Developed TIS-B and FIS-B requirements and specifications.
- Began installation of a TIS-B and FIS-B broadcast capability at Memphis.
- Updated the Operational Safety Assessments (OSA) of SF-21 Enhancements that use ADS-B, which will include an assessment of each hazard identified in the existing OSA (each of which will be evaluated in the context of the Safe Flight 21 ADS-B applications).
- Conducted a Preliminary Hazard Assessment (PHA) of ADS-B technology, which will include updating and modifying the existing ADS-B Initial Hazard Analysis (IHA) to meet the requirements for a PHA in accordance with the NAS Modernization System Safety Program Plan (SSMP).
- Conducted a Comparative Safety Assessment (CSA) to compare the NAS with ADS-B and without ADS-B at a future state.
- Conducted a CSA of ADS-B as a Conflict Detection and Resolution technology.
- Completed technical assessment of candidate ADS-B links.
- Certified the Anchorage Micro-En Route Automated Radar Tracking System (EARTS) for radar-like services using ADS-B and begin service provision.
- Completed ADS-B avionics installation in remaining Capstone-participating aircraft.
- Demonstrated incorporation of WAAS technology with Capstone avionics in southeast Alaska.
- Evaluated FIS-B products and capabilities in the cockpit.
- Obtained globally harmonized ADS-B link decision.
- Approached the Joint Resource Council (JRC) for limited deployment of ADS-B applications in Alaska statewide.

KEY FY 2002 PRODUCTS AND MILESTONES:

Key FY 2002 products and milestones involve activities related to the limited implementation of ADS-B applications in the Ohio River Valley and Alaska that prove beneficial in meeting the intended outcomes of improving flight safety and increasing capacity and efficiency.

Avionics and ground systems

- Coordinate within FAA to initiate the integration of ADS-B into the ARTS and STARS baselines.
- Complete initiated procurement activities to acquire avionics for OpEval use with airport surface moving maps and TIS-B and FIS-B products.
- Complete installation of a TIS-B and FIS-B broadcast capability at Memphis.
- Conduct end-to-end evaluations.

Engineering and operational evaluation

- Conduct OpEval-3 Phase II in Memphis in 1st quarter FY 2002, focusing on a cooperative, interactive Surface Management System with decision support tools.
- Begin measuring system benefits at Memphis against an established baseline.
- Conduct OpEval-4 in Memphis in third quarter FY 2002, focusing on terminal airspace applications, TIS-B and FIS-B broadcast services in the terminal airspace, and a full-up demonstration of an integrated surface environment to enhance safety and efficiency.
- Start Investment Analysis for NAS-wide ADS-B implementation.

FY 2002 PROGRAM REQUEST:

FY 2002 funding completes procurement of avionics and ground systems necessary to conduct operational evaluations. The funding also provides for operational evaluation, procedures development, certification tasks, and simulation activities.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$32,000
FY 2001 Enacted	35,000
FY 2002 Request	24,000
Out-Year Planning Levels (FY 2003-2006)	109,400
Total	$200,400

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Safe Flight 21	0	16,000	16,000	35,000	24,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**16,000**	**16,000**	**35,000**	**24,000**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	16,000	16,000	35,000	24,000
Total	**0**	**16,000**	**16,000**	**35,000**	**24,000**

Safe Flight 21 (Capstone Initiative/Ohio Valley) Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Safe Flight 21 (Capstone Initiative/Ohio Valley)							
Operational Enhancements	$24,000						
Provide Weather and Other Information to the Cockpit		◆	◇	◇			
Provide Affordable Means to Reduce Controlled Flight Into Terrain (CFIT)		◆	◇	◇			
Improve Capability for Approaches in Low Visibility Conditions		◆	◇	◇			
Enhance Capability to See and Avoid Adjacent Traffic		◆	◇	◇			
Enhance Capability to Delegate Aircraft Separation Authority to the Pilot			◇	◇	◇	◇	◇
Improve Capability of Pilots to Navigate Airport Taxiways		◆	◇	◇	◇		
Enhance Capability for Controllers to Manage Aircraft and Vehicular Traffic on Airport Surface		◆		◇	◇	◇	◇
Provide Surveillance Coverage in Non-Radar Airspace		◆		◇	◇	◇	
Provide Improved Separation Standards		◆					
Data Link Evaluation		◆					
Program Management and Support		◆	◇	◇	◇	◇	◇
Safety Assessment		◆	◇	◇			
Total Budget Authority	$24,000	$35,000	$24,000	$26,400	$31,400	$29,100	$22,500

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.
– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.
– The FY 1999 Facilities and Equipment appropriation allocated $11M for the Alaska Capstone project and $5 for the Ohio Valley project.
– In FY 2000 Safe Flight 21 was Funded in F&E Budget Activity 1.

F&D 1F01 — Operations Concept Validation

GOALS:

Agency Outputs: The agency provides:

- A well-defined and well-understood "validated" operational concept based on system modeling and simulation.
- Validated, integrated, configuration managed requirements for the subsystems of the new target system to provide a coherent, comprehensive framework to guide associated research and development activities (e.g., specific requirements for Automatic Dependent Surveillance Broadcast (ADS-B) capabilities, Surface Management capabilities, Advanced Concept Probe).
- Top-level designs for the major new Air Traffic Management (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 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. The FAA has conducted a detailed survey of the major stakeholders to obtain their ranking of future concept sub-elements to support modernization. This level of stakeholder participation, essential for validating the concept for a modern NAS based on a shared, integrated infrastructure, ensures that the concept fully reflects user community requirements.

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 4.0. Additional details appear in the appendices to this document.

Starting in FY 1999, activities initiated included validation of concepts and associated top-level designs, risk-mitigation planning, and coordination of a validation plan with the human factors activity. These activities include:

Operational concept development

- Developed a detailed framework for individual service enhancement and domains to support the development of system level requirements for modernization.
- Developed a NAS performance model for evaluating the impact of proposed concepts on operational performance. Developed quantitative measures and goals for midterm concept capabilities.
- Developed detailed concepts for individual service enhancement and domains to support the development of system level requirements for modernization (in particular, to support development of a concept of use for integrated Decision Support Tools for the 2003-2005 timeframe).

Concept validation

- Conducted a comparison of U.S. Eastern Triangle operations to European core airspace.
- Developed the capability for fast-time analysis of new concepts such as multi-sector planning and dynamic resectorization.
- Conducted joint FAA/NASA/user concept validation activities, including human-in-the-loop simulations.

Concept system design

- Conducted an analysis of the effects of dynamic boundaries on operational and controller performance. This is a step in the development of dynamic sectorization to support

increased route flexibility in the face of increasing demand.

- Conducted analysis of en route sectorization strategies to support the mid-term design for the Eastern Triangle.

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

The concept development and concept validation effort 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, which would impose an undue burden on U.S. carriers, manufacturers, and other participants in the global airspace system.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Operational concept development

- Developed detailed concepts for Flight Intent.
- Developed detailed concepts for Information Management of airspace resources to facilitate improved flight planning and impact assessment.

Concept validation

- Developed testbed for modernization.
- Performed airspace assessment of gridded airspace uniform ultra-high sectors, ultra-high centers.
- Developed information flow model to translate concepts into interface requirements.

Concept system design

- Conducted closed-loop modeling of changes in airspace/airports and user demand.

KEY FY 2002 PRODUCTS AND MILESTONES:

Operational concept development

- Develop detailed concepts of operations for the interaction of service providers in en route and terminal airspace to support the validation of the FAA's Airspace Management Concept.
- Develop detailed concept of operations for the evolution of Traffic Flow Management.
- Develop concept and potential measures for Required Total System Performance (RTSP).

Concept validation

- Establish the Validation Data Repository to capture all activities and results associated with concept and concept of use validation activities in the FAA. Establish metrics to allow comparability of results across program validation efforts in the U.S. and Europe.
- Conduct SWIM –System Wide Information Management (SWIM) concept validation.
- Validate the flight intent concept of use to assure completeness and harmonization of the definition for integration into ground and airborne decision support systems in the US and Europe.

Concept system design

- Extend closed-loop system dynamic modeling of decisions and demand dynamics related to scheduling and management of aircraft in congested en route airspace.
- Leverage the work in the human factors research and the human factors and the operational validations experimentation to define the information type, update rate, and display requirements that needed to support the agreed to operational improvements of the NAS concept of operations through 2010.

FY 2002 PROGRAM REQUEST:

The FY 2002 request extends the high level concept of operations and the early validation efforts into detailed concepts of operation for the evolution of Airspace Management and Traffic Flow Management. Concept validation efforts provide the performance requirements for information management to support the tactical and strategic common situational awareness assumption and needs of the next generation of ground and airborne support systems, including weather and traffic information distribution. The

operational concept validation efforts extend the identification of information type, update rate, and display requirements to decision support tools in general. The request also extends the development of performance measures to validate the operational improvements of future concepts as well as dynamic models of the interactions of schedule and control decisions on the performance of the NAS.

Also leveraging work is being performed by: (1) EUROCONTROL on the European Air Traffic Management System (EATMS) Concept and the associated ATM 2000+ strategy, and (2) the FAA in support of the International Civil Aviation Organization (ICAO) Air Traffic Management Concept Panel.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$9,018
FY 2001 Enacted	1,400
FY 2002 Request	2,500
Out-Year Planning Levels (FY 2003-2006)	15,900
Total	$28,818

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Operations Concept Validation	0	3,412	2,200	1,400	2,500
Personnel Costs	0	3,406	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**6,818**	**2,200**	**1,400**	**2,500**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	6,818	2,200	1,400	2,500
Total	**0**	**6,818**	**2,200**	**1,400**	**2,500**

Operations Concept Validation Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Operations Concept Validation							
Operational Concept Development	$300						
Develop Detailed Concepts for Flight Intent		◆	◇				
Develop Detailed Concepts for Information Management of Airspace Resources to Facilitate Improved Flight Planning and Impact Assessment		◆	◇	◇			◇
Concept Validation	$800						
Develop Testbed for Modernization		◆	◇	◇	◇	◇	◇
Perform Airspace Assessment of Gridded Airspace Uniform Ultra-High Sectors, Ultra-High Centers		◆	◇	◇	◇	◇	◇
Conduct Joint FAA/NASA/User Concept Validation Activities, Including Human-in-the-Loop Simulations		◆	◇	◇	◇	◇	◇
Complete Development of Information Flow Model to Translate Concepts into Interface Requirements		◆	◇	◇	◇	◇	◇
Validate flight intent concept			◇	◇	◇	◇	
Conduct Closed-Loop Modeling of Changes in Airspace/ Airports and User Demand		◆	◇	◇	◇	◇	◇
Ops Concept Development	$300						
Develop Detail Concepts of Operations for Interaction of Enroute & Terminal			◇	◇	◇	◇	
Develop Concept for Evolution of Traffic Flow Management			◇	◇	◇	◇	
Develop Concept & Measures for RTSP			◇	◇	◇	◇	◇
RTCA	$400						
Communication Concepts & Standards Ground/Ground	$700						
Total Budget Authority	$2,500	$1,400	$2,500	$2,600	$2,700	$5,000	$5,600

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 Software Engineering R&D

GOALS:

Intended Outcomes: The FAA intends to improve NAS and avionics safety and reduce NAS and avionics acquisition, development, and maintenance costs by developing and implementing improved software processes and procedures. These actions will directly benefit passengers (as well as all elements of air transportation) and greatly contribute to a safe, secure, and efficient NAS.

The FAA Software Engineering Resource Center (SERC), established in June 1998, is a focal point for research on FAA software-intensive systems. The SERC is an FAA-wide resource that addresses strategic software technology problems impacting the mission performance and enhancement of FAA in-house software/systems engineering competencies. The primary SERC facilities are located at the William J. Hughes Technical Center.

Agency Outputs: The principal products of SERC efforts include a series of standards, guidelines, models, research papers, and "evolvable" prototypes. They demonstrate, validate, and verify the safety properties, performance, and other critical attributes of anticipated new NAS technologies. The SERC also evaluates and validates improved software processes, methods, and engineering tools that enhance architecture and systems, as well as engineering, testing, and certification functions for the life cycle of NAS systems software. The SERC brings together recognized experts and FAA personnel to solve problems related to Commercial Off-The-Shelf/Nondevelopmental Item (COTS/NDI) and the next generation architecture. These activities transfer skills to and increase the technical competency of the FAA workforce.

Following are specific focus and outcomes of SERC applied research work:

Research on applying COTS/NDI within the NAS ground systems and avionics

- COTS/NDI software assurance research: This research directly supports the Flight Controls and Digital Avionics Systems by investigating conditions that allow COTS software products to be certified to a given currently-defined level of safety. 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. The research also will identify and evaluate techniques for reducing cost and schedule to ensure that COTS/NDI software sytems 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 analysis and design, and testing that are appropriate for safety-related systems using COTS/NDI software. It includes investigating methodologies to quantify, characterize, and guard against the risk of accidentally activating unintended COTS functionality for a given system and environment.
- Software estimation models for COTS-intensive systems Research is seeking to identify/develop better ways of estimating and predicting the life cycle 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 produce a set of evaluation criteria and guidelines for COTS software proposed for use in safety-related aviation systems. It will also establish the processes and technical methods required to evaluate COTS/NDI-based systems prior to contract awards and ensure that use of COTS/NDI software will not compromise aviation system safety.

NAS architecture research

- Evaluation and prototyping of high-integrity, safety-critical architectures: The emphasis is to find better and less expensive ways to ensure that NAS hardware and software are safe, secure, and efficient in the face of chal-

lenges from bad code, security breaches, and the like.

- Architecture definition and description: This research is investigating unified approaches to formal architecture definition and description for cost-effective evaluation and comparison of competing candidate architectures for acquisition.
- Analytical and simulation architecture models for the NAS: This research is investigating the operational effects of optimized constraints, including cost and performance, before committing resources to NAS systems implementation and deployment.

Specific research outputs will be guidelines and standards for defining, representing, and designing high-integrity architectures for the NAS and, executable and reusable architecture models and simulations that can be extended or tailored to support NAS domain-specific engineering and product acquisitions.

Software certification research

- Processes for certifying software of safety-critical airborne and ground-based systems within the NAS. Current certification processes require a long lead time and are costly: Resulting delays affect the rate at which aircraft can be equipped with modern, affordable avionics and are a significant contributor to the long lead time required for NAS modernization. This research is exploring 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: Air and ground segments are becoming more integrated within the NAS through new services such as data link. The current practice of separately certifying NAS airborne and ground components can no longer be relied upon as the sole means to ensure safety of the integrated air-ground system. This research is investigating and will validate different approaches for performing end-to-end safety assessments and certification of the integrated air-ground systems.

This research will produce a series of guidelines and processes for improving certification of avionics and ground systems. Specific recommendations will also be provided to the appropriate RTCA committees that develop standards and guidelines for certification of avionics systems.

Customer/Stakeholder Involvement:

The goal of streamlining the software aspects of certification is to assess cost and schedule drivers for certifying both avionics and ground systems software, and to prototype solutions that may reduce cost and schedules. This supports objectives of the Office of the Associate Administrator for Research and Acquisitions (ARA) and the Office of the Associate Administrator for Regulation and Certification (AVR).

Recommendation R-14 of the "Report of the Challenge 2000 Subcommittee of the FAA R,E&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 SERC's COTS/NDI software assurance research work is directed toward answering the recommendations of this Subcommittee and also addresses concerns and recommendations contained in the *COTS/NDI in Safety-Critical System* 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 its section 4.0 to Software Engineering Research and Development. It concludes with a number of critical recommendations concerning 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 to address the concerns and identified weaknesses noted by the Subcommittee.

ACCOMPLISHMENTS:

Research on applying COTS/NDI within the NAS ground systems and avionics

- Completed first phase of development of a Constructive COTS Cost Estimation Model (COCOTS), collected maintenance data on 20 projects, conducted research on life-cycle cost criteria, and began development of a full life-cycle cost model.

NAS architecture research

- Completed NAS Adaptation Process Improvement (API) study. This resulted in initiation of Summary of Mission Analysis Findings for the National Airspace System Resources (NASR) System.
- Funded studies to develop a business case for consolidating projects requiring computing resources in order to reduce acquisition, operations and maintenance costs. ("Enterprise view" as opposed to "stovepipe/project specific" approach).
- Developed a proposal to leverage investments in Enroute Sustainment projects to include requirements supporting the NAS 4.0 infrastructure. (Cost and People resource savings).

Software certification research

- Initiated a Streamlining Software Aspects of Certification (SSAC) program to focus on identifying cost/schedule/quality issues in the certification of ground-based systems software components.
- R&D Partnerships:
- Constructive COTS Cost Model – University of Southern California
- COTS Guidelines – Software Engineering Institute
- Adaptation Process Improvement – Boston University
- Evolutionary Spiral Process – Software Productivity Consortium
- Partnership agreements will be initiated with EUROCONTROL, DOD, National Institute of Standards and Technology (NIST), and others.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Research on applying COTS/NDI within the NAS ground systems and avionics

- Complete Constructive COTS Cost Estimation Model and pilot the model on three FAA projects.
- Support development of COTS life-cycle management plans and life-cycle issues.

NAS architecture research

- Fund research studies to develop business cases for consolidation of projects requiring computing resources to reduce acquisition, operations and maintenance costs ("enterprise view" vs. "stovepipe/project specific").
- Conduct studies and develop prototype applications to improve efficiency of accomplishing NAS adaptation services.

Software certification research

- Continue to maintain and develop Communication, Navigation, and Surveillance/Air Traffic Management (CNS/ATM) guidelines to ensure consistency with RTCA SC 190, CNS/ATM subgroup.

KEY FY 2002 PRODUCTS AND MILESTONES:

During FY 2001, the COCOTS life-cycle model will be available for use within the FAA's Acquisition Management System. Training, workshops, and briefings will be provided on the use of COTS/NDI products in acqusitions. Electronic access to aeronautical information prototype products will be made available for field use. The SERC will act as a virtual and physical facility to coordinate completion of these

software engineering research products. Technology transfer liasons will be established with remote researchers and research sites.

FY 2002 PROGRAM REQUEST:

The software engineering research programs will build upon prior related activities conducted by the SERC and will continue to leverage resources throughout the United States, particularly those of aviation-related programs already underway at several universities. Specific work will be focused on advanced software architecture and technology applications for specific NAS Programs, and on continued end-to-end assurance of safety critical software systems.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$1,300
FY 2001 Enacted	900
FY 2002 Request	1,000
Out-Year Planning Levels (FY 2003-2006)	5,200
Total	$8,400

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Software Engineering R&D	0	462	300	900	1,000
Personnel Costs	0	538	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**1,000**	**300**	**900**	**1,000**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	1,000	300	900	1,000
Total	**0**	**1,000**	**300**	**900**	**1,000**

F&E 1F01 — 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 realized by the airlines, the traveling public, and the FAA include:

- Increased air traffic control efficiencies and NAS capacity through an airspace system that is restructured to accommodate direct routings between airports, as well as reduced separation standards.
- Reduced fuel cost to airlines and reduced travel time to the public through use of more economical air routes.
- Reduced FAA operating costs through the potential decommissioning of existing ground-based navigation equipment.
- Simplified Global Positioning System (GPS) augmentation infrastructure through introduction of wide area and local area interoperability that provides satellite navigation services at a reduced cost.

Agency Outputs:

Wide Area Augmentation System (WAAS)

The FAA uses the National Satellite Test Bed (NSTB) as the foundation for all current research and development activities associated with implementing the Wide Area Augmentation System (WAAS). The NSTB is essential to the development and implementation of Global Positioning System (GPS) and its WAAS augmentations. Findings from the NSTB help the FAA develop required user equipment through avionics manufacturers, continue development of GPS user procedures, and gain international acceptance of a seamless Global Navigation Satellite System (GNSS).

Using the NSTB as a prototype system, the program is developing and implementing the capability to monitor and evaluate system performance of both the basic GPS service and the WAAS during implementation activities. During these evaluations, large quantities of complex technical data will be collected, analyzed, and archived.

The data will be made available to the FAA and other Government Agencies (as well as to industry, academia, and international entities) to facilitate information exchange, foster cooperation around the world, and achieve a seamless global air navigation system.

The results of this “live” data collection and analysis will assist the FAA in: (1) analyzing and defining the satellite-based navigation technology requirements of air traffic and airway facilities; and (2) determining connectivity and interoperability requirements for international augmentation systems being developed by other countries. The information obtained from these performance evaluations will also allow the FAA to monitor the WAAS system contractor performance.

When the Phase I WAAS becomes operational, the FAA plans to approve the use of GPS as a primary means of navigation for en route through non-precision approaches. Initial WAAS capability will provide Lateral Navigation/ Vertical Navigation (LNAV/VNAV) capabilities. Future phases of WAAS are expected to provide precision approach capabilities which will increase the numbers of airfields with a precision approach capability, and potentially enable the decommissioning of some existing ground-based navigation equipment throughout the U.S.

Local Area Augmentation System (LAAS)

The Local Area Augmentation System (LAAS) Test Prototype (LTP) system is being used to test and validate the expected performance of LAAS systems. The LAAS is intended to complement the WAAS, and the systems function together to supply users of the NAS with seamless satellite-based navigation for all phases of flight. The LAAS will be used to meet Category I Precision Approach requirements at those locations where WAAS is unable to meet those requirements. LAAS will also be used to meet the more stringent Category II/III requirements at selected locations throughout the U.S. LAAS will yield the extremely high accuracy, availability, and

integrity necessary for Category II/III precision approaches. It is fully expected that the end-state configuration will pinpoint an aircraft's position to within one meter or less.

The FAA has developed and provided a functional Category I LAAS specification, architecture, and Minimum Operational Performance Standards (MOPS) to industry for implementing local area systems across the United States. The FAA will validate the capability to perform Category II/III precision approaches through continued research and development efforts associated with the LAAS Program. An LTP has been developed, and is being used to conduct nationwide flight tests in cooperation with several end-state users of LAAS technology including United Parcel Service (UPS) and Federal Express (FedEx).

Customer/Stakeholder Involvement:

The program's implementation strategy involves other government agencies, industry, and academia.

The FAA has established and continues to actively participate on various teams addressing immediate needs for operational implementation issues. These include the Satellite Operational Implementation Team (SOIT), Satellite Procedures Implementation Team, Air Traffic SOIT (ATSOIT), and many other Teams and working groups.

The FAA has also founded the Technical Interoperability Working Group (IWG) in which the developers of all worldwide Satellite Based Augmentation Systems (SBAS) [U.S. WAAS, the European Geostationary Navigation Overlay Service (EGNOS), Japan MTSAT Satellite Based Augmentation System (MSAS), and Canadian WAAS] meet on a periodic basis to identify and address potential technical barriers to seamless travel between any of these systems. These meetings began in 1997 and are expected to continue until approximately 2001-02.

The FAA works cooperatively with the Positioning and Navigation Executive Committee, the Joint Precision Approach and Landing System Program, and the Department of Defense to establish and promote a national consensus on GPS management and operation. The FAA also provides active support to the Interagency GPS Executive Board (IGEB) regarding overall GPS modernization issues.

Accomplishments:

On September 2, 1999 the FAA Joint Resource Council (JRC) meeting was held to decide the future direction of satellite navigation programs. This forum also considered information from the recently performed and congressionally mandated Investment Analysis (IA). The JRC reaffirmed the FAA's commitment to satellite-based navigation; approved the WAAS Acquisition Program Baseline (APB); approved additional satellite leasing preparatory activities; and approved the LAAS Acquisition Program Baseline, including quantities and schedule changed as the result of this IA, increasing from 143 to 160 systems.

WAAS

The development of WAAS has continued to achieve many significant program milestones. In FY 00, WAAS successfully completed a milestone stability test. The WAAS signal-in-space continues to provide accuracies well within the range required by the WAAS specification.

To support the expansion of WAAS to the Caribbean and South American Region (CAR/SAM) region, the FAA has secured letters of intent from Mexico and Panama for participation in the operational U.S. WAAS. Additionally, both countries signed bilateral agreements for the installation of NSTB reference stations to be used to prepare for the installation of operational WAAS reference stations in the near future. Related uses of the reference stations include pre-operational support, technology familiarization, flight tests, certification activities, procedure development, and siting analyses. These agreements will significantly cut the FAA's expenses by reducing the agency's need to field WAAS reference stations along the southern U.S. border.

In addition, the FAA has assisted the International Civil Aviation Organization (ICAO) with plans and strategies for the development of a WASS/LAAS-based GNSS test bed capability for the CAR/SAM region. The resulting South American Test Bed (SATB) will pave the way for

an operational system in the region that is completely compatible with the U.S. systems. This future capability, based on U.S. technology, will also provide cost-sharing opportunities on GEO satellite services, significantly reducing projected FAA leasing expenses for end-state WAAS GEOs.

The successful completion of all flight tests and other activities helped to: (1) demonstrate U.S. technological leadership in satellite navigation; (2) ensure the seamless transfer from one regional satellite-based navigation system to another; (3) promote the adoption of satellite navigation in regions where improved navigation capability will increase the safety of flight for U.S. citizens traveling abroad. WAAS will provide the groundwork necessary to achieve the International Civil Aviation Organization's vision of a future, worldwide, seamless, navigation capability.

LAAS

Research and development activities to use LAAS to achieve Category I and Category III precision approaches progressed substantially through the use of the LAAS Test Prototype. Tests using the LTP were completed with excellent results at various locations around the nation.

In August 1999, the FAA, in conjunction with UPS and the Air Transport Association (ATA), conducted approximately 40 precision approaches using a wide-body aircraft and the LTP. These tests had very positive results for the use of LAAS and its pseudolite technology on wide-body aircraft. All previous tests were conducted on narrow-body aircraft.

In October 1999, the FAA, in conjunction with FedEx and ATA, conducted further wide-body flight testing at Memphis International Airport. The purpose of these tests was to verify the reception of the airport pseudolite (APL) signal by a wide body aircraft (MD-10) and the ability to accurately range from that signal. A total of 45 precision LAAS approaches were conducted to all six runway ends. Results of the test indicated the typical horizontal Navigation System Error (NSE) estimate was less than one meter, and the vertical NSE was less than two meters. These results are well within LAAS requirements. These successful flight tests demonstrated the potential of this new technology and the significant contribution LAAS will make to the advancement of satellite-based aviation.

The LAAS Integrity Monitoring Test Bed (IMT) is another tool currently being utilized to validate LAAS requirements and performance. The final version is expected to be deployed at San Francisco International Airport for ground data collection.

Furthermore, LAAS Category I development is proceeding forward. Government Industry Partnerships (GIP) reflecting this effort were signed with Honeywell and Raytheon in April 1999. The LAAS Category I Specification was finalized and approved in September 1999. The Category I MOPS is expected to be approved by February 2000. Category II/III research and development efforts are continuing. LAAS development is ongoing with an initial public use expected for 2003 for Category I and late 2005 for Category III. Work has begun on a LAAS siting document.

R&D Partnerships:

The FAA has approximately 20 grants, interagency agreements, and contracts 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), and the Central Intelligence Agency (CIA).

In addition, 15 cooperative bilateral agreements are in place, with additional agreements currently in progress, to facilitate and promote the communication and information transfer for a seamless global navigation satellite system.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Perform data collection and analyses using the NSTB to further develop WAAS performance-assessment capabilities.
- Support developing WAAS antenna interference mitigation and rejection methods, a safety processor to meet FAA safety assur-

ance standards, and analyze satellite alternatives for WAAS final operating capability.

- Continue to conduct ionosphere data collection and analysis to define WAAS final operational capabilities.
- Continue research into signal quality monitoring, operations and maintenance, flight control monitoring, and automatic dependent surveillance with participation from Stanford and Ohio Universities.
- Continue investigation studies and analysis for surface movement guidance, helicopter operations, and advanced LAAS augmentations using pseudolites.
- Continue to develop and mature the LAAS integrity algorithms.
- Continue installing and testing of LAAS prototype systems at several sites to ensure that the systems will validate the functional specification in particularly difficult sites.
- Continue to demonstrate and test international connectivity as a transition to a seamless global navigation system.
- Continue to coordinate with ICAO to produce Standards and recommendation Practices (SARPS) to define LAAS in the international community.
- Continue interference analysis to identify and mitigate potential threats.
- Continuation/Completion of LAAS Category I Specification Validation efforts.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Define optimum SATNAV architecture for Alaska.
- Investigate satellite anomalies.
- Perform time transfer studies for SBAS interoperabillity.
- Develop WAAS performance monitoring and assessment capabilities.
- Define and test SBAS interoperability scenarios.
- Characterize peak solar cycle in support of developing a WAAS ionospheric algorithm for future phases of WAAS.
- Develop interference detection and mitigation techniques.
- Analyze impact of additional civil frequencies.
- Validate LAAS Category I Integrity.
- Develop LAAS Category III requirements for autoland.
- Further refine FAA LAAS Category II/III test prototype.
- Develop and validate LAAS Category III Specification.
- Validate LAAS Category II/III Integrity Monitoring.
- Develop Improved Signal Quality Monitoring Techniques for CAT III LAAS.
- Investigate Ephemeris Monitoring requirements for CAT III LAAS.
- Develop ICAO SARPS Standards for Category II/III LAAS.
- Develop Airport Pseudolite Integration Techniques.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program request of $5.7M will focus on developing and implementing GPS augmentations to further the transition to satellite-based navigation technology. Efforts will focus on research and analysis of issues associated with WAAS accuracy, integrity, and availability to the users, with specific emphasis on the ionosphere and interference to ensure integrity and continuity of service. Current research efforts will focus on better utilization of present and future global navigation satellite systems, analysis of LAAS VHF data broadcast characteristics and LAAS category I/II/III evaluations at various locations across the country.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$17,895
FY 2001 Enacted	6,900
FY 2002 Request	5,700
Out-Year Planning Levels (FY 2003-2006)	24,100
Total	$54,595

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Navigation	0	* 10,718	4,900	6,900	5,700
Personnel Costs	0	2,277	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**12,995**	**4,900**	**6,900**	**5,700**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	12,995	4,900	6,900	5,700
Total	**0**	**12,995**	**4,900**	**6,900**	**5,700**

*** Contract amount includes $4.0M for Low Cost Next Generation Precision Gyroscope Technology earmarked by Congress.**

Navigation Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Navigation							
Wide Area Augmentation System (WAAS)	$2,900						
Perform Data Collection and Analyses Using the National Satellite Test Bed (NSTB) to Further Develop WAAS		◆	◇	◇	◇	◇	◇
Continue to Conduct Ionosphere Data Collection and Analysis to Define WAAS Final Operational Capabilities and Support the Development of Enhanced WAAS Ionospheric Algorithm		◆	◇	◇	◇	◇	◇
Define Optimum Architecture for Alaska		◆	◇	◇	◇	◇	◇
Investigate Satellite Anomalies							
Continue Interference Analysis to Identify and Mitigate Potential Threats		◆	◇	◇	◇	◇	◇
Develop WAAS Performance Monitoring and Assessment Capabilities		◆	◇	◇	◇	◇	◇
Define Assumptions and Parameters for Worldwide Service Volume Model							
Perform Interoperability Analyses to Support Seamless Global Navigation Satellite System (GNSS)							
Local Area Augmentation System (LAAS)	$2,800						
Validate LAAS Category I (CAT I) Integrity		◆	◇	◇	◇	◇	◇
Develop LAAS CAT II/III Algorithm		◆	◇	◇	◇		
CAT II/III Implementation and Testing		◆		◇	◇	◇	◇
Develop Improved Signal Quality Monitoring Techniques for CAT III LAAS		◆		◇	◇	◇	
Develop Improved Integrity Algorithms for CAT III LAAS		◆				◇	◇
Investigate Ephemeris Monitoring Requirements for CAT III LAAS							
Develop Airport Pseudolite Integration Techniques							
Total Budget Authority	**$5,700**	**$6,900**	**$5,700**	**$5,900**	**$6,000**	**$6,100**	**$6,100**

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01— Surveillance

GOALS:

Intended Outcomes: The FAA plans to improve system efficiency and safety by implementing a low-cost surveillance system that enables Free Flight capabilities and enhances safety and efficiency. This program develops domestic and international Automatic Dependent Surveillance - Broadcast (ADS-B) standards to facilitate global system interoperability. It also evaluates specific applications and technologies of ADS-B to support standards development.

ADS-B uses an onboard Global Navigation Satellite System (GNSS) receiver or other backup source of navigation data to derive the altitude and position of an ADS-B-equipped aircraft. These data and aircraft identity are broadcast directly to ground receivers as well as to nearby aircraft. An ADS-B message displayed on a neighboring aircraft's airborne Cockpit Display of Traffic Information (CDTI) facilitates the flight crew's situational awareness, conflict detection, and Free Flight capabilities. The ground receivers can provide the information to ATM facilities and other users.

The ADS-B technology's modular design and cooperative nature offer a low cost alternative to the surveillance coverage in existing nonradar areas, and potentially, in some areas currently served by radars. Through accurate and timely updates directly to pilots, the system offers the potential to reduce current separation standards while still improving overall safety, efficiency, and airspace capacity.

Agency Outputs: Current efforts focus on developing standards for the system's avionics, its applications, and display (CDTI) system. Standardization efforts include RTCA minimum aviation system performance standards (MASPS), minimum operational performance standards (MOPS), technical standard orders, and design criteria. Analyses and evaluations will be conducted to provide technical inputs to RTCA MASPS/MOPS on ADS-B links, airborne surveillance and separation assurance processing, and other surveillance system sources necessary to support ADS-B applications. International standards such as the International Civil Aviation Organization's (ICAO) Standards and Recommended Practices (SARPS) will also be developed. These standards must be developed and maintained in order for the designs of avionics, ground and other systems to be compatible and capable of operating together.

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 SC 186. Some of the specific stakeholders include the Cargo Airline Association, Air Transport Association, Airline Pilots Association, Aircraft Owners and Pilots Association, United Airlines, Northwest Airlines, avionics manufacturers, ICAO panels, and the European Work Group on ADS-B.

Accomplishments: Draft ADS-B avionics standards development continues at RTCA. Analysis and simulation have been conducted to complete the technical standards development. Flight test of 1090 MHz ADS-B has been completed in US and Germany. Specific accomplishments include:

- Completed a significant portion of ADS-B 1090 MHZ MOPS
- Completed a significant portion of ADS-B/ CDTI MOPS for selected applications
- Completed a flight test of 1090 MHz ADS-B at Frankfurt, Germany, one of world's highest interference environments.
- Completed a technical report on the results of the flight test of 1090 MHz ADS-B at Los Angeles basin. Flight test data and analysis results have been incorporated in ADS-B MOPS.

R&D Partnerships: The joint government/ industry committee, RTCA SC 186, is tasked with achieving R&D consensus on system standards for ADS-B. Massachusetts Institute of Technology Lincoln Laboratory, MITRE, Federal Aviation Administration Technical Center (FAATC) and NASA are also jointly involved in the technical development and integration of ADS-B technology into the NAS.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Completed development of ADS-B 1090 MHz Minimum Operation Performance Standards (MOPS) with RTCA (Version 1).
- Developed initial draft of ADS-B/CDTI Minimum Operational Performance Standards (Version 1).
- Initiated RTCA ADS-B MOPS on Universal Access Transceiver (UAT).
- Initiated RTCA ADS-B MOPS on Version 2 of 1090 MHz.
- Initiated RTCA MOPS on Traffic Information System-Broadcast (TIS-B).
- Completed report on flight test of ADS-B 1090MHz at Frankfurt, Germany.
- Completed ADS-B Master Plan/Roadmap.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Provide update to RTCA ADS-B 1090 MHz MOPS (Version 2) and ICAO SARPS on extended squitters.
- Complete Version 1 of RTCA ADS-B MASPS on Airborne Separation Assurance (ASA).
- Complete draft RTCA ADS-B MOPS on UAT.
- Complete Version 1 of RTCA TIS-B MASPS.
- Continue work on Airborne Surveillance and Separation Assurance Processing (ASSAP) MOPS.

FY 2002 PROGRAM REQUEST:

The FAA and RTCA will continue to update the RTCA ADS-B 1090 MHz MOPS. Analysis will be conducted to complete Version 1 of the RTCA ASA MASPS. The draft MOPS on UAT will be completed. Additionally, updates to the RTCA MASPS on TIS-B will be completed. Development of the ASSAP MOPS will continue.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$6,190
FY 2001 Enacted	2,600
FY 2002 Request	2,800
Out-Year Planning Levels (FY 2003-2006)	8,900
Total	$20,490

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Surveillance	0	3,506	1,900	2,600	2,800
Personnel Costs	0	784	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**4,290**	**1,900**	**2,600**	**2,800**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	4,290	1,900	2,600	2,800
Total	**0**	**4,290**	**1,900**	**2,600**	**2,800**

Surveillance Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Automatic Dependent Surveillance-Broadcast (ADS-B)							
Plans, Standards, and Analysis							
Minimum Operational Performance Standards (MOPS) and Standards and Recommended Practices (SARPs)	$2,800						
Provide Initial RTCA UAT MOPS		◆	◇				
Update RTCA UAT MOPS			◇	◇	◇		
Provide and Update ASA MASPS and ASSAP MOPS		◆	◇	◇	◇	◇	
Provide Technical Support to RTCA MASPS on Traffic Information System – Broadcast (TIS – B)		◆	◇	◇	◇		
Update RTCA MOPS on 1090 MHz		◆	◇	◇			
Update ICAO SARPs and Documents on Extended Squitters		◆	◇	◇			
Analyze Architecture of Multi-Link ADS – Ground Station				◇	◇		
Develop ADS – B Master Plan		◆	◇				
Develop high – Fidelity Simulation & Validation Plan for ADS - Applications		◆	◇				
Integrate ADS-B/Radar Data with Ground Automation					◇	◇	◇
Total Budget Authority	$2,800	$2,600	$2,800	$1,500	$2,000	$2,000	$3,400

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 — Airspace Management Laboratory

GOALS:

Intended Outcomes: The mission of the Air Traffic Airspace Management Program Office (ATA) is to ensure that the sectorization and routes are designed for the safest and most efficient use by operators, while maintaining diligent consideration for local and national environmental policy, to meet the demand for air transportation.

The ATA Airspace Laboratory serves to support that mission by providing detailed, quality information through the creation of databases, simulation modeling for the analysis and reporting or presentation aids for ATA and Region management and specialists, and development of information systems for, and data requests by, other FAA lines of business as resources permit.

Major caterories of activities carried out by the Laboratory include:

- Identify issues and perform analyses, with appropriate attention to potential environmental impact in support of the ATA airspace assessment and redesign activities. This includes the continuing development of data management and simulation tools for the evaluation of airspace design alternatives by FAA field personnel and Federally Funded Research and Development Center (FFRDC) analysts.
- Develop information system applications to support other FAA lines of business dependent on extensive operational data such as overflight "fee for service" assessments and obstacle awareness and evaluation.
- Serve as the agency's repository and redistribution center for the regular reporting and research applications of air traffic operational activity data. For example, the Laboratory currently provides Enhanced Traffic Management System (ETMS) data to various FAA offices, including the Consolidated Operations and Delay Analysis System and the Daily Measurement of Air Traffic Service.

Information products provided on a regular basis during the past year include:

- Acquisition, storage, distribution, and information extraction of air traffic operational data.
- Quantitative analysis of current air traffic activity including some performance measures such as reported cancellations, diversions, and delays.
- Environmental (noise) analyses.
- Development of the following information systems:
  - Obstruction evaluation database.
  - Overflight "fee for service" assessments.
  - Foreign Overflight Notification System (for DOD).
  - The Consolidated Operations and Delay Analysis System (CODAS).
  - The Daily Measurement of Air Traffic Service (DMATS).

Customer/Stakeholder Involvement:

Successful demonstration of the capabilites of the ATA Laboratory has been shown to have value and even greater protential value across several FAA lines of business. In addition to the Airspace Management Program Office, the Office of System Architecture and Investment Analysis (ASD), the Office of System Capacity (ASC), Air Traffic Planning and Procedures (ATP), and Air Traffic System Management (ATM), the Lab has supported the missions of the Cost Accounting Team, the Office of Financial Services, the Office of Aviation Policy, and the Y2K Contingency Planning Work Group.

The Laboratory also has provided ongoing support for numerous projects of the FAA Eastern Region (AEA) involving field analyst staffing, analytical work, daily access to operational data, and continuing technical support for database query programming.

The ATA Laboratory has been identified as the element responsible for supporting airspace design dependencies for FAA Facilities and Equipment (F&E) programs with broad government and industrial involvement, including:

- Local Area Augmentation Systems (LAAS)

– all category approaches.

- Low Altitude Direct Routing using Wide Area Augmentation Systems (WAAS).
- Runway Incursion Program.
- WAAS Precision Approaches.
- Automatic Dependent Surveillance (ADS) studies.
- Single and Multi-center metering.
- Final Approach Spacing Tool (FAST) implementation studies.
- New Host Consolidation/Dynamic Resectorization studies.

Accomplishments:

Airspace issue identification

- Tracked critical parameters for proactive identification of issues.
- Visualized/analyzed past and current traffic patterns.
- Analyzed system performance.

Airspace design and environmental evaluation

- Developed alternative airspace designs for examination.
- Analyzed changes to airspace design on flow, capacity, delay, workload, and other metrics as required.
- Developed data necessary to evaluate noise and consider pollution impacts to complement airspace design analysis.

R&D Partnerships: Organizations that will use or support the laboratory include the Office of System Architecture and Investment Analysis (ASD), the Office of System Capacity (ASC), Air Traffic Planning and Procedures (ATP), and Air Traffic System Management (ATM).

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Developed national listing of aircraft diversions.
- Developed New York and Washington metro area arrival and departure fix reports.
- Provided analytical support with two operational studies:
  – Compari
  – son of sector densities from four Aircraft Management Program (AMP)-based systems—OAMP, HAME, Staffing to Traffic (STT), and PCOAT.
  – Review of the STT data (Input Data, Air Traffic Activity Measures, and Output Reports). (See CNAC reports CRM 95-22 and CRM 94-128.)
- Performed analytical work/studies on behalf of Eastern Region.
- Provided Sector Design Analysis Tool (SDAT) support with sector analysis studies.
- Developed concept papers on a range of topics, including:
  – Concept for a Field-Level Traffic Management Unit Operational Test, Evaluation and Development Capability.
  – En Route Sector Spacing Tool.
  – Smart Log and Lessons Learned.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Continue collection and management of data from air traffic operations in support of the following:
- Analyze and report Current NAS Traffic Activity.
- Begin Integration of local and regional airspace design concepts into a system-wide national level scope.
- Support environmental studies, especially noise related.
- Support the examination of technologies being acquired or alternative procedures with respect to potential for Air Traffic Control (ATC) efficiency and other performance- related improvements.
- Continued development of information systems as demanded by several FAA lines of business.

FY 2002 PROGRAM REQUEST:

Significant changes in avionics and air traffic control technology, coupled with continuing changes in the type, amount, and distribution of traffic, have created a need to study and redesign the nation's airspace for current and future use. It is particularly likely that airspace redesign will be

required to complement FAA's implementation of global positioning navigation systems, Free Flight, and related dynamic sectorization. While airspace changes have been analyzed and implemented for decades at the local level, a systematic, comprehensive national analysis has not been performed. An overall approach to a national design is being developed.

The above described activities serve to demonstrate the proven technical capability in prototype form. The need to develop this capability into a full-scale mission capability has been validated by FAA Mission Need Statement #331. Acquisition analysis and planning will begin following a detailed definition of the full-scale requirements beginning in FY 2001.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$3,000
FY 2001 Enacted	4,000
FY 2002 Request	4,500
Out-Year Planning Levels (FY 2003-2006)	27,600
Total	$39,100

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Airspace Management Lab	0	0	3,000	4,000	4,500
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**3,000**	**4,000**	**4,500**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	3,000	4,000	4,500
Total	**0**	**0**	**3,000**	**4,000**	**4,500**

F&E 1F01 — Separation Standards

GOALS:

Intended Outcomes: The Separation Standards Program works to reduce separation standard values within international airspace to make the following benefits available to providers and users of oceanic air traffic control systems:

- Increased system efficiency—evidenced through reduced aircraft fuel-burn and transit times.
- Increased theoretical system capacity—evidenced through an increase in the number of routes and flight levels controllers can safely support within the same volume of airspace.
- Increased international standardization of separation criteria and resultant enhanced system safety.

Agency Outputs: The FAA's "Strategic Plan for Oceanic Enhancements and Separation Reductions" describes a systematic process for revising international separation values and establishes priorities for such changes. To document and evaluate each separation change, the FAA produces a series of supporting products:

- Operational assessments of the value the change brings to Air Traffic Control (ATC) system providers and users.
- Benefit-cost analysis regarding the change.
- Safety assessment of the system before and after application of the separation change.
- Publication of FAA regulatory material required by the change.
- Completion of any new rulemaking required by the change.
- Development of ATC procedures required by the change.
- Development of any new or changed International Civil Aviation Organization (ICAO) guidance material, annexes, or regional supplementary procedures required to standardize and make the reduced separation value safe for international operations.
- Establishment and maintenance of any long-term safety oversight functions required for the implementation and continued safe use of the reduced separation value.

Customer/Stakeholder Involvement: The Separation Standards Program establishes appropriate ICAO-government-industry forums to draw all parties concerned with a change in separation standards into a common process. The cooperating entities may include: state Civil Aviation Authorities (CAA), ICAO Regional and Headquarters elements, ATS providers, ATC system users, industry trade organizations, and unions representing controllers and pilots.

Participants in specific change processes include:

- Pacific separation standards. Changes proceed with the coordination and endorsement of the (North Pacific) Oceanic Work Group, Informal (North) Pacific ATC Coordinating Group, and Informal South Pacific ATS Coordinating Group, as well as the ICAO Pacific Reduced Vertical Separation Minimum (RVSM) Task Force.
- North Atlantic separation standards. Changes are carried out through the ICAO Regional Planning Group, the North Atlantic Systems Planning Group.
- West Atlantic Route System Separation Standards (WATRS). Proposed improvements involve participation of the New York Oceanic Capacity Enhancement Task Force.
- Gulf of Mexico and Caribbean Separation Standards. Proposed changes involve participation of the Gulf of Mexico Work Group and the ICAO CAR/SAM Regional Planning and Implementation Group (GREPECAS) group.
- The program also provides FAA representation on ICAO's Review of the General Concept of Separation Panel (RGCSP)—the focal point for development of the technical justification for new separation minima as well as the forum for assessing application of recommended ICAO separation practices on a global and regional basis.

Accomplishments: The Separation Standards Program has been the vehicle for the FAA to bring about major reductions in separation standard values affecting international airspace.

In the past three years, the program has been responsible for several significant changes:

- North Atlantic RVSM, or 1000-ft. vertical separation standard above flight level (FL) 290 (March 1997). Introduction of this change marked the culmination of a 15-year effort by the FAA and other State CAAs to reduce the high-altitude separation standard. Several studies had predicted that the RVSM would be the single most cost-beneficial separation change possible for oceanic airspace; actual experience has proven that the studies were accurate forecasters of RVSM benefits. Within the first 12 months after RVSM implementation, each of the 10 operators accounting for a combined 60 percent of annual North Atlantic operations had recovered the sunk costs associated with bringing its aircraft into compliance with RVSM requirements.
- Northern Pacific 50-nm lateral separation standard based on operator compliance with Required Navigation Performance (RNP)-10 requirements (April 1998; December 1998; and February 2000). This linkage between a separation standard and an RNP value marked the first use of the ICAO-endorsed concept in any portion of worldwide airspace. The change has led to measurable improvements in both ATC operations and aircraft fuel-burn and transit time.
- North Atlantic Implementation Management Group Cost Effectiveness (NICE) Program (October 1999). This comprehensive fast-time-simulation-based assessment of the benefits associated with North Atlantic separation changes proposed through the year 2010 resulted in significant changes. Plans were modified for ATS system infrastructure expenditures and users were held to different schedules and equipage requirements in order to participate in the project within the airspace. The FAA's NICE Program contributions were the result of a combined effort by federal staff members and grant-sponsored university researchers.
- Pacific RVSM (February 2000). Based on FAA encouragement, contributions, and previous experience in the North Atlantic, the ICAO Asia and Pacific Region planning group established the Pacific RVSM Task Force which oversaw successful implementation of the RVSM in February 2000. The FAA chaired or co-chaired all Task Force working groups and provided the technical consultation concerning RVSM implementation to states in the region. The ICAO Asia Pacific Region planning group agreed that the FAA Technical Center would provide the safety oversight function associated with RVSM implementation and endorsed establishment of the Asia/Pacific Approvals Registry and Monitoring Organization (APARMO) to carry out this function.

R&D Partnerships: The Separation Standards Program provides FAA representation to ICAO's RGCSP, the principal global forum for moving ahead with the development of new separation minima. The FAA and other CAAs typically cooperate in such work, with each state-participant freely sharing research results within the Panel. In addition, the Separation Standards Program maintains close research ties with academia through sponsorship of grants and cooperative work with Rutgers University in the development of large fast-time simulation models of oceanic airspace. The program also has a direct link with international separation research activities in which the FAA's GPS Monitoring System supports EUROCONTROL's RVSM safety oversight activities. In turn, that international body provides access to the products of its RVSM research.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Emphasis in FY 2001 will be in four major areas:

- Pacific RVSM: expansion of the RVSM upper stratum from FL 390 to FL 410 throughout the Pacific.
- Development and acceptance by ICAO of requirements for 30-nm lateral separation standard based on automatic dependent surveillance in oceanic and remote airspace.
- Preparations for November 2001 implementation of RVSM in the West Atlantic Route System.

- Establishment of a comprehensive plan to introduce RVSM and horizontal–plane separation reductions in the Gulf of Mexico and the ICAO Caribbean/South American Region.
- Initiation of work to introduce NICE simulation methodology into Pacific system planning and analysis.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Implement the West Atlantic Route System RVSM in November 2001.
- Complete work within RGCSP to formalize implementation requirements for 30-nm lateral and 30-nm longitudinal separation standards.
- Implement plan formulated in FY 2001 to reduce separation minima in Gulf of Mexico and ICAO Caribbean/South American Region.
- Continue to provide a safety oversight function in Pacific and North Atlantic.
- Finalize of NICE work to quantify North Atlantic communication requirements associated with reduced separation minima.
- Production of preliminary Pacific airspace planning and analysis methodology-based upon NICE developments.

FY 2002 PROGRAM REQUEST:

The FY 2002 program request provides for:

- Completion of real-time simulation, procedure development and safety oversight activities necessary to permit November 2001 introduction of RVSM into the West Atlantic Route System.
- Completion of work necessary to finalize implementation requirements for reducing horizontal-plane separation minima to 30-nm—with such requirements anticipated as satisfied by Automatic Dependent Surveillance.
- Expansion of safety oversight assistance beyond the Pacific and North Atlantic, including augmentation of the GPS Monitoring System to support Gulf of Mexico, Caribbean/South American, and possible NAS RVSM implementation.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$2,545
FY 2001 Enacted	2,200
FY 2002 Request	2,200
Out-Year Planning Levels (FY 2003-2006)	10,500
Total	$17,445

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Separation Standards	0	0	1,400	2,200	2,200
Personnel Costs	0	* 1,145	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**1,145**	**1,400**	**2,200**	**2,200**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	1,145	0	0	0
Development (includes prototypes)	0	0	1,400	2,200	2,200
Total	**0**	**1,145**	**1,400**	**2,200**	**2,200**

*** In FY 1999 in-house costs for Separations Standards Project was included in System Capcity, Planning and Improvements budget item.**

Separation Standards Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Separation Standards							
West Atlantic Route System (WATRS) Reduced Vertical Separation Minima (RVSM)	$200						
Conduct Safety Oversight				◇	◇	◇	◇
Develop Procedures		◆	◇				
Implement		◆	◇	◇	◇	◇	◇
Complete North Atlantic Implementation Management Group Cost Effectiveness (NICE)	$200						
Develop Final Recommendations		◆	◇				
		◆	◇	◇	◇	◇	
Pacific RVSM	$300						
Implement Fully		◆					
Conduct Safety Oversight		◆	◇	◇	◇	◇	◇
30–nm lateral/30-nm Longitudinal Separation	$300						
Develop Requirements		◆	◇				
Implement Changes					◇	◇	◇
Gulf of Mexico and Caribbean Separation Changes	$1,000						
Developed Requirements		◆					
Develop Procedures		◆					
Implement Changes			◇	◇	◇	◇	◇
Pacific System Analysis	$200						
Modify NICS Model		◆	◇	◇			
Develop Recommendations		◆	◇	◇	◇	◇	
Total Budget Authority	$2,200	$2,200	$2,200	$2,400	$2,500	$2,500	$3,100

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

F&E 1F01 — Domestic Reduced Vertical Separation Minima

GOALS:

Intended Outcomes: The Domestic Reduced Vertical Separation Minima (DRVSM) Program is working to reduce the separation standard within the domestic airspace of the continental United States, in order to achieve the following benefits for providers and users of the domestic air traffic control system:

- Increased system efficiency through reduced fuel-burn and decreased delays.
- Increased theoretical system capacity through increased capability of controllers to support greater numbers of routes and flight levels safely within the same airspace.

Agency Outputs: The DRVSM Plan decribes a systematic process for revising domestic separation standards between FL290 and FL410 and establishes priorities for such changes. To document and evaluate each separation change, the FAA produces the following supporting products:

- Operational assessments of the value the change brings to providers and users of the Air Traffic Control (ATC) system.
- A benefit-cost analysis regarding the change.
- A safety assessment of the system before and after application of the change.
- Publication of FAA regulatory material required by the change.
- Completion of any new rulemaking required by the change.
- Development of ATC procedures required by the change.
- Development of any new or changed guidance material and procedures required to standardize and make the reduced separation standard safe for domestic operations.
- Establishment and maintenance of any long-term safety oversight function required for the implementation and continued safe use of the reduced separation standard.

Customer/Stakeholder Involvement: The DRVSM Program creates appropriate government-industry forums to draw all concerned parties into a common process. The cooperating entities include: DOD, Canada, ATS providers, ATC system users, industry trade organizations, and unions representing controllers and pilots.

Accomplishments: The DRVSM Program is the vehicle for the FAA to effect major reduction in separation standards affecting domestic airspace within the United States. This recently funded program has established a comprehensive plan for the implementation of its objectives. Fast-time simulations were conducted for a preliminary assessment of benefits. An industry day seminar was conducted for users, who included representatives identified as customers/ stakeholders.

R&D Partnerships: Colorado State University has teamed with the program to investigate the impact of mountain wave activity on DRVSM. A relationship also was stablished with EUROCONTROL to collect and anaylyze data related to RVSM in Europe.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Conducted a cost-benefit analysis.
- Examined the operational factors and controller workload associated with implementation of DRVSM via human-in-the-loop simulations.
- Developed and deployed a monitoring system and established North American Approvals Registry and Monitoring Organizaion.
- Performed rulemaking for the implementation of DRVSM .
- Conducted DRVSM seminar for customers and stakeholders.
- Developed pilot procedures for application within DRVSM airspace.
- Developed ATC procedures for use within DRVSM airspace.
- Developed procedures for handling mountain wave activity within DRVSM airspace.
- Began an initial safety analysis.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Assess the impact of DRVSM implementation on NAS automation systems and plan for upgrades/modifications.
- Continue simulations to test newly developed ATC procedures and report on simulation results.
- Continue work on the safety assessment.
- Develop and test acceptable ATC procedures for non-approved military aircraft to transit DRVSM airspace.
- Continue the rulemaking process.

FY 2002 PROGRAM REQUEST:

The FY 2002 program request provides for:

- The conduct of real-time simulation and safety assessments necessary to progress the DRVSM Program towards implementation.
- Analyses of the outcomes and implications of completed real-time simulations and safety assessments.
- The development of procedures based on an operational understanding of real-time simulation and safety assessment analyses.
- The continuation of tasks necessary in the rulemaking process for the phased implmentation of DRVSM beginning in December 2004.
- Expansion of the collaborative effort with academia, users and providers of ATC services and the aviation industry to ensure understanding, and acceptance of DRVSM benefits.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$0
FY 2001 Enacted	0
FY 2002 Request	2,100
Out-Year Planning Levels (FY 2003-2006)	*
Total	$2,100

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Domestic Reduced Vertical Separation Minima	0	0	0	0	2,100
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**2,100**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	0	2,100
Total	**0**	**0**	**0**	**0**	**2,100**

Note: FY 2002 is the first year of funding under Facilities and Equipment Advanced Technology Development and Prototyping.

*** Out year funding under review**

Domestic Reduced Vertical Separation Minima Program Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Domestic Reduced Vertical Separation Minima							
DRVSM	$2,100						
Conduct Role Making			◇				
Conduct Safety Assessment			◇	◇	◇	◇	
Develop Database			◇	◇	◇	◇	◇
Develop Monitoring Procedure			◇				
Conduct Modeling and Simulations			◇	◇			
Conduct Analysis of Data			◇	◇			
Develop Procedures			◇				
Total Budget Authority	$2,100		$2,100	*	*	*	*

Notes:
– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.
– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

* Out Year Funding Request Under Review. FY 2002 is the First Year of Funding under Facilities and Equipment Advanced Technology Development and Prototyping.

F&E 1F01— NAS Requirements Development

GOALS:

Intended Outcomes: This program will support mission analysis (MA) and NAS requirements development efforts. It will fund studies and other efforts to prepare and validate strategies and proposals designed to increase overall NAS efficiency. Also, it will support the FAA System Efficiency mission goal to "*provide an aerospace transportation system that meets the needs of users and is efficient in the application of FAA and aerospace resources*."

As part of the Agency's Acquisition Management System (AMS) process, the FAA routinely examines current and projected needs within the NAS, with the goal of defining requirements to meet identified needs. This budget line item provides, on a recurring basis, the means to independently investigate the particulars of selected programs (service or system) or technologies. Such investigations assist in determining and selecting only those programs or technologies best suited to advance overall NAS system efficiency.

Agency Outputs: Activities funded by this budget line item include:

- Simulation
- Human factors
- Procedure development
- Performance definition
- Impact analysis
- Workload analysis
- Hazard analysis
- NAS architecture development

Specific FY02 programs include:

- Define and conduct requirements activities in support of developmental programs
  - Develop a Requirement Evaluation Plan in order to resolve a number of functional and performance requirements issues. The goal is to incorporate developmental programs into the AMS.
- Develop ARS En Route requirements for the NAS Design Tool.

  and assumptions, status and progress of in-
  - Prepare and validate an integrated set of future Air Traffic Services (ATS) en route domain requirements and a roadmap for implementing those requirements—to be incorporated into the NAS Design Tool.
- Maximize value of En Route investments
  - Develop a detailed Results Chain for En Route services.
  - Define investment packages containing necessary and sufficient initiatives to produce a meaningful end-user benefit.
  - Prepare an En Route services strategy paper containing a set of Value Cases for each investment package considered.
  - Provide a plan to manage the realization of benefits.
- Evaluate use of Collaborative Convective Forecast Product (CCFP) as a tool within the Collaborative Decision Making (CDM) program
  - Monitor and assist in the development of CCFP into a 24-hour-a-day program.
  - Evaluate the effectiveness and utilization of CCFP during previous poor weather sessions.
  - Develop an overall aviation weather telecommunications strategy and mission needs analysis.
- Support requirements definition and development of research demonstration program for the Traffic Management Units (TMU)
  - Develop, coordinate and provide oversight of research demonstration programs required by the TMUs

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Developed a four-part Results Chain that elaborates a strategy for sustaining and enhancing En Route services.
- Completed two Value Plots that illustrate the relative value of investments contemplated to sustain and enhance En Route services.
- Developed a Benefits Register that tracks achievement of benefits, management of risks

  vestment packages.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Prepare oral and written findings on efforts to prepare and validate future En Route domain requirements.
- Complete an En Route services strategy paper that informs decision makers of choices available to them.
- Develop a Governance Process – a sequence of investment reviews that report on the progress of investments, review assumptions and risks, and achievement of expected benefits.
- Evaluate use of CCFP within the overall Collaborative Decision Making program—including development of real-time verification statistics.
- Develop, coordinate, and provide oversight of the Traffic Management Unit research demonstration program.

FY 2002 PROGRAM REQUEST: A major key to maintaining objective, integrated NAS requirements development is a reliable, sustainable funding source that allows critical analyses of selected developmental systems—those systems that provide both the greatest potential payoffs for NAS system efficiency and the greatest risk of failure. The requested funding will allow investigations that will increase the probability of system success and identify factors and situations that require solutions before development begins.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$0
FY 2001 Enacted	2,900
FY 2002 Request	3,000
Out-Year Planning Levels (FY 2003-2006)	12,600
Total	$18,500

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
NAS Requirements	0	0	0	2,900	3,000
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**2,900**	**3,000**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	2,900	3,000
Total	**0**	**0**	**0**	**2,900**	**3,000**

NAS Requirements Development Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Define and Conduct Requirements Activities in Support of RE&D Activities	$1,375	◆	◇	◇	◇	◇	◇
Develop ARS En Route Requirements for NAS Design Tools	$225	◆	◇	◇			
Maximize Value of En Route Investments	$100	◆	◇	◇			
Evaluate Use of Collaborative Convective Forecast Product (CCFP) within the Collaborative Decision Making (CDM) Program	$675	◆	◇	◇	◇	◇	
Support Requirements Definition and Development of Research Demonstration Program for Traffic Management Unit (TMU)	$625	◆	◇	◇	◇	◇	
Total Budget Authority	$3,000	$2,900	$3,000	$3,000	$3,000	$3,000	$3,600

Notes:

– Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

– In the Facilities and Equipment appropriations, personnel and other costs are budgeted in Activity 5, not the program budget line item.

A04a Weather Program:

GOALS:

Intended Outcomes: The FAA intends to prothat are more accurate, accessible, and efficient than existing services. These upgrades will 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.

As required by the Federal Aviation Act of 1958, as amended, the FAA cooperates with the Department of Commerce in promoting and developing meteorological science, and in fostering support of research projects through the use of private and governmental research facilities. These duties are further amplified by recommendations contained in the National Aviation Weather Initiatives (1999), prepared by the Joint Action Group for Aviation Weather for the National Aviation Weather Program Council of the Office of the Federal Coordinator for Meteorology, and the final report of the Weather Joint Services Implementation Team (2000).

The weather program directly supports FAA Strategic Goal #1 in the performance area of Safety: "Through research, identify methods that, when implemented would reduce the fatal accident rate, due to weather" and Goal #2, Efficiency – reducing system delays, through development of weather dependent wake turbulence spacing standards for aircraft.

The weather program supports the FAA's policy of focusing its research, development, and acquisition on "products that will improve the safety and efficiency of the Air Traffic System," and it also directly supports the agency's "Safer Skies" initiatives.

This weather R,E&D program, in collaboration with National Weather Service (NWS) programs, produces weather algorithms (technology), more accurate and rapid forecasting and dissemination of forecasts (delivery) enhanced intuitive capability for aviation decision makers, and supports the development of aviation weather instructional material (education).

Agency Outputs: The weather program focuses on conducting applied research to solve operational problems through the development of new and improved weather algorithms and more efficient wake turbulence standards and procedures. The weather algorithms, are being developed for implementation on appropriate National Airspace System (NAS) platforms (including the weather and radar processor, and the integrated terminal weather system) and on NWS systems and continue to be transferred to private weather service companies in support of the NAS. This transfer of technology enables these companies to derive specialized aviation weather products from FAA research efforts. Algorithm development provides capabilities for dissemination to aviation weather users in support of air traffic control automation tools including:

- Depiction of current and forecasted in-flight icing areas to enhance safety, airspace efficiency, and aircraft utilization.
- Interactive data assimilation, editing and forecast tools to improve aviation advisories and forecasts issued by the NWS.
- Location, timing, and severity of convective weather hazards to improve flight safety and enhance capacity.
- Depiction of current and forecasted precipitation type and rate to enhance safety and efficiency in the terminal area.
- Short-term forecasts and prediction of ceiling and visibility in the terminal area for enhanced capacity
- In-situ and remote detection and forecast of enroute turbulence including clear air.

In addition, the weather program is conducting wake turbulence research to reduce airport delays. The goal is to adapt NASA Aircraft Vortex Sensing System (AVOSS) technology for weather dependent wake turbulence spacing with an initial focus on safety and capacity initiatives for closely spaced parallel runways.

Customer/Stakeholder Involvement: The weather research priorities and plans are consistent with user needs. The program works in concert with the Aviation Weather Directorate

(ARW), to derive research projects and priorities from the interagency National Aviation Weather Initiatives (1999), merged with other NAS drivers, such as "Safer Skies," Freeflight implementation and the NAS operational concept documents. The weather program continually revalidates these priorities and plans by giving briefings in public forums such as the 2000 National Business Aircraft Association conference to the Friends/Partners in Aviation Weather Forum.

The weather program has also analyzed aviation weather service users' needs and requirements found in the Aviation Safety Action Plan. Additionally, it has addressed industry recommendations and requirements found in several related documents and publications.

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

- Rapidly updated cycle analyses and forecast capabilities to provide more accurate and higher resolution upper winds, temperature, and precipitation data. Use of more accurate data on hazardous weather and jet streams has reduced flight times and/or flight delays.
- 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 (WVSS) program, leveraged with NOAA. The availability of detailed water vapor data in real time will be utilized to make more accurate in-flight icing, ceiling, and visibility forecasts.
- Completed upgrades to Next-Generation Weather Radar (NEXRAD) algorithms, storm cell identification and tracking, hail detection, and 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 convective storm growth and decay field tests in Dallas and Orlando. This research is resulting in the accurate short-term prediction of the initiation, growth, and decay of storm cells as it is providing operational benefit at the above two sites. It is enhancing 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.
- Transferred Weather Support to Deicing Decision Making (WSDDM) system technology to a commercial weather provider to provide ground deicing decision making information to airlines, airports and cities. WSDDM system information has resulted in increased safety (at time of takeoff) cost savings in use of deicing fluids/associated equipment/ personnel, and efficiencies in runway and off-airport plowing/departures/arrivals. Awarded 1999 Government Technology Leadership Award.
- Implemented initial operating capability of the Aviation Gridded Forecast System (AGFS) at the NWS, providing an aviation specific weather database for the aviation community and user access to this data via the Aviation Digital Data Service (ADDS). The ADDS flight path tool depicting vertical cross sections of weather along user-specified flight routes is providing benefit to users especially general aviation. Awarded 2000 Government Technology Leadership Award.
- Installed a wake turbulence monitoring system at San Francisco International Airport to support the Simultaneous Offset Instrument Approach (SOIA) safety and capacity initiative.

R&D Partnerships: In addition to its partnership with the FAA's Aviation Weather Directorate, weather research 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 Agree-

ment (MOAs). Principal partners include the National Center for Atmospheric Research; NOAA's Forecast Systems Laboratory; the Environmental Technology Laboratory and National Severe Storms Laboratory; Massachusetts Institute of Technology's Lincoln Laboratory; NWS's Aviation Weather Center and Environmental Modeling Center; the Center for Wind, Ice, and Fog Research at the Mount Washington Observatory; NASA Dryden, Langley and Glenn; the Office of Naval Research; the U.S. Army Cold Regions Research and Engineering Laboratory; UPS; and facilities of several universities, airlines, port authorities, and cities.

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

Wake turbulence activities are conducted jointly or closely coordinated with NASA, the Volpe Center, MIT Lincoln Labs, MITRE, and international research efforts.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Obtained FAA approval for an icing diagnosis algorithm for operational NAS use.
- Commenced inclusion of turbulence in-situ data into forecast models.
- Transfered ADDS to AWC for 24/7 operations.
- Obtained FAA approval for an initial national convective weather product for operational NAS use.
- Commenced development of 1-2 hour precipitation forecast.
- Conducted evaluation of marine stratus burn-off forecast at San Francisco International Airport (SFO).
- Delivered damaging downburst algorithm to Radar Operations Center (ROC).
- Implemented Phase I wind data & dissemination system at Juneau Airport.
- Commenced Phase I development of oceanic convective nowcasting products.
- Commenced analysis and planning for the National Ceiling and Visibility (C&V) Program.
- Developed delay reducing wake turbulence procedures and standards for San Francisco International Airport.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Implement icing intensity and threat fields into icing potential products.
- Implement cloud display forecast via ADDS flight path tool.
- Implement boundary layer data into Integrated Terminal Weather System (ITWS) prototypes.
- Complete in-situ based turbulence detection product evaluation.
- Implement 1-2 hour marine stratus burn-off forecast for San Francisco International Airport.
- Deliver a storm tracker algorithm to ROC.
- Implement a certified wind system at Juneau Airport.
- Complete analysis of Phase I demo and benefits of Oceanic Convective Nowcasting manual products.
- Develop an instrument flight rules (IFR) product for the Aviation Weather Center (AWC) as part of the National C&V program.
- Complete implementation of a wake turbulence monitoring system at San Francisco.
- Initiate wake monitoring system at Newark to support Precision Runway Monitoring (PRM) operations.

FY 2002 PROGRAM REQUEST:

- Develop new algorithms for improved forecasts of freezing drizzle aloft.
- Continue to develop automated data analysis and assimilation techniques.
- Transition weather research products to operations in the NWS, the FAA, and industry automation and weather systems.
- Develop oceanic convective nowcasting products.

- Conduct wake turbulence research to enable terminal procedures for closely spaced, parallel runway operations at major airports.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 202,019
FY 2001 Enacted	24,751
FY 2002 Request	28,368
Out-Year Planning Levels (FY 2003-2006)	118,038
Total	$ 373,176

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Weather Program	14,500	17,836	18,635	23,960	26,406
Personnel Costs	664	817	629	705	1,506
Other In-house Costs	136	31	36	86	456
Total	**15,300**	**18,684**	**19,300**	**24,751**	**28,368**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	15,300	18,684	19,300	24,751	28,368
Development (includes prototypes)	0	0	0	0	0
Total	**15,300**	**18,684**	**19,300**	**24,751**	**28,368**

A04a - Weather Program Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
041-110 Aviation Weather Analysis and Forecasting							
In-Flight Icing	$2,068						
Icing Diagnosis Algorithm Approved by FAA for Operational NAS Use		◆					
Implement Icing Intensity & Threat Fields into Icing Potential Products			◇				
Implement Icing Algorithms for Data-Poor Regions				◇			
Test Airborne Detection Systems							◇
Storm Growth and Decay	$2,964						
Initial National Product Approved by FAA for Op. NAS use Product		◆					
Implement Boundary Layer Data into ITWS Prototype Forecast			◇				
Complete Demo of Growth & Decay Algorithms with ATC Users				◇			
NEXRAD Algorithms	$1,500						
Deliver Damaging Downburst Algorithm to Op. Spt. Facility		◆					
Deliver Storm Tracker Algorithm to OP. Spt. Facility			◇				
Deliver Storm Tracker Algorithm to OP. Spt. Facility							◇
Aviation Gridded Forecast System	$1,870						
Transfer ADDS to AWC for 24/7 operations		◆					
Implement Cloud Display fc via ADDS Flight Path Tool			◇				
Implement at AWC Capability to Interactively Generate Collaborative Products				◇			
Model Development and Enhancement	$1,659						
Commence Development of Weather Research & Forecasting Model (WRF)		◆					
Winter Weather Research	$1,550						
Commence Development of 1-2 hr. Snowfall Forecast		◆					
Develop Techniques to Detect/Forecast Precip. Type/rate			◇	◇			
Ceiling and Visibility	$750						
Evaluate Performance of 1-2 hr. Burn-Off Forecast at SFO		◆					
Implement a 1-2 hr. Marine Stratus Burn-Off Forecast at SFO			◇				
Juneau	$6,700						
Implement Phase 1 Wind Data Ingest & Dissemination Sys.		◆					
Turbulence	$2,749						
Commence Inclusion of In-Situ Turbulence Data into Models		◆					
Complete In-Situation Based Detection Product Evaluation			◇				
Airborne Humidity Sensor	$501						
Complete Sensor Evaluation/NOAA/FAA Decision on Utility							
National Ceiling and Visibility	$1,956						
Commence Analysis and Planning		◆					
Develop IFR product for the AWC			◇	◇			
Oceanic Convective Nowcasting	$1,139						
Commence Phase 1 Development of Manual Products		◆					
Commence Phase 1 Development of Manual Products			◇				
Wake Turbulence	$1,000						
Support Safety/Capacity Initiative at High Priority Airports				◇			
Adapt NASA AVOSS Technology for FAA Operational Use					◇		
Personnel and Other In-House Costs	$1,962						
Total Budget Authority	**$28,368**	**$24,751**	**$28,368**	**$28,827**	**$29,229**	**$29,807**	**$30,175**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

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2.2 Airports Technology Program Area Description

Mission

The Airport Technology program mission is to enable the nation's airports to accommodate projected traffic growth within an operational environment free of accidents and fatalities. The Agency's regulatory obligation, under 49 U.S.C. 47105(b) 3, is key to achieving this mission. The development and promulgation of standards, criteria, and guidelines provide technology solutions that affect the plan, design, construction, operation, and maintenance of the massive airport system.

Each year, the U.S. airport system logs over 600 million passenger enplanements at over 17,000 landing facilities with terminal buildings and access roads. Today's system consists of six billion square feet of pavement with a replacement value estimated at $100 billion. The aircraft fleet will certainly grow in number; but more significantly, individual aircraft will increase in size, operating speed, gear loading, and configuration. To deal safely with greater numbers of more demanding aircraft, airport pavements will need capital improvements costing billions of dollars.

The program's areas of focus include:

- Airport pavement design
- Airfield design
- Wildlife control and hazard mitigation
- Runway incursions
- Visual guidance systems
- Surface traction
- Post-crash rescue and firefighting

Intended Outcomes

The most important program outcomes are reducing or eliminating aircraft accidents and lowering the cost of developing and maintaining safe airports.

The Airport Technology program area supports several FAA Strategic Plan goals:

- *System Safety*: Reduce the number of accidents and incidents occurring on or near the airport surface. Current areas of emsis involve the reduction of incidents in which airport surface condition is a cause or factor, reduction of hazards from wildlife strikes, and reduction of runway incursions and runway transgressions.
- *System Capacity*: Enhance airport capacity.
- *Industry Vitality*: Enhance the vitality and international competitiveness of the U.S. commercial air transportation industry.
- *Global Leadership*: In cooperation with industry and other Federal agencies, promote U.S. aviation system technologies.
- *Environmental Responsibility*: Create an environmentally effective and responsive FAA both domestically and internationally.

System Safety **—** A comprehensive R&D program targets the reduction or elimination of aircraft accidents and incidents. The program seeks to reduce the risk of aircraft sliding off runways due to the presence of water, snow, and ice, or other surface contaminants such as rubber and anti-icing materials. Improved runway traction through use of improved methods, materials, and procedures for detecting and removing contaminants from runway surfaces is the central focus of this research.

The program is developing national standards for the design of soft-material arrester beds. Although these devices have already been proven effective in stopping an overrunning aircraft, more economical materials and installation methods must be found to encourage their increased use.

Ongoing research in the area of wildlife control at or near airports seeks methods of reducing hazards from wildlife strikes with aircraft. These efforts include cooperative research with the Department of Agriculture in assessing wildlife hazards at airports and maintaining a national bird strike database.

Continued research in visual guidance systems is necessary to improve the safety of ground operations during daytime, nighttime, and under low-visibility conditions. Pilots and vehicle operators must receive clear and unambiguous information from lights, signs, and markings. Improvements in this area will help eliminate runway incursions and aircraft collisions on airport surfaces. State-of-the-art light sources and applications are nec-

essary to enhance the safety and efficiency of aircraft operations.

Industry Vitality, Global Leadership, and System Capacity — A comprehensive airport pavement design research and development (R&D) program is directed toward the achievement of these agency goals. The program receives broad based support from the U.S. and international governments as well as the collaboration of industry. The International Civil Aviation Organization (ICAO) has formally agreed to use the results from the Airport Technology program to develop worldwide pavement design standards.

The FAA's pavement research has the potential to provide large benefits. Each year, approximately $2 billion is spent by airport operators in conjunction with federal, state, and local governments to construct, rehabilitate, and maintain airport pavements. About $4 million is spent annually on research. Increasing the pavement life by as little as ten percent through research would result in a 50 to 1 benefit/cost ratio. The program is working to achieve this attainable goal.

ICAO relies heavily on the results of visual aids research performed in the United States. An increasing amount of visual aids research is being performed here in cooperation with the United Kingdom and other European countries in order to reduce costs and to develop uniform international standards.

Research efforts are required to develop strategies for attacking post-crash fires on the new multilevel, high-density seating, passenger aircraft being designed by manufacturers around the world. Elevated waterway and boom penetration devices are examples of ways to provide increased passenger survivability and evacuation protection. Training requirements and firefighting simulators must still be developed to fully utilize the new capabilities. ICAO is using research results to develop international firefighting standards.

Program Area Outputs

The airport advisory circular system is the FAA's principal means of communicating with the the Nation's airport planners, designers, operators, and equipment manufacturers. Advisory Circulars (AC) publish the standards used in the design, construction, installation, maintenance, and operation of airports and airport equipment. In all projects funded through the Airport Improvement Program (AIP), project work must meet standards set in one of these ACs. Requirements for pavement construction to meet standards for design, performance, and durability ensure that the $100 billion investment in airport pavement is protected. In addition, ACs provide information that promotes safe and efficient 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 condition weather sensors, wildlife control, terminal building design, snow/ice control, and equipment and procedures for measuring friction.

The FAA updates ACs, as needed, through information and data collected in the entire Airport Technology R&D program.

Program Area Structure

Various elements of the Airport Technology program area affect the safety and operation of aircraft at or near the airport. Factors that determine the eventual safety of a flight include:

- Push-back from gate
- Movement on aprons, holding bays, deicing pads, etc.
- Taxi to/from runway
- Visibility conditions
- Pavement configuration
- Lighting, markings, and signs to guide the aircraft to/from the runway
- Other ground traffic
- Runway surface conditions
- Presence of birds or deer
- Available overrun area beyond the ends of the runway
- Pavement structural integrity

In addition, the potential of rejected takeoff and possible rescue efforts is a safety concern associated with every flight. This program area systematically addresses these issues with a single determination to establish an operational environment that is free of accidents and fatalities.

Customer and Stakeholder Involvement

Airport Technology's major projects support the overall FAA mission of fostering a safe and efficient airport system. Runway traction research directly supports the FAA Challenge 2000 recommendation to develop new technologies and standards for runway friction measurement and safety overrun arrester systems.

Several issues in the Aviation Safety Plan are supported by Airport Technology research. These include preventing runway incursions; improving takeoff and landing performance monitoring; developing environmentally acceptable alternatives for deicing and anti-icing agents; and improving ground navigation technologies, planning, standards, signage, and procedures.

Airport Technology rescue and firefighting research supports an ICAO initiative to replace environmentally harmful Halon 1211 for extinguishing engine fires and other fuel fires.

Aircraft manufacturers and the FAA urgently need new pavement design standards for operating next generation heavy aircraft. Manufacturers need them to ensure compatibility of their aircraft on airport surfaces throughout the world. The FAA needs them to assure the public that federal funds for rebuilding or strengthening runways are being judiciously spent to protect the $100 billion infrastructure investment.

These standards will be developed from data being collected on the National Airport Pavement Test Machine—the first-ever of its kind—over the next ten years. Both the FAA and the Boeing Company are stakeholders in this important project. Financed through a cooperative R&D agreement between the FAA and the Boeing Company, the design and construction of the machine has been completed and operation of the testing facility began in June 1999. Boeing provided $7 million (one-third of the total cost) towards its completion. The FAA, Boeing, and ICAO will develop pavement design standards for ensuring aircraft-airport compatibility on a worldwide basis.

Accomplishments

During the past five years, the Airport Technology Program has provided products that have enhanced the safety of aircraft operations in the United States and around the world. Ongoing research will save the public billions of dollars and protect the environment while attempting to provide an operational environment free of accidents and fatalities.

The program has provided an engineering solution to aircraft overruns by developing the engineered materials arresting system. The Port Authorities of New York and New Jersey have authorized installation of up to five systems at New York airports at a cost of $4.5 million. The first installation was completed in December 1996 at John F. Kennedy Airport. The May 8, 1999 overrun of Eagle Saab 340 at JFK, with its arrestment and rescue of all 27 passengers and crew of three, is a prime example of payoff of our research in the engineered materials arresting systems.

The Airport Technology Program has developed a concept for an advanced taxiway system that is expected to reduce inadvertent aircraft incursions when demonstrated in the field in FY 2001. The system controls taxiway lights and signs without inputs from radar devices to guide aircraft automatically to and from runways and ramps during low-visibility conditions.

The program has enhanced the performance of pavement markings (visibility, durability, and skid resistance) by adding retro-reflective glass beads and silica. Work also has advanced on a new Driver's Enhanced Vision System that allows airport rescue and firefighting vehicles to navigate through fog, rain, sleet, and snow. This technology enables quick and effective response to crash sites. Several airports around the country have adopted this technology for their rescue vehicles.

A new pavement design standard has been introduced through the program to allow the new Boeing 777 to operate without weight penalties on existing pavements. Without this standard, hundreds of millions of dollars would have been needed to strengthen U.S. airport pavements.

The Airport Technology Program also has successfully tested an innovative technology for aircraft deicing using infrared energy. The first air transport category installation became operational at Newark International Airport in February 2000.

This technology offers potential cost savings over conventional methods.

R&D Partnerships

The Airport Technology Program is committed to working closely with airport operators and experts from all branches of the aviation industry and with existing expertise and facilities in the Department of Defense, academics, highway sectors, foreign countries, and the ICAO. The program developed several cost-effective partnerships and agreements, including:

- FAA-U.S. Army Waterways Experiment Station, Interagency Agreement (Pavement).
- FAA-U.S. Air Force, Tyndall Air Force Base, Interagency Agreement (Aircraft Rescue and Fire Fighting).
- FAA-University of Illinois/Northwestern University, Center-of-Excellence for Airport Pavement Research, Partnership through matching funds.
- FAA-Boeing Company, Cooperative Research and Development Agreement, Partnership through $7 million influx from Boeing towards the test machine.
- FAA-Canada (Public Works and Government Services) Project Arrangement for cooperative research in pavement technology.
- FAA-National Aeronautics and Space Administration (NASA) Memorandum of Understanding for joint runway traction research.

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

Long-Range View

Support for friction testing of new products to eliminate slipperiness as a cause of accidents will continue beyond 2005. Operation of FAA's national pavement test facility began in June 1999 and will continue for ten years. The data collected from the test machine will allow smooth introduction of new heavy aircraft expected to join the fleet well into the next century. The pavement design standards based on these data will:

- Provide assurance to manufacturers about the compatibility of their aircraft with airports throughout the world.
- Provide airport operators precise costs estimates to permit new aircraft operations at their facilities.
- Allow airlines to plan for new equipment and routes.
- Give airport designers confidence in their designs.

This long-range commitment to improving airport technology gives the FAA the tools required ensuring the public that federal funds are being judiciously spent and that public investment in infrastructure is prudently managed..

Airport Technology

Intended Outcomes: The FAA intends to improve airport system safety, efficiency, and capacity through advancements in aircraft technology and air traffic control systems. The FAA will also develop and maintain standards in all airport system areas 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 airport design, construction, and maintenance. The FAA uses the airport Advisory Circular (AC) system as its principal means of communicating with a user community consisting of U.S. airport planners, designers, operators, and equipment manufacturers. ACs cover 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 and update these agency outputs in a timely manner.

Customer/Stakeholder Involvement: Approximately $2 billion is spent annually to provide operationally safe and reliable airport pavements. The FAA provides about half of this amount as AIP grants; state and local governments and airport operators provide the remainder. Projects funded under the AIP grants must conform to the FAA ACs or standards.

Aircraft manufacturers need new pavement design standards for operation of next-generation heavy aircraft to ensure compatibility of their aircraft with airport surfaces throughout the world. 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 agency's William J. Hughes Technical Center. The FAA, the Boeing Company, and the International Civil Aviation Organization (ICAO) will use data collected from the project in developing international pavement design standards.

The FAA needs these standards to assure the public that Federal funds for rebuilding or strengthening runways are being judiciously spent and also to protect the $100 billion investment in the U.S. infrastructure.

Accomplishments: During the past five years, the Airport Technology research program has provided products to enhance the safety of aircraft operations in the United States and around the world. Research results are published as FAA ACs and made available to users worldwide. Some major accomplishments are:

- Produced a manual on wildlife control methods for airports.
- Installed soft-ground arresting systems to stop aircraft overruns at a major international airport. On May 8, 1999, the arrestor bed installed at John F. Kennedy International Airport, New York, safely stopped a Saab 340 aircraft carrying 27 passengers and 3 crew members, from possibly plunging off the end of the runway into Thurston Bay.
- Developed improved pavement marking for enhancing visibility, durability, and skid resistance.
- Began operations of an aircraft deicing facility using infrared energy at a major hub airport.

- Developed a driver's enhanced vision system for firefighting vehicles to navigate in rain, snow, and fog.
- Developed an environmentally acceptable replacement for the chlorofluorocarbon (CFC) ozone depletor Halon 1211.
- Developed specification for a 55-foot elevated boom and aircraft cabin skin-penetration system.
- Completed a study on stability of heavy rescue vehicle and anti-rollover systems.
- Completed an evaluation of ramp access to commuter aircraft for people with mobility impairments.
- 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.
- Completed construction of the National Airport Pavement Test Facility and dedicated it on April 12, 1999. Testing at the facility started on June 4, 1999.
- Established an airport pavement data base containing field data collected at Denver International Airport, allowing on-line access to researchers worldwide.
- Completed data collection for taxiway centerline deviation study at John F. Kennedy International Airport, and began data collection at a second major airport.

R&D Partnerships:

- FAA-U.S. Army Waterways Experiment Station*
- FAA-U.S. Air Force, Tyndall Air Force Base*
- FAA-USDA, National Wildlife Research Center, Sandusky, Ohio*
- 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 Authorities of New York and New Jersey (for design and construction of aircraft arrestor bed)*
- FAA-industry (to test and develop infrared deicing facilities and soft-ground arrestor materials)***

* Interagency agreement or Memorandum of Agreement (MOA)

** Partnership through matching funds

*** Cost Sharing

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

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Airport planning and design technology

- Produced reports providing data for sizing terminal elements such as ticket counters and hold rooms.

Airport pavement technology

- Continued 3-dimensional Finite Element Model (FEM) development: computational efficiency, study of effects of slab size and gear configurations.
- Completed documentation report for Layered Elastic Pavement Design Program Package (LEDFAA).

- Refined failure models for 6-wheel and 4-wheel gear configurations based on analysis of data collected from NAPTF.
- Continued data collection and analysis at Denver International Airport (DIA).
- Published report on 3D finite element model field verification using DIA data.
- Published interim report on National Registry of Airport Pavements.

National Dynamic Airport Pavement Tests

- Completed the first series of full-scale traffic (life) tests at FAA's National Airport Pavement Test Facility (NAPTF).
- Implemented a database of full-scale test results, allowing on-line access to the test data.
- Began analyzing full-scale traffic test data to relate pavement performance to design.
- Reconstructed all pavement test items at the NAPTF and programmed the second series of full-scale traffic tests.
- Continued material testing and evaluation for the NAPTF.

Airport safety technology

- Continued development means to acquire and report runway surface friction values for pilot use.
- Completed evaluation of Light-Emitting Diode (LED) light strips for movement and non-movement areas.
- Completed evaluation of fiber-optic runway-distance-remaining signs at Pittsburgh International Airport.
- Completed initial development of the full-scale post crash interior fire suppression facility.
- Published testing standards for airport fire-fighting extinguishing agents.
- Completed wildlife habitat study at John F. Kennedy International Airport focusing on grass height and vegetation types.
- Initiated the following studies on wildlife habitats: habitat study in the Pacific Northwest (focusing on vegetation); relocation of raptors at Chicago O'Hare Airport; grass height at USDA Plum Brook Station; habitat study in the southwest.
- Investigated airport wildlife control and detection techniques including use of bird effigies, laser, and microwave as wildlife dispersion methods, and evaluation of radar for wildlife detection.
- Continued to develop bird-strike risk assessment factors for civilian airports.
- Set up comprehensive web site on wildlife mitigation methods and techniques, and continued to populate the National Strike Database.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Conduct the second series of full-scale traffic tests (life tests) at NAPTF.
- Complete reports on sizing terminal components and compiling information on other aspects of terminal planning.
- Continue to analyze full-scale traffic test data from NAPTF to relate performance to designs.
- Release updated pavement design program package (LEDFAA 2.0).
- Continue development of three-dimensional finite element based pavement design procedures.
- Continue data collection and analysis at Denver International Airport.
- Complete improvement of back-calculation methods for Nondestructive Testing (NDT) of airport pavements.
- Produce report on taxiway centerline deviations of B-747 wide body aircraft at JFK and Anchorage.
- Conduct evaluation of improved airport lighting.
- Publish specifications for aircraft infrared deicing system.
- Complete full-scale 2nd level interior fire suppression facility (Phase II).
- Conduct full scale 2nd level fire suppression testing.
- Complete research on next generation elevated boom technology.
- Develop specifications for prototype Interior Intervention Vehicle (IIV).

- Initiate research for replacement primary fire extinguishing agent.
- Continue wildlife habitat studies in the Southwest and Pacific Northwest, at Chicago O'Hare Airport, and at USDA Plum Brook Station.
- Continue evaluation of wildlife dispersion techniques.
- Begin development of the National Advisory Wildlife Strike System for Airports.
- Continue populating the National Wildlife Strike Database.

FY 2002 PROGRAM REQUEST:

The Airport Technology FY 2002 research program is a collaborative effort among many government organizations, universities, and industry associations. The program funding requested provides the contract support necessary for an integrated, effective research program that delivers the standards and guidelines for maintaining and enhancing airport infrastructure.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$9,200
FY 2001 Enacted	11,400
FY 2002 Request	9,547
Out-Year Planning Levels (FY 2003-2006)	55,197
Total	$85,344

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Airport Technology	0	2,703	4,200	9,400	7,547
Personnel Costs	0	2,016	0	1,800	1,800
Other In-house Costs	0	281	0	200	200
Total	**0**	**5,000**	**4,200**	**11,400**	**9,547**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	5,000	4,200	11,400	9,547
Total	**0**	**5,000**	**4,200**	**11,400**	**9,547**

Notes:

- Airport Technology FY 2002 funding request is included in the AIP Appropriation.

- Current year and all out years request includes in-house costs. Out year funding request is under review.

Airport Technology Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Airport Technology	$7,547						
Conduct the Second Series of Full-Scale Traffic Tests (Life Tests)		◆	◇				
Continue to Analyze Full-Scale Traffic Test Data from NAPTF to Relate Performance to Designs		◆	◇				
Release Updated Pavement Design Program Package							
Continue Development of Three-Dimensional Finite Element Based Pavement Design Procedures		◆	◇	◇	◇	◇	◇
Continue Data Collection and Analysis at Denver International Airport		◆	◇	◇	◇	◇	◇
Complete Improvement of Back-Calculation Methods for Non-Destructive Testing of Airport Pavements							
Produce Report on Taxiway Centerline Deviations of B-747 Wide Body Aircraft		◆	◇	◇	◇		
Conduct Evaluation of Improved Airport Lighting		◆		◇	◇	◇	◇
Publish Specifications for Aircraft Infrared Deicing System		◆		◇	◇	◇	
Develop Standards for Anti-Rollover and Stability Requirements for Heavy Airport Rescue Vehicles		◆	◇		◇	◇	◇
Develop Full-Scale Interior Fire Suppression Facility to Perform Next Generation Aircraft Requirements Research		◆		◇			◇
Publish Testing Standards for Airport for Fire Fighting Extinguishing Agents		◆	◇		◇		◇
Continue Populating the National Strike Data Base		◆		◇			
Perform Wildlife Habitat Modeling at Selected Airports		◆	◇		◇		◇
Total Budget Authority	$7,547	$9,400	$7,547	$16,270	$15,762	$11,890	$11,275

Note:

– Airport Technology FY2002 funding request is included in the AIP appropriation.

– Current year and all out years request includes in-house costs. Out year funding request is under review.

2.3 Aircraft Safety Program Area Description

Mission

The mission of the Aircraft Safety program is to provide a safe global air transportation system by establishing safety standards and acceptable practices through development of technical information, tools, and technology to ensure safe operation of the civil aircraft fleet.

This program addresses the many hazards that face 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 embedded software, and construction of new non-metallic materials—present significant challenges in certification, continued airworthiness, and operation. However, all aircraft, old or new, must deal with the hazards of adverse weather.

Intended Outcomes

The Aircraft Safety program supports the FAA's safety mission goal, "by 2007, reduce U.S. aviation fatal accident rates by 80 percent from 1996 levels."

The Aircraft Safety program focuses on improving system safety through the following research programs:

- *Support aging aircraft* by developing technologies, procedures, and practices that ensure the continued airworthiness of aircraft structures and aircraft mechanical and electrical systems in the civil fleet.
- *Prevent catastrophic failure* by developing technologies and methods that will assess the risk and prevent defects, failures, and malfunctions of aircraft, aircraft components, and aircraft systems that could result in catastrophic failure of the aircraft.
- *Promote flight safety and reduce the effects of atmospheric hazards* by addressing atmospheric hazards in the design, development, and certification process.
- *Improve propulsion and fuel systems* by enhancing the airworthiness, reliability, and performance of civil turbine and piston engines, their propellers, fuels, and fuel management systems.
- *Support fire research and safety* by developing near-term fire safety improvements to prevent uncontrollable in-flight fires and increase post-crash fire survival rates and conduct long-range research to develop ultra fire-resistant cabin materials.
- *Promote 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.
- *Introduce a new disk design and life management computer tool*, "Design Assessment of Reliability with Inspection," with potential to allow engine manufacturers to reduce the disk failure rate in turbine-powered engines. Use of the new tool will provide a further measure of safety by allowing disk designers to assume the potential presence of tiny flaws in the design life determinations. This new method also will give insight into planning the most effective inspection program. The technology is the result of a four-year FAA-funded research project conducted in collaboration with engine manufacturers AlliedSignal, Rolls Royce-Allison, General Electric, and Pratt & Whitney.
- *Develop an aircraft mounted wide area ice detection system* to reduce icing accidents. A hand-held system will allow the inspector to work more conveniently, quickly, and accurately in detecting ice on critical surfaces. Unnecessary use of environmentally harmful deicing fluids will be eliminated, airlines will save time, and travelers will save money.

Aircraft safety improvements will reduce fatalities and injuries, reduce hull losses, improve aircraft designs, and impact maintenance and inspection procedures. Potential significant safety benefits include:

- Reduction of the approximately 30 to 35 U.S. fire fatalities per year and 135 worldwide, in otherwise survivable accidents.
- Use of a more reliable airframe inspection technique that has been approved as an alter-

nate inspection technique for detecting corrosion at the juncture of wing and fuselage on DC-9's. The new technique will save over 700 person-hours per inspection, compared to the current inspection method. The technique also requires less disassembly of the aircraft part to conduct the inspection, resulting in less chance for damage during disassembly and reassembly. One airline estimates that by using the new inspection technique, it can save over $2 million over the maintenance cycle for its fleet of DC-9s.

Program Area Outputs

The FAA establishes rules for aircraft certification, operation, inspection, maintenance and repair, and publishes advisory circulars to outline acceptable means of meeting the rules. The agency also disseminates technical information in various forms to its airworthiness inspectors and to industry to improve aircraft construction and maintenance practices. Technical information is developed to establish criteria for safety systems, such as seat restraints and protective breathing equipment. The primary objective is to improve system safety based on elimination of causal factors related to aircraft and flight hazards. Aircraft safety research provides the technical information necessary to support agency outputs.

Aircraft Safety program research customers include aviation manufacturers and aircraft and avionics maintenance facilities, aircraft operators, and the general public who use commercial air transportation. The safety research program supports customer requirements by providing tools that enable demonstration of compliance and development of advisory information to ensure the safety of the flying public. Aviation safety research sponsors are FAA personnel in Flight Standards (AFS) and Aircraft Certification (AIR). The aircraft safety program supports sponsor requirements by providing the research to aid rulemaking and regulation development and by developing technical data and guidance material to develop standards, rules, and regulations.

Program Area Structure

The Aircraft Safety program includes research in a wide range of areas related to aircraft and passenger safety. It focuses on eliminating hazards to the air transportation system, by both preventing accidents from happening and mitigating the effects of those accidents that do occur. Prevention and mitigation activities include:

- *Accident and incident prevention*
  - – Structural integrity (preventing aircraft structural failure)
  - – Propulsion systems (ensuring reliable aircraft power)
  - – Flight safety (minimizing operational hazards)
  - – Mechanical and electrical system reliability and integrity (reducing aircraft systems failure)
- *Accident and incident mitigation*
  - – Crashworthiness (maximizing crash survivability and escape)
  - – Fire safety (preventing fire and fire fatalities)

Customer and Stakeholder Involvement

Research programs within the Aircraft Safety program directly support the Aviation Safety Plan (February 1996) through research supporting priority issues associated with the following 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 the Aircraft Safety program area. The most recent review was completed in 2000. The program described here is fully responsive to the advice of the subcommittee.

The FAA's primary mission, 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 FAA's research mission was expanded when Congress passed the legislation known as the Aviation Safety Research Act of 1988 (Public Law 100-591). This act mandates that the FAA: "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 act also authorized the FAA to generate technology breakthroughs where technology gaps need to be closed while emphasizing the importance of long-range research.

Passage of the Aircraft Catastrophic Failure Prevention program under the Omnibus Reconciliation Act of 1990 (Public Law 101-508) further expanded the FAA research mission. While the FAA mission originally focused on airplane improvements, the 1990 amendment added proactive research to make airplanes safe from catastrophic failure.

In 1998 the FAA published the Aging Transport Nonstructural Systems Plan in response to the Gore Commission's recommendation. Research is being developed as recommended in that plan.

Safety research will reduce the hazards of operating aircraft, thus providing a higher level of safety. Much of the technology developed will also enhance U.S. aviation industry competitiveness for both manufacturers and operators.

Accomplishments

Research results are disseminated to the agency (aircraft certification and flight standards) and to industry (aircraft manufacturers, operators, and maintainers) as:

- 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 that provide 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. One method for engine component inspection in particular has shown a dramatic improvement in sensitivity for detecting the type of flaw that led to the 1989 Sioux City accident that killed 211 people.

A large number of advisory circulars (AC) have been developed for a wide range of aviation safety-related activities, including design of composite structures, corrosion control, aircraft deicing, inspection, and repair. ACs controlling aircraft ground deicing for both large transport airplanes (AC 120-58, 9/92) and smaller commuter airplanes (AC 135-17, 12/94) are aimed at ensuring the safe operation of large airplanes and air taxis during icing conditions. These ACs provide guidelines for developing adequate deicing procedures.

R&D Partnerships

Program activities are closely coordinated with related initiatives underway within other government agencies, including the Department of Energy (DOE), DOD, and NASA. Formal agreements of cooperation are in place with the Air Force, Army, Navy, NASA, DOE, and in developing standardization data for materials in Military Handbooks 5 and 17.

International agreements are in place with government agencies and research laboratories in the

United Kingdom, The Netherlands, France, Italy, Australia, Canada, and Russia and the Peoples Republic of China.

Numerous 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. For example, the Airworthiness Assurance Center of Excellence (AA-COE) was established in September 1997 to conduct research in the areas of:

- Maintenance, inspection, and repair

- Crashworthiness
- Propulsions and fuel systems safety technologies
- Advanced materials

The AA-COE consists of nine core members, 90 industry partners, 45 university affiliates, and seven other partners, including other Government laboratories and state organizations. The COE provides matching funds, which solidify a significant COE-FAA partnership. Through this partnership, the Government, academic institutions, and industry leverage the resources available for aviation research.

Technology transfer will occur through a variety of mechanisms, including:

- Technical reports documenting research results.
- Conferences on a wide range of subjects designed to disseminate technical information.
- Technical organizations, such as the American Society on Testing and Materials (ASTM), Society of Automotive Engineers (SAE), and American Institute of Aeronautics and Astronautics (AIAA), that use study committees to ensure the transition of research results to standards, guidelines, etc.
- Hardware and software prototype demonstrations and technology workshops.
- The FAA Airworthiness Assurance Nondestructive Inspection Validation Center (AANC) demonstrations and validations of cost-effective aircraft inspection equipment and techniques to industry.

Long-Range View

As air traffic continues to increase, and as aircraft continue to age, the need for safety and safety-related research will continue indefinitely. Research in aircraft safety must be continued to understand the full impact of changes in technology on current regulatory safety standards, certification procedures, and acceptable practices.

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 fuel tank explosions and eliminating burning cabin materials as a factor in post-crash 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 fuel tank explosion protection, fire detection and suppression systems and interior materials fire test methods and criteria.

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 Aircraft Safety 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 FAA created an Aviation Rulemaking Advisory Committee (ARAC) on fuel tank inerting to recommend viable methods of fuel tank protection. This industry working group will be supported by the FAA and will impact related research.
- The aircraft manufacturers and airlines have a need to improve fire detection and suppression systems and interior material fire tests. Recognizing the FAA's unique capabilities in fire safety, the aviation industry actively participates in systems fire protection and material fire tests working groups headed by the FAA. Foreign airworthiness authorities are active participants, as well, to ensure harmonization of outputs.
- The National Transportation Safety Board (NTSB) relies heavily on program personnel for on-site accident investigation and related testing.

Accomplishments: Results of fire research and safety were provided to FAA certification 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:

- Developed new, broader and more stringent thermal acoustical insulation fire test criteria that were the basis for a major Airworthiness Directive (AD) adopted on May 26, 2000, requiring insulation blanket replacement in over 700 commercial airliners, and a planned Notice of Planned Rulemaking (NPRM). Published upgraded Aircraft Materials Fire Test Handbook, the most complete description of all required as well as currently available aircraft fire test standards.
- Developed thermal protection criteria for medical oxygen cylinder carrying cases (overpacks) proposed in NPRM issued by the Research and Special Programs Administration (RSPA).
- Developed performance standards for gaseous halon replacement agents used in cargo compartment fire suppression systems and cabin hand-held extinguishers.

- Completed detailed cost analysis of a ground-based inerting system, demonstrating a positive cost/benefit (viability).
- Demonstrated a decorative panel with 60% reduction in heat release rate per FAR 25.853.
- Completed development of commercial prototype microscale heat release rate calorimeter (patent awarded).
- Supported pilot plant production by a major resin supplier of chloral polymers for aircraft interior applications demonstrated by the FAA to have superior fire performance.

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 investigations 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 systems fire protection working group. This group collaborates in research and development related to fuel tank protection, fire/smoke detectors and halon replacement. 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. FAA and NASA have an integrated program to conduct research on gas generation systems for fuel tank protection and emergency oxygen, advanced fire/smoke detectors and ultra fire resistant materials. 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 an interagency agreement with the National Institute of Standards and Technology (NIST) to research the impressive fire retardant mechanism of nanometer clay particles. The agency has a memorandum of cooperation with the British Civil Aviation Administration (CAA) 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 grant programs 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 2001 ACCOMPLISHMENTS:

Fire Resistant Materials

- Developed user friendly method for predicting material flammability from chemical structure.
- Made available heat release data base for cabin materials on FAA web site.
- Demonstrated elastomers for seat cushions with 50% reduction in heat release rate.

Fire Safety Improvements

- Completed aircraft test article for test, evaluation and development of a fuel tank ground-based inerting system.
- Determined the effect of oxygen concentration and altitude (pressure) on the severity of fuel tank explosions.
- Characterized hollow fiber membrane nitrogen generating system in small-scale fuel tank test article.
- Tested and evaluated a hybrid water spray/nitrogen inerting system for cargo compartment fire suppression effectiveness.
- Determined replacement agents (CF3I and HFC-125) quantities for equivalent performance to halon as specified by engine nacelle minimum performance standard.
- Evaluated aircraft cargo smoke detector response to fire and nuisance alarms.
- Characterized smoldering and flaming cargo fire sources for development of certification standards for cargo smoke detectors.
- Designated and constructed a full-scale fuselage test article for characterizing fire hazards in new double-decked Very Large Transport Aircraft (VLTA).

KEY FY 2002 PRODUCTS AND MILESTONES:

Fire Resistant Materials

- Demonstrate fiber for seat upholstery, carpet, drapes and decorative murals with 50% reduction in heat release rate.
- Scale-up and formulate ultra-fire resistance plastics for aircraft applications.
- Conduct physical, chemical and flammability tests on scaled-up plastic specimens.

Fire Safety and Improvement

- Design, fabricate and install an airborne ground-based inerting system in aircraft test article.
- Determine applicability of an on-board ground-based fuel tank inerting system to replace or supplement cargo compartment and other fire suppression systems and the associated weight savings.
- Draft a revised Advisory Circular (AC) for approval testing of cargo smoke detectors.
- Validate mathematical model to predict the transport of in-flight fire products throughout a cargo compartment.
- Characterize VLTA cabin fires under full-scale fire test conditions.

FY 2002 PROGRAM REQUEST:

In FY 2002, the superior fire performance of a fiber for seat upholstery and carpet will be demonstrated. With the completion of this milestone, promising polymers for all four major interior material categories (resins, plastics, elastomers and fibers) will have been identified with demonstrated low heat release performance. In FY 2002, ultra fire resistance plastics will be formulated and scaled up for aircraft applications. Physical, chemical and flammability tests will also be conducted on the scaled-up specimens. Based on the measured performance, serviceable aircraft materials will be down selected in FY 2003 with comparable life cycle costs to current materials.

In FY 2002, research on fuel tank protection will focus primarily on the development and evaluation of a ground-based inerting (GBI) system. Recent FAA cost analysis, computer modeling and small-scale experimental findings indicate that GBI is the most cost effective and practical approach for fuel tank flammability protection. In FY 2002, an airborne GBI system will be designed, fabricated and installed in an airplane, and will be tested and evaluated in FY 2003. A study will also be conducted to determine if and how nitrogen supplied by a GBI system will meet the performance requirements of required or optional fire suppression systems, and the assorted weight savings.

In FY 2002, a mathematical model to predict the transport of in-flight fire products throughout a cargo compartment will be validated. The model capabilities and other research findings will be used in a revised advisory circular that will be completed in FY 2002. The AC will specify standards for the approval of cargo smoke detectors, including advanced designs incorporating multiple sensors and computer algorithms designed to improve detector sensitivity and reduce false alarms. With the launching of the new A3XX mega transport by Airbus becoming a distinct possibility, the need for new fire safety standards for these double decked VLTAs needs to be determined. In FY 2002, VLTA fires will be characterized under full-scale test conditions in order to establish fire safety areas that may require new or enhanced requirements.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 96,076
FY 2001 Enacted	4,740
FY 2002 Request	5,242
Out-Year Planning Levels (FY 2003-2006)	22,636
Total	$ 128,694

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Fire Research and Safety	3,377	2,098	1,292	1,671	2,340
Personnel Costs	3,001	2,315	3,116	2,856	2,621
Other In-house Costs	615	337	342	213	281
Total	**6,993**	**4,750**	**4,750**	**4,740**	**5,242**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	6,993	4,750	4,750	4,740	5,242
Development (includes prototypes)	0	0	0	0	0
Total	**6,993**	**4,750**	**4,750**	**4,740**	**5,242**

A06a - Fire Research and Safety Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
061-110 Fire Research & Safety							
Fire Resistant Materials	$987						
Demonstrated Elastomer for Seat Cushions with 50% Reduction in Heat Release Rate		◆					
Demonstrate Fiber for Seat Upholstery with 50% Reduction in Heat Release Rate			◇				
Scale-Up and Formulate Plastics for Evaluation			◇				
Conduct Physical, Chemical and Flammability Tests on Scaled-Up Specimens			◇				
Down Select Plastics to Serviceable Aircraft Materials				◇			
Identify Low Heat Release Interior Materials with Comparable Life Cycle Costs/Service Performance to Current Materials							◇
Fire Safety Improvements	$1,353						
Designed & Constructed a Full-scale VLTA Fuselage Test Article		◆					
Characterize Cabin & Fuselage Fires in VLTA			◇				
Define VLTA Fire Protection Methodology						◇	
Tested and Evaluated a Hybrid Cargo Compartment Water Spray/Nitrogen Inerting Fire Suppression System		◆					
Determined Effect of Oxygen and Pressure on Severity of Fuel Tank Explosive Hazards		◆					
Complete Aircraft Test Bed for GBI System		◆					
Design and Install an Airborne GBI Fuel Tank Inerting System			◇				
Flight Test GBI Fuel Tank Inerting System					◇		
Recommend Design Criteria for a GBI Fuel Tank Protection System						◇	
Evaluated Cargo Smoke/Fire Detector Response to Fire and Nuisance Alarms		◆					
Characterized Smoldering and Flaming Cargo Fire Sources for Development of Certification Standards for Cargo Smoke Detectors		◆					
Validate Math Model to Predict Transport of Cargo Five Products			◇				
Revise Draft Advisory Circular for Smoke/Fire Detection			◇				
Personnel and Other In-House Costs	$2,902						
Total Budget Authority	$5,242	$4,740	$5,242	$5,404	$5,565	$5,749	$5,919

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

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 study of advanced materials focuses on the following technical areas:

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

The study of structural safety 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 understanding of aircraft crash events to lead to more efficient certification.

Agency Outputs: The FAA establishes rules for aircraft certification and operation and publishes Advisory Circulars (AC) 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. AC 20-107A, "Composite Structure" has been published, but advances in technologies and materials lead to periodic updates 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, aircraft configurations, and seat/restraint systems.

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

- The Aviation Rulemaking Advisory Committee (ARAC) is a 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 the 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 the FAA to step up advanced materials research for aircraft community benefits.
- The 1994 DOT 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, resulted in an FAA policy memo, published more than 50 technical reports, articles, and papers, and has cosponsored three technical conferences with

attendance of approximately 1,200 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. One of the gaps was rectified by developing an American Society for Testing and Materials (ASTM) standard for compression testing. 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 worldwide practice.

In the structural safety area, six 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's efforts to develop a composite property database for General Aviation (GA) aircraft under the NASA Advanced GA Transport Experiments (AGATE)/Integrated Design and Manufacturing (IDM) Program. The FAA has also initiated a partnership with the Rotorcraft Industry Technology Association (RITA) to share in rotorcraft composite materials research.

The FAA cosponsors, 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 material data contained in this handbook will be acceptable for use in the certification process. In the structural safety area, there are agreements for cooperative programs with the National Highway Traffic Safety Administration (NHTSA), with the U.S. Army and Navy, and with 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 airframe manufacturers such as Boeing and Raytheon and with manufacturers of overhead bins and auxiliary fuel tanks. The advanced materials and structural safety areas are benefiting from a close working relationship with the Airworthiness Assurance Center of Excellence. The research performed under this program is leveraged by the monetary and intellectual contributions of its core universities.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Advanced Materials

- Established methodology to predict delamination initiation and growth at critical details in composite structures.
- Generated a database for durability of textile forms and stitching as manufactured by resin transfer molding.
- Established criteria to assure damage tolerance of composite sandwich structures for small aircraft and rotorcraft.
- Initiated addressing certification issues of composite materials pertaining to rotorcraft.

Structural Safety

- Completed vertical drop test of a B737 fuselage section with overhead bins to deter-

mine their behavior under a survivable crash scenario.

- Completed assessment of the crash resistance of current rotorcraft, commuter, and transport fuel systems.
- Established guidelines for conducting Head Injury Criteria (HIC) component testing to supplement full scale testing.
- Published data on behavior of transport aircraft overhead stowage bins in a severe but survivable crash.

KEY FY 2002 PRODUCTS AND MILESTONES:

Advanced Materials

- Complete database on in-plane shear test methods and develop a new improved standard.
- Develop validated analytical methodology describing behavior of sandwich structures after impact event.
- Establish a database on verified safe design practices insuring structural integrity and damage tolerance of adhesive joints.
- Establish guidelines for probabilistic design certification.

Structural Safety

- Conduct a vertical drop test of currently in-service commuter aircraft with wing main spar seating.
- Conclude overhead stowage bin research.
- Conclude auxiliary fuel tank research.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program continues to focus on the areas listed at the beginning of the GOALS section above. Specific areas are damage tolerance of sandwich structures applicable to current and future aircraft fuselages, durability of textiles, and developing a database for certification of bonded composite joints in small aircraft. In addition, work will continue to develop data applicable to rotorcraft including high-cycle fatigue. Research in out years will encompass material behavior at elevated temperatures with application to engine parts and reusable launch vehicles. Within the structural safety area, a unified analytical modeling capability will be under development in order to reduce costly testing. The models will include the response of seats, restraint systems, seat attachments, and airframes under dynamic crash conditions. Other areas of research to be continued are crash resistance of fuel systems, determination of criteria for HIC and neck injury compliance. These criteria will be applicable to side facing seating in business jets. After conducting the vertical drop test of a currently in-service commuter aircraft, sufficient data will be available to compile a crash test database for all types of aircraft.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 59,792
FY 2001 Enacted	2,791
FY 2002 Request	2,974
Out-Year Planning Levels (FY 2003-2006)	12,699
Total	$ 78,256

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Advanced Materials	1,030	347	596	975	962
Structural Safety	1,029	462	493	819	808
Personnel Costs	835	803	1,109	937	1,091
Other In-house Costs	171	122	140	60	113
Total	**3,065**	**1,734**	**2,338**	**2,791**	**2,974**

Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	3,065	1,734	2,338	2,791	2,974
Development (includes prototyp	0	0	0	0	0
Total	**3,065**	**1,734**	**2,338**	**2,791**	**2,974**

A06b - Advanced Materials/Structural Safety Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
062-111 Advanced Materials Structures							
Advanced Materials	$962						
Established Methodology to Predict Delamination Initiation		◆					
Generate Data Base for Durability of Textile Forms		◆					
Establish Criteria for Damage Tolerance of Sandwich Structures		◆					
Complete Database on In-plane Shear Test Methods			◇				
Establish Guidelines for Probabilistic Design Certification			◇				
Develop Data Base on Verified Design Practice for Adhesive Joints			◇				
Develop Analytical Methods for Sandwich Structures			◇				
Develop Data Base on Damage Tolerance of Sandwich Structure				◇			
Durability and Damage Tolerance Data for Rotorcraft				◇			
Develop Certification Methodology for New Materials and Forms					◇		
Develop Certification Methodology for High Cycle Fatigue						◇	
Identify Data for Certification of Materials at Elevated Temperatures							◇
062-110 Structural Safety							
Structural Safety	$808						
Completed Vertical Drop Test of B737 Fuselage Section with Stowage Bins		◆					
Establish Guidelines for Conducting (HIC) Component Testing		◆					
Complete Assessment of the Crash Resistance of Fuel Systems		◆					
Complete Rotorcraft Ditching Research in Conjunction with the Navy				◇			
Publish Data on Crash Resistance of Transport Aircraft Stowage Bins		◆					
Conclude Overhead Storage Bin and Fuel Tank Research			◇				
Develop Analytical Capability to Model Aircraft Crash Events				◇			
Conduct a Vertical Drop Test of Commuter Aircraft with Main Spar Seating			◇				
Establish Crash Test Data Base					◇		
Develop Occupant Protection Criteria for Side Facing Seating						◇	
Improve Crash Resistance of Transport Fuel System							◇
Personnel and Other In-House Costs	$1,204						
Total Budget Authority	$2,974	$2,791	$2,974	$3,052	$3,129	$3,220	$3,298

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

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.
- Reduced the number of intrinsic turbine rotor failures by improved and standardized design and life management procedures.
- Improved melt processes for premium quality titanium alloys used for turbine rotor components.
- Improved manufacturing and quality practices to eliminate manufacturing induced anomalies in turbine rotor components.
- Reduced turbine engine failure/downtime and improved maintenance efficiency through advanced monitoring/diagnostic hardware and software.
- Continued reliability and safe use of Jet A fuel containing red dye contamination.
- Provided engineering support for the certification of the next generation general aviation piston and turbine engine.

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 various forms in the public domain. 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 the 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, Rotor Manufacturing 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 of high octane unleaded aviation gasoline. EPA regulations and the Clean Air Act of 1990 mandate removal of lead from all gasoline. 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 (AOPA), Experimental Aircraft Association (EAA), and General Aviation Manufacturers Association (GAMA); the research sponsor, the FAA New England Region Engine and Propeller Directorate; and the FAA Small Airplane Directorate in Central Region.

- The FAA sponsored Technical Oversight Group On Aging Aircraft (TOGAA) reviews technical aspects of the airworthiness assurance R&D activities. TOGAA has provided feedback on the progress of the turbine engine program over the last four years.
- The Subcommittee on Aircraft Safety of the FAA Research, Engineering and Development Advisory Committee was briefed on the propulsion program, an initiative that the subcommittee strongly supports.
- The FAA/industry initiative on turbine engine rotor integrity research in this program addresses National Transportation Safety Board (NTSB) recommendations A-90-89 and A-90-90.
- 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.
- The Aerospace Industries Association convened an ad hoc group to study the effects of red dye contamination of Jet A fuel and to identify solutions to this problem. This effort has resulted in a program funded by the FAA, Defense Energy Support Center, Internal Revenue Service (IRS), Air Transport Association, and engine and airframe manufacturers. Additional funding from the oil refiners may be forthcoming.

Accomplishments: Results of the propulsion and fuels research program provided to engine and aircraft regulatory and industry stakeholders:

- Drafted an advisory circular on the correlation, operation, design, and modification of turbofan/jet engine test cells, which provide guidance on the testing of aircraft engines.
- Completed a training video production entitled; "Aircraft Turbine Engine Test Cell Correlation."
- Hosted and sponsored four annual joint FAA/Air Force public workshops with published proceedings on the application of probabilistic design methodology to gas turbine rotating components.
- Demonstrated integrated probabilistic rotor design and life management code (DARWIN™ version 3.2) for titanium alloys to provide commercial aircraft turbine engine manufacturers a tool to augment their current "safe life" management philosophy approach.
- Conducted DARWIN™ Code version 3.2 FAA/Industry training workshop.
- Demonstrated and delivered the DEFORM™ defect deformation micro code for analysis of titanium alloy defects during the 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.
- Participated in establishing matrix components to be used in developing candidate fuel formulations.
- Initiated engine tests on an industry-supplied fuel formulation.
- Completed report on engine octane requirements.
- Determined and defined detonation detection procedures for proposed American Society for Testing and Materials (ASTM) method to test unleaded replacement fuel(s).
- Issued final determination of fleet octane requirements for unleaded replacement in high fuel performance piston engines to be greater than 100 octane.
- Completed final report on in-service Jet A fuel sample analysis volatility survey.
- Completed report on the results of titanium melting enhancements.

R&D Partnerships:

A cooperative grant was awarded to the Southwest Research Institute, which has teamed with major engine manufacturers Pratt and Whitney, General Electric, Honeywell (AlliedSignal), and Rolls Royce-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 U.S. Air Force Wright

Laboratory, which conducts complementary research, and with ongoing research activities of the FAA Engine Titanium Consortium sponsored under budget item A06e, Aging Aircraft. The FAA transfers the completed probabilistic engine design code versions for use by the industry via training workshops.

A research partnership has been initiated with the Specialty Metals Processing Consortium (SMPC) based at the Sandia National Laboratory; SMPC includes the Sandia Liquid Metals Processing Laboratory, Allvac, Oremet Titanium Co., RMI Titanium Co., Timet Co., General Electric Aircraft Engines, and Pratt & Whitney.

- 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.
- A FAA contract with the Southwest Research Institute will determine an acceptable level of fuel dye contamination, which allows continuous safe turbine engine operation. The following organizations contribute funding to this effort: the FAA, Defense Energy Support Center, IRS, Air Transport Association, American Petroleum Institute, General Electric, Pratt & Whitney, Rolls Royce, Honeywell (AlliedSignal) and Boeing.
- Research to demonstrate the feasibility of a temporary (safety net) fuel will be will be done in partnership with the Cessna Aircraft Co.
- The program is benefiting from a close working relationship with the Airworthiness Assurance Center of Excellence. The research performed under this program is leveraged by the monetary and intellectual contributions of its core universities.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Completed rotor manufacturing induced anomaly database.
- Continued laboratory characterization and engine ground testing of preliminary industry-supplied candidate unleaded fuels using FAA test facilities.
- Began characterization and testing of industry supplied candidate fuels using FAA engine ground test facilities.
- Commercialized the DARWIN™ rotor design and life management code.
- Completed validation of the DARWIN™ rotor design and life management code for subsurface anomalies.
- Completed spin pit tests of disks that contain hard alpha defects to validate the FLIGHT_LIFE fracture mechanics module in DARWIN™.
- Completed report that defines an acceptable concentration of red dye contamination in Jet A fuel for continuous engine operation.
- KEY FY 2002 PRODUCTS AND MILESTONES:
- Complete validation of DEFORM™ forging microcode for tracking subsurface anomalies.
- Demonstrate DARWIN™ code version for surface anomalies.
- Verify hearth melt process models.
- Continue laboratory characterization engine ground testing of preliminary industry-supplied candidate unleaded fuels using FAA test facilities.
- Begin flight tests on industry-supplied candidate unleaded fuels.
- Complete demonstration of safety net unleaded fuel.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program continues development of a probabilistically-based turbine engine rotor design code with damage tolerance assessment. This code will be a life and risk management tool to augment the current “safe life” design approach for integration into engine manufacturer rotor design procedures. The application of this tool, as

an FAA-approved 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. In FY 2002 fuel tests using the FAA flight test aircraft will begin. All parameters impact on safe engine operation and all data supports eventual certification of a replacement fuel. In the event that a successful candidate fuel formulation is not available, the feasibility of a temporary (safety net) fuel will be demonstrated.

The program continues to develop rotor disk alloy material melt processes to establish commercial manufacturing standards that will eliminate metallurgical defects to produce premium quality, rotor grade alloy materials. Commercial aircraft accident history has shown that the presence of these defects in rotor disks have been the initiating cause of uncontained rotor failures. These failures are a major contributor associated with the engine failure fatal accident rate.

In FY 2002, the program will continue R&D support of the AIA Rotor Manufacturing Subcommittee to develop advanced manufacturing technologies. The purpose of this activity is to qualify and control the final surface manufacturing processes that could have an impact on rotor disk fatigue life.The FY 2002 program continues research to establish an improved understanding of the metallurgical, cold dwell time factors that can shorten fatigue life in titanium rotor disk alloys. The microstructure-based modeling capability developed by this activity will enable more accurate prediction of the risk of serious engine caused accidents.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 46,212
FY 2001 Enacted	8,182
FY 2002 Request	5,168
Out-Year Planning Levels (FY 2003-2006)	21,786
Total	$ 81,348

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Propulsion Systems Resear	3,643	1,761	1,754	6,994	3,944
Personnel Costs	1,126	932	1,230	1,114	1,079
Other In-house Costs	231	138	142	74	145
Total	**5,000**	**2,831**	**3,126**	**8,182**	**5,168**

Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	5,000	2,831	3,126	8,182	5,168
Development (includes prototyp	0	0	0	0	0
Total	**5,000**	**2,831**	**3,126**	**8,182**	**5,168**

A06c - Propulsion and Fuel Systems Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
063-110 Propulsion and Fuel Systems Research							
Turbine Engine Research	$3,096						
Validate the Probabilistic Rotor Design and Life Management Code (DARWIN) for Subsurface Defects		◆					
Commercialize Darwin Code		◆					
Demonstrate Probabilistic Integration Design Code – Surface Flaws			◇				
Deliver Probabilistic Rotor Design Code – Nickel Alloys					◇		
Complete Rotor Manufacturing Induced Anomaly Database		◆					
Verify Hearth Melt Process Models			◇				
Complete Ingot Surface Quality Model				◇			
Demonstrate the On-line Monitoring for Alloy Composition Control in a Commercial Electron Beam Melt Furnace						◇	◇
Develop Equations for Finite Element Modeling of Cold Dwell Fatigue					◇		
Develop Computer Model for Cold Dwell Fatigue Damage Evolution and Failure in Titanium						◇	
Unleaded Fuels and Fuel System Safety Research	$848						
Continued Laboratory Characterization of Industry Supplied Preliminary Candidate Fuels		◆	◇				
Begin Laboratory Characterization and Engine Ground Testing of Industry Supplied Candidate Unleaded Fuels		◆					
Complete Determination of Acceptable Concentration of Red Dye Contamination in Jet A Fuel for Continuous Engine Operation		◆					
Begin Flight Tests on Industry Supplied Candidate Fuels			◇				
Begin Fleet Evaluation of Candidate Unleaded Aviation Gasoline				◇			
Complete Demonstration of Safety Net Unleaded Fuel			◇				
Personnel and Other In-House Costs	$1,224						
Total Budget Authority	$5,168	$8,182	$5,168	$5,278	$5,381	$5,513	$5,614

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

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 measures help ensure safe operation of the civil fleet in icing conditions and in the electromagnetic environment, and address safety issues pertaining to software, digital flight controls and avionics systems.

In the area of aircraft icing, the program focuses 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 in-flight operation in icing conditions.

The software and digital systems safety program addresses aircraft safety and certification 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. The electromagnetic hazards to aircraft systems program focuses on protecting aircraft electrical and electronic systems against the effects of lightning and High Intensity Radiated Fields (HIRF). HIRF effects may come from airborne, shipborne and ground based emitters. The program also focuses on the effects of spurious emissions from portable electronic devices, i.e., tape players, laptop computers, cellular phones, etc.

Agency Outputs: The FAA establishes rules for aircraft operation in icing conditions and the electromagnetic environment, software, digital flight controls, avionics systems, and electromagnetic hazards. It also publishes Advisory Circulars (AC) 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 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 FAA Strategic Plan Mission Goal for Safety: By 2007, reduce U.S. aviation fatal accident rates by 80 percent from 1996 levels. The program directly supports the Safety Strategic Focus Area of Accident Prevention. It does this through enhancements to aircraft certification, inspection, and maintenance relative to atmospheric hazards and advanced software and 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 (FTHWG) addresses performance and handling requirements standardization, and guidance material for operation in icing conditions. The ARAC Ice Protection Harmonization Working Group (IPHWG) addresses definition of an icing environment that includes Supercooled Large Droplets (SLD) and means, such as ice detectors, to discriminate between conditions within and outside the certification envelope and to warn flightcrews of ice accumulation on critical surfaces. An SAE committee also address aircraft lightning protection (AE-2). This committee develops ACs, 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, ACs and rules. Since 1992, the program has updated or issued two ACs, five technical bulletins, and the Aircraft Icing Handbook (twice), and it has published more than 45 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), on aircraft in-flight icing (more than 400 participants from 20 countries), and on mixed-phase and glaciated icing conditions (more than 50 participants from five countries). It has also issued holdover time guidelines for deicing and anti-icing fluids.

In the area of software and digital systems safety, a report was published addressing structural coverage testing of aircraft software. Numerous forms of coverage were addressed including software mutation testing methods. A Commercial-off-the-Shelf (COTS) software and hardware study was completed where guidelines, verification methods and assessment criteria, for both aircraft software and hardware, were developed. In addition, detailed design data and a hardware implementation plan were developed and published as part of a complex electronic hardware case study.

In the electromagnetic hazards area, the program published three SAE lightning documents addressing the aircraft lightning environment and related test waveforms, certification of aircraft electrical systems and aircraft lightning zoning. The program also published a HIRF users guide for AC 20-1317, a report on in-service lightning strikes and continued the lightning strike characterization study to better define the lightning environment.

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

- ARAC, EEHWG international certification authority/industry forum – HIRF environment, User's Guide for AC 20-1317.
- SAE–AE2 Lightning Protection of Aircraft, Lightning Environment, Waveforms and Testing Standard, Aircraft Zoning Standard, and User's Manual for AC 20-136.
- RTCA Special Committee-135, "Environmental Conditions and Test Procedures for Airborne Equipment."
- RTCA Special Committee-190, "Software Considerations in Airborne Systems and Equipment Certification."
- Multiyear 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.
- Letter of agreement to leverage HIRF certification research with Sandia Corporation, Army Directorate for Applied Technology, Test and Simulation, and ORION International Technologies, Incorporated.
- Certification Authorities Software Team (CAST) consisting of avionics software systems certification authorities from U.S., Europe and Canada.
- Cooperative efforts on aircraft icing activities with the NASA Glenn 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.
- An international memorandum of cooperation exists with the Meteorological Service of Canada for research on in-flight icing conditions.
- An Interagency agreement with the Air Force for development of a new icing tanker for military and commercial use.
- ARAC IPHWG directly supported with data on and analysis of SLD conditions in the atmosphere.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Aircraft Icing

- Continued consolidating and assessing atmospheric icing data aloft.
- Evaluated time effectiveness and aerodynamic performance of environmentally friendly and other modern fluids.
- Published report on improvement of icing simulation methods.
- Published report on documentation and quantitative comparison of ice shapes.
- Published report on residual and intercycle ice.
- Published report on acquisition of atmospheric icing data from operational aircraft.
- Published report on hot water deicing.
- Software and Digital Systems Safety.
- Published report on acceptance criteria for using Software Service History (SSH) on certification projects.
- Evaluated acceptance criteria/guidelines and structural coverage issues for Object Oriented Technology (OOT).
- Completed investigation of COTS software and hardware protection architectures and techniques.

Electromagnetic Hazards to Aircraft Systems

- Published HIRF User's Guide for AC 20-1317.
- Published report on spurious emissions from cell phone and effects on aircraft navigation equipment.
- Published report from lightning strike characterization study for definition of aircraft lightning environment.
- Published updated report for in-service lightning strike data and analysis.
- Published Lightning User's Manual for AC 20-136.

KEY FY 2002 PRODUCTS AND MILESTONES:

Aircraft Icing

- Evaluate time effectiveness and aerodynamic performance of environmentally friendly and other modern fluids.
- Complete study of airfoil sensitivity to location, size, and shape of geometric representations of ice shapes.
- Publish report on recycled glycol technologies/utilization.
- Complete acceptance criteria for icing simulation tools.
- Interim report on procedures and methods for laboratory determination of fluid holdover times.

Software and Digital Systems Safety

- Completed investigation of use of wrappers as a protection methodology for safety of COTS software in airborne systems.
- Complete study of OOT structural coverage tools issues and acceptance criteria/guidelines.
- Electromagnetic Hazards to Aircraft Systems.
- Revise RTCA DO-160 and prepare advisory circular with updated electromagnetic compatibility test methods and requirements for large systems.
- Continue Electro Magnetic Interference/Electro Magnetic Compatibility (EMI/EMC) continued protection integrity investigation for aging aircraft systems and components and recommend methods for detecting EMC performance degradation.
- Publish Protection Integrity Report.

FY 2002 PROGRAM REQUEST:

- Aircraft Icing
- Continue to collect and assess the global atmospheric icing environment data, including steps to acquire data from operational aircraft.
- Continue investigation of procedures and methods for laboratory determination of fluid holdover times.
- Continue investigation and assessment of ice detection technologies.

- Reassess and initiate investigation of promising ice phobic technologies.

Software and Digital System Safety

- Continue research relative to emerging flight safety and certification issues identified by CAST and RTCA SC-190 efforts.

Electromagnetic Hazards to Aircraft Systems

- Continue research relative to lightning protection, HIRF protection, electromagnetic compatibility, in-service lightning data, single event effects/upset and continued integrity research.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 54,303
FY 2001 Enacted	4,100
FY 2002 Request	4,150
Out-Year Planning Levels (FY 2003-2006)	17,674
Total	$ 80,227

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Flight Safety	0	261	345	167	165
Atmospheric Hazards	705	1,233	1,598	2,490	2,452
Personnel Costs	1,127	973	1,744	1,349	1,388
Other In-house Costs	231	152	157	94	145
Total	**2,063**	**2,619**	**3,844**	**4,100**	**4,150**

Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	2,063	2,619	3,844	4,100	4,150
Development (includes prototyp	0	0	0	0	0
Total	**2,063**	**2,619**	**3,844**	**4,100**	**4,150**

A06e Aging Aircraft

GOALS:

Intended Outcomes: The FAA intends to improve aviation safety by developing technologies, technical information, procedures, and practices that ensure the continued airworthiness of aircraft structures and components in the civil transport 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 (NDI) techniques development and validation to detect and quantify damage in the forms of corrosion, cracking, disbonding, and material processing defects.
- Flight and landing loads and airworthiness standards updates and validation by acquiring and analyzing actual usage data for civil transport aircraft.
- Maintenance and repair requirements and procedures establishment for airframes.
- Damage tolerance methodology, health and usage monitoring methodology, and updated design load spectrums (based on actual usage) for the rotorcraft fleet.
- Development of information, technologies, and techniques to ensure the continued safe operation of aircraft electrical and mechanical systems.

Agency Outputs: The FAA establishes rules for aircraft certification, inspection, maintenance, and repair and publishes Advisory Circulars (AC) to outline acceptable means for compliance. Additionally, the agency disseminates technical information in various forms to its airworthiness inspectors and to industry. These outputs improve aircraft construction and maintenance practices. The objective of all of these products is to improve flight safety by increasing the 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 research, including:

- The Aviation Rulemaking Advisory Committee (ARAC) is an FAA/industry forum established to ensure that industry's resources are used to their fullest extent and that the agency's rulemaking achieves intended results. ARAC also identifies requirements and priorities for supporting R&D activities.
- The FAA sponsored Technical Oversight Group on Aging Aircraft (TOGAA) ensures effective coordination of aging aircraft program activities with related activities in 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.
- The aging nonstructural systems research program is the primary vehicle for supporting the recommendations of the White House Commission on Safety and Security, which states that "in cooperation with airlines and manufacturers, the FAA's Aging Aircraft Program should be expanded to cover non-structural systems."

Accomplishments: A series of four panel tests were completed at the Full-Scale Aircraft Structural Test Evaluation and Research

(FASTER) facility, located in the Safety Research and Development area at the FAA William J. Hughes Technical Center. The data obtained from the tests will be used to validate analytical models being developed by the FAA and NASA. All testing is monitored using state-of-the-art video equipment for continuous observation. The test fixture is capable of applying pressurization, longitudinal, hoop, and shear loads to a curved panel test specimen to simulate realistic operational conditions in the laboratory.

The FAA's Airworthiness Assurance Nondestructive Inspection Validation Center (AANC), located in Albuquerque, NM, continues to expand. The Center has specialized in the performance of comprehensive, independent, quantitative evaluations of new and enhanced NDI, maintenance, and repair techniques. The hangar facility contains several aging aircraft, large fuselage sections, and a sample structural defect library. Aircraft test articles include a B-747, B-737, DC-9, HU-25A, Fairchild Metro II, UH-1H, and TH-57 aircraft.

Civil transport flight and ground loads data collection programs have been reestablished for large as well as small transport aircraft. To collect flight loads data, optical quick access recorders have been installed on several B-737, B-757, B-767, MD-82, and A-320 aircraft, and usage data is being analyzed. Similar recording technology is being employed to collect data on BE-1900D and CRJ commuter aircraft.

The FAA is conducting a series of video landing parameter surveys at high capacity commercial airports to better understand typical contact conditions for a wide variety of aircraft and airports and how these conditions relate to current aircraft design criteria and practices. Airplane landing contact parameters have been obtained from the analysis of video images recorded during surveys conducted at representative high activity commercial large transport and commuter airports. To date, five such surveys have been completed at John F. Kennedy International Airport, Ronald Reagan Washington National Airport, Honolulu International Airport, London City Airport in the United Kingdom, and Philadelphia International Airport. Reports have been published on the first three surveys. Data collection is continuing at the four-camera video landing survey facility that was established at the Atlantic City International Airport to collect landing data under fair and poor weather conditions.

In partnership with the Naval Air Systems Command and the Office of Naval Research, the FAA began development of Arc Fault Circuit Breakers (AFCB) to replace thermal circuit breakers currently in use. Unlike thermal breakers, AFCBs can detect electrical arcing and rapidly remove power to the affected circuit, drastically reducing the chances of fire and related damage. AFCB prototypes were successfully tested aboard the FAA 727.

In support of the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC), the FAA completed intrusive wiring inspections of six recently retired transport aircraft. Samples were removed from the aircraft and subjected to an extensive battery of laboratory tests. Results of the inspections are documented in a report prepared for the ATSRAC.

R&D Partnerships: Program activities are closely coordinated with related initiatives being undertaken by industry, NASA and DOD. The FAA, DOD, and NASA have cosponsored several conferences in the area of aging aircraft and airworthiness assurance. Interagency agreements are in place between the FAA and NASA, U.S. Navy, U.S. Air Force, and DOE. International agreements are in place between the FAA and the regulatory authorities in the United Kingdom, The Netherlands, Australia, and Canada. A Memorandum of Cooperation is in place between the FAA and Russia.

The FAA Center of Excellence for Airworthiness Assurance (AACE), established in FY 1997, was formed with a broad mission in aircraft and aircraft systems safety research. AACE is a consortium consisting of eight core universities, Sandia National Laboratories, and more than 100 affiliates from government, industry, and academia.

The Center for Aviation Systems Reliability (CASR) is a consortium of four universities, Iowa State University, Northwestern University, Wayne

State, and Ohio State University, formed to develop NDI techniques.

AANC is a partnership with Sandia National Laboratory to test and evaluate inspection techniques in a realistic hangar environment and to enhance technology transfer.

The Engine Titanium Consortium (ETC) is comprised of Iowa State University, Pratt & Whitney, General Electric, and Allied-Signal. It was formed to develop methods for the inspection of engine components.

Numerous research grants have been awarded and are in place with universities and not-for-profit laboratories to leverage their interests and capabilities. Cooperative Research And Development Agreements (CRDAs) are in place with several airline operators as part of the flight loads data collection program.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Completed development of an engineering manual with guidelines to predict the onset of WFD and residual strength and structures.
- Released an enhanced version of a user-friendly software tool for damage tolerance analysis and design of aircraft repairs for commuter aircraft. Completed development of a methodology for the prediction of the in-flight loads in the empennage of a general aviation aircraft.
- Published flight loads data reports for various transport and commuter aircraft models.
- Published landing loads data reports from video landing parameter surveys.
- Published results of testing of aged circuit breakers to determine whether their performance had degraded below the original manufacturer's specification.
- Enhanced fracture mechanics computational capabilities used for damage tolerance analyses of structural helicopter components.
- Developed crack-growth-based predictive methodology for inspection and maintenance programs for non-rotating, safety critical components of aircraft engines.
- Continued development of first generation, prototype arc fault circuit interrupter for aircraft applications.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Continue enhancement to a user-friendly software tool for the damage tolerance analysis and design of aircraft repairs for commuter aircraft.
- Continue the FAA/industry jointly funded investigation of the susceptibility of an aging airframe to WFD.
- Continue development and validation of enhanced inspection systems for engine components.
- Continue development and validation of inspection techniques to detect damage in airframe structures typical of WFD.
- Continue flight and landing loads data collection, analysis, and reduction for large transport and commuter aircraft.
- Complete validation study on liquid penetrant inspection methodology.
- Develop ultrasonic contact transducer for crack detection.
- Complete development of prototype risk assessment algorithms for aircraft wiring.
- Begin development of 28v DC Arc Fault Circuit breakers.
- Complete testing of aged power control relays and remotely controlled circuit breakers to determine whether the performance of these devices has degraded below original manufacturer specifications.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program continues to focus on the areas listed at the beginning of the GOALS section above. The near-term emphasis continues on a better understanding of the effects of WFD; developing supplemental inspection requirements to better account for airframe and component damage; developing and validating enhanced inspection techniques; and, understanding the effects of aging on nonstructural systems and developing technologies to eliminate or mitigate potential hazards associated with these effects.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 202,367
FY 2001 Enacted	33,311
FY 2002 Request	27,111
Out-Year Planning Levels (FY 2003-2006)	113,709
Total	$ 376,498

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Aging Aircraft	18,466	11,945	17,714	29,250	22,462
Personnel Costs	2,551	2,381	3,547	3,451	4,041
Other In-house Costs	523	368	333	610	608
Total	**21,540**	**14,694**	**21,594**	**33,311**	**27,111**

Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	21,540	14,694	21,594	33,311	27,111
Development (includes prototyp	0	0	0	0	0
Total	**21,540**	**14,694**	**21,594**	**33,311**	**27,111**

A06e - Aging Aircraft Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
065-110 Aging Aircraft							
WFD and Residual Strength Analysis	$7,225						
Completed Development of an Engineering Manual with Guidelines for Onset of Widespread Fatigue Damage (WFD)		◆					
Complete Destructive Examination of Aging Airframe and Publish Results					◇		
Continue Development & Validation of Inspections Techniques		◆	◇	◇			
Develop Prototype for Detection of WFD-Size Cracks					◇		
Commuter Aircraft Requirements	$994						
Released Enhanced Version of User Friendly Software Tool for Damage Tolerance Analysis and Design of Aircraft Repairs for Commuter Aircraft		◆					
Continue Enhancement of User Friendly Software Tool for Damage Tolerance Analysis and Design of Aircraft Repairs for Commuter Aircraft		◆	◇	◇			
Airborne Data Monitoring Systems	$1,514						
Continue Data Collection Analysis on Flight Loads		◆	◇	◇	◇	◇	◇
Conduct Video Landing Parameter and Loads Survey at Commercial Airports		◆	◇	◇	◇	◇	◇
Published Flight Loads Data Reports for Various Transport and Commuter Aircraft Models		◆					
Inspection for Engines	$3,534						
Continue Development and Validation of Enhanced Inspection Systems for Engine Components		◆	◇	◇	◇	◇	◇
Complete Development of Ultrasonic Inspection Tools for Engines						◇	
Rotorcraft Structural Integrity	$808						
Complete Final HUMS Advisory Circular (AC) and Compliance Guidance for Part 29 & 27 Rotorcraft						◇	
Update AC 29-2A and 27-1 for Fatigue and Damage Tolerance						◇	
Aging of Nonstructural Systems	$8,387						
Develop First Generation, Prototype Arc-Fault Circuit Interrupter for Aircraft Applications		◆	◇	◇			
Complete Assessment of Feasibility of Service Life for Aircraft Wire				◇			
Develop a Prototype Testing or Inspection Device to Identify Hazardous Conditions Involving Aircraft Wire				◇			
Complete a Report on Performance of Aged Circuit Breakers		◆					
Begin development of 28v DC Arc Fault Circuit breakers			◇	◇	◇		
Complete Testing of Aged Power Control Relays and Remotely Controlled Circuit Breakers to Determine if the Performance of these Devices has Degraded Below Original Manufacturer Specifications			◇				
Personnel and Other In-House Costs	$4,649						
Total Budget Authority	$27,111	$33,311	$27,111	$27,634	$28,113	$28,750	$29,212

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

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 potentially catastrophic defects, failures, and malfunctions in aircraft, aircraft components, and aircraft systems.

The Aircraft Catastrophic Failure Prevention Program focuses principally on using historical accident data and National Transportation Safety Board (NTSB) recommendations to examine and investigate known problem areas, such as:

- Turbine engine uncontainment events, including mitigation and modeling of uncontainment and aircraft vulnerability to uncontainment (AC20-128, phase II).
- Propulsion malfunctions and potential solutions (with the help of industry).
- Explosive fuel tank issues, where the current focus is on the fuel quantity indication system wiring and the impact of sulfide deposits.

Agency Outputs: The FAA establishes certification criteria for aircraft and publishes Advisory Circulars (AC) 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 with organizations such as the following to ensure a balanced, responsive Aircraft Catastrophic Failure Prevention Program:

- The Aviation Rulemaking Advisory Committee (ARAC) is a FAA-industry forum established to ensure that agency rulemaking achieves intended results, and that the resources of industry are fully utilized in accomplishing these results. ARAC also identifies requirements and priorities for supporting R&D activities. The ARAC Powerplant Installation and Harmonization Working Group (PPIHWG) provides guidance to this program for the update of AC20-128.
- The FAA sponsors a series of workshops on turbine engine uncontainment characterization, modeling, and mitigation. This forum brings together industry and government (civil and military) to review progress on this subject and to recommend future courses of action.
- The FAA has developed partnerships with industry through the ARAC PPIHWG to collaborate in developing a modeling toolkit for the modeling of engine uncontainment events.
- The FAA supports the Aerospace Industries Association (AIA) - Transport Committee (TC) report examining propulsion system malfunctions and inappropriate crew response. This project brings industry and the FAA together to recommend courses of action to foster safety and to develop associated regulations and advisory materials.
- The ARAC Fuel Tank Harmonization Working Group advises the program on issues related to fuel tank explosions.
- The program also responds to Public Law 100-591 (the Aviation Safety Act) and Public Law 101-508 (the Omnibus Reconciliation Act), which together established the aircraft catastrophic failure prevention program.

Accomplishments: Results of the catastrophic failure prevention program research are provided to certification officials to form the technical basis for rule changes as well as new or modified ACs. Results are also provided to airframe and engine manufacturers and designers. Recent accomplishments include:

- Developed the uncontainment database and experimental test data needed by ARAC to establish new guidance for uncontained turbine engine failure methodology.
- Developed improvements to an aircraft vulnerability model to predict aircraft vulnerability to engine uncontainment events.
- Completed development of advanced material DYNA-3D fabric tensile failure model.

- Completed experimental work required for aircraft material uncontained engine failure analysis.
- Developed sulfide deposits in the laboratory for study of fuel quantity indication systems.

R&D Partnerships: Through interagency agreements, grants, and contracts, program activities are closely coordinated with governmental, academic, and commercial experts to leverage the full advantage of existing knowledge and technologies. Significant program benefits are realized from the following agreements:

- Interagency agreement with Naval Air Warfare Center Weapons Division, China Lake, which partners with Boeing 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 Lawrence Livermore National Laboratory, which partners with Boeing, Honeywell Engines, and Pratt & Whitney, to develop a modeling toolkit to address turbine engine uncontainment events modeling.
- Center of Excellence contract with SRI, which partners with University of Dayton Research Labs and Arizona State University, and in-kind support provided by Boeing and B. F. Goodrich.
- Interagency Agreement with NASA Glenn for cooperation on turbine engine uncontainment.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Engine Uncontainment Research

- Delivered a prototype aircraft vulnerability model for evaluation of uncontained engine debris hazards in cooperation with ARAC.
- Continued modifications to vulnerability code based on airframe manufacturers' evaluations.
- Continued expansion of the advanced material DYNA-3D model to include failure modes and fabric interaction identified in system impact testing.
- Performed full scale tests of advanced armor design concepts.

Explosive Fuel Tank Issues

- Continued research on copper-silver sulfide contamination on fuel quantity indicating systems.

Propulsion Malfunction

- Developed a plan, in conjunction with Flight Standards, for producing propulsion malfunction database.

KEY FY 2002 PRODUCTS AND MILESTONES:

Engine Uncontainment Research

- Complete the Uncontained Engine Debris Damage Assessment Model (UEDDAM) vulnerability code.
- Complete work on a calibrated design tool to model engine uncontainment debris impact with titanium and aluminum aircraft materials.
- Complete advanced containment and mitigation material DYNA-3D model for designers.
- Develop a plan for an engine crack detection monitoring system.
- Complete work on the calibrated design system for certification purposes.

Propulsion Malfunction

- Deliver a beta version of the propulsion malfunction database.

Explosive Fuel Tank Issues

- Continue research into explosive fuel tank issues, focusing on the formation of sulfidation products in fuel tanks and complete second interim report on sulfide deposits.
- Initiate research into hazards of fuel pump malfunctions that could become an ignition source.

FY 2002 PROGRAM REQUEST:

The program continues to modify aircraft vulnerability codes to incorporate suggestions obtained from airframe manufacturers' evaluations. It continues to work toward the certification of a calibrated design system that examines engine uncontainment by modeling the

mitigation effects of advanced materials and improving penetration equations for aluminum and titanium. Uncontained engine failures are the result of rotating component failures. The program will initiate development of technologies to detect these conditions during operation and prevent the failure from occurring in service.

The program also develops engine malfunction materials to better define a variety of propulsion malfunctions, including turbine engine surge. Materials will be used as input to simulator programs and as a resource for future monitoring programs.

Lastly, the program will continue to be responsive to the ARAC Fuel Tank Harmonization Working Group in examining issues and potential solutions to the explosive fuel tank issue.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 19,810
FY 2001 Enacted	2,776
FY 2002 Request	2,794
Out-Year Planning Levels (FY 2003-2006)	11,785
Total	$ 37,165

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Aircraft Catastrophic Failure Prevention Research	3,289	1,329	1,308	2,131	2,101
Personnel Costs	590	397	607	610	621
Other In-house Costs	121	61	66	35	72
Total	**4,000**	**1,787**	**1,981**	**2,776**	**2,794**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	4,000	1,787	1,981	2,776	2,794
Development (includes prototypes)	0	0	0	0	0
Total	**4,000**	**1,787**	**1,981**	**2,776**	**2,794**

A06f - Aircraft Catastrophic Failure Prevention Research Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
066-110 Aircraft Catastrophic Failure Prevention Research							
Engine Uncontainment Research	$1,251						
Delivered Prototype Aircraft Vulnerability Model for Evaluation of Uncontained Engine Debris Hazards		◆					
Continue Modifications to Vulnerability Code Based on Airframe Manufacturers' Evaluations		◆					
Continued Expansion of Advanced material Model in DYNA-3D to Include Failure Modes and Fabric Interaction		◆					
Complete Calibrated Design Tool To Model Uncontainment Debris Impact With Titanium and Aluminum			◇				
Complete DYNA-3D Model of Advanced Containment & Mitigation Materials			◇				
Complete UEDDAM Vulnerability Model			◇				
Complete Calibrated Design System for Certification Purposes			◇				
Complete Plan for Engine Crack Detection Monitoring System			◇				
Demonstrate Engine Crack Detection Monitoring System					◇		
Explosive Fuel Tank Issues	$425						
Continue Research On Copper-Silver Sulfide Contamination		◆					
Complete Second Interim Report on Sulfide Deposits			◇				
Continue Work on Sulfide Deposits				◇			
Initiate Research Into Hazards Of Fuel Pump Malfunctions			◇				
Complete Recommendations for Fuel Pump Malfunctions						◇	
Conduct Research on ARAC Recommendations to Eliminate Fuel Tank Explosions					◇	◇	
Develop Appropriate Technologies to Prevent Fuel Tank Explosions							◇
Propulsion Malfunction	$425						
Develop a Plan for Producing Propulsion Malfunctions Database		◆					
Deliver Beta Version of Propulsion Malfunction Database			◇				
Complete Population of Propulsion Malfunction Database				◇			
Develop Recommendations for Propulsion Malfunction Diagnostics					◇		
Personnel and Other In-House Costs	$693						
Total Budget Authority	$2,794	$2,776	$2,794	$2,854	$2,910	$2,982	$3,039

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A06g Aviation Safety Risk Analysis

GOALS:

Intended Outcomes: The FAA will continue to increase its collaboration with industry in their mutual search for programs and systems with true potential for increasing aviation safety. Accordingly, the partners will build on their previous collaboration to improve risk assessment, safety performance measurement and the shared use of safety-related data. The Aviation Safety Risk Analysis (ASRA) Program focuses primarily on:

- Design/Development and/or enhancement of risk management/decision support tools embedded in FAA analytical systems, e.g., flight standards service Safety Performance Analysis System (SPAS), and the aircraft certification service safety management program products. These tools encompass particulars about air carriers, aircraft design, aircraft maintenance, discrepancy reports, repair stations (both domestic and foreign) aviation training schools, and air personnel.
- Development of advanced risk assessment indicators/safety performance measures and graphical techniques. These allow the FAA to more effectively and efficiently use information contained in various FAA and industry databases.
- Establishment of a forum with industry to exchange aviation risk assessment/risk management and safety performance measures models and methodologies.
- Development of an improved safety analysis methodology that will be used to certify new products by including human factors and operational issues.
- Development of a risk-based process to improve aircraft certification oversight activities and promote synergy with policy development.
- Development and/or enhancement of the Maintenance Malfunction Information Reporting (MMIR) System with capabilities to track critical helicopter parts, to capture part utilization/performance data, and to perform trend analysis on the captured data.
- Complete research materials necessary to support the development of Advisory Circulars on Eligibility and Evaluation of U.S. Military Flight Safety Critical Aircraft Parts (FSCAP) for other critical aircraft systems.
- Development of guidelines for using onboard Built-in Test Equipment (BITE) as approval to return aircraft to service after maintenance.

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 the Aviation Safety Risk Analysis research program improve the data, data gathering techniques, analysis, and risk management/decision support tools needed for FAA certification, surveillance, investigation, and certificate management processes. These outputs enable systematic risk assessment and safety performance measurement to take proactive steps to reduce the rate of aviation related accidents and incidents. Based on insights from risk analysis, the FAA targets and increases its leverage of aviation safety inspector and certification engineering resources.

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

In 1997, the Flight Standards Service introduced their new business process, the Air Transportation Oversight System (ATOS); a system-based approach to FAA certification, surveillance, and certificate management oversight. ATOS is designed to provide the FAA with the people, procedures, equipment, facilities, software, tools, and materials necessary to make surveillance more systematic and better targeted to deal with

identified risks. In support of this effort, the ASRA program will provide: systems engineering; analyses in the form of design of safety performance measures, data sources, analysis methodologies, information presentation; and system safety risk assessment research (such as hazard analysis, design of risk indicators, Markovian Models, and Aviation System Risk Models).

The ASRA Program responds directly to the Safer Skies Agenda, 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 that corrective action is taken much sooner. Thus, the primary beneficiaries of this effort are the general flying public.

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

The FAA worked with Helicopter Association International (HAI) to develop and release the maintenance malfunction information reporting system. This software tool has 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 (GAO) report recommends that the FAA increase the quality and timeliness of their aviation safety data. More importantly, analytical and decision support tools rely on high quality data to identify potential safety risk areas.

Accomplishments: Full deployment of SPAS II was initiated in FY 1997 and was completed by December 1999. This is a computer-based analytical tool used by FAA aviation safety inspectors and certification engineers, as well as DOD aviation analysts, to support the oversight activities of FAA certificate holders (i.e., air operators, air agencies, aircraft, and air personnel). A study was initiated to establish baseline risk parameters related to continued airworthiness of aircraft and to analyze the factors that generally precede aircraft accidents.

R&D Partnerships: The U.S. Air Force Air Mobility Command provides technical support and assistance in developing safety critical performance measures. Discussions have been initiated with the Department of the Interior (DOI) regarding a partnership with DOI for sharing aviation safety data. An interagency agreement was established with the Department of Energy (DOE), enabling Sandia National Laboratories to contribute their technical expertise in developing system design, development, and safety, as well as safety performance measures, risk indicators, and the implementation of a data quality improvement strategy. The Air Carrier Operations System Model (FAR Part 121) will be developed with several major air carriers. HAI continues to work with the FAA to develop and enhance the Web-based MMIR system that now accepts data from helicopter on-board Health, Usage and Monitoring Systems (HUMS) for safety analysis and condition based maintenance monitoring. Several university grants have been awarded to support the development and testing of aviation safety risk models. For example, Rutgers University is contributing to the development of the Intelligent Decision Support Tool and the Aviation System Risk Model.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Risk Management Decision Support

- Initiated the design of flight standards next generation safety critical performance measures and risk indicators based on system engineering and system safety models of FAR Parts 121, 142, and 145. These tasks were accomplished in conjunction with industry.
- Continued development of new and enhanced risk analysis models and capabilities.
- Continued the development and incorporation of safety critical performance measures into flight standards (SPAS).
- Continued a decision support system requirements study.
- Continued workshops with industry to discuss aviation risk analysis and safety perfor-

mance measurement methodologies and tools.

- Continued to develop risk/hazard/accident models and tools based on FAR Parts 129, 142, and 145.
- Continued the development of the Aviation Safety Risk Management System.
- Released the Repair Station Prototype.
- Completed a repair station information requirements study and analysis.
- Continued development of systems engineering models based on FAR Parts 121,129,142, and 145.

Aircraft Maintenance - Maintainability and Reliability

- Established a demonstration network between a service station and a central server for downloading data from helicopters fitted with part tracking capabilities.
- Completed a handbook on Eligibility and Evaluation of U.S. Military Surplus Flight Safety Critical Aircraft Parts, Engines and Propellers.
- Initiated development of a web-based information system that facilitates the collection, analysis, dissemination and archive of aircraft maintenance related data such as MIS reports.
- Initiated research into establishing criteria for utilizing BITE.

Safety Analysis Methodology

- Continued the development of a methodology that will enable the Aircraft Certification Systems Evaluation Program (ACSEP) to focus on those areas statistically found to have the greatest impact on aviation safety.
- Continued the development of probabilistic safety assessment methodology that addresses aircraft systems safety analysis.

KEY FY 2002 PRODUCTS AND MILESTONES:

Risk Management Decision Support

- Continue to develop, test, and validate new and enhanced risk analysis models and capabilities.
- Complete the development of risk assessment indicators and safety critical performance measures using enhancements to the system engineering and system safety models based on Parts 121, 142, and 145 in conjunction with industry.
- Release the Repair Station Module.
- Initiate the development of a system engineering model based on FAR Part 135 operations.
- Continue workshops with industry to discuss aviation risk analysis and safety performance measurement models and methods.
- Continue the development of the Aviation Safety Risk Management System.
- Continue the design of decision support system options analysis.
- Continue the development of Risk/Hazard/Accident models and tools.

Aircraft Maintenance - Maintainability and Reliability

- Continue to enhance the Maintenance Malfunction Information Reporting System with the capability to collect helicopter flight hours and usage profiles.
- Completed the establishment of criteria for utilizing BITE as an approval for returning aircraft to service.
- Continue the development of a web-based information system that facilitates the collection, analysis, dissemination and archive of aircraft maintenance-related data such as MIS reports.
- Continue research to develop Advisory Circulars on eligibility and evaluation of U.S. Military FSCAP for other critical aircraft systems.

Safety Analysis Methodology

- Complete the development of a probabilistic safety assessment methodology that addresses aircraft systems safety analysis.
- Complete the ACSEP improvement of a methodology that incorporates inspection results into the policy development process.

FY 2002 PROGRAM REQUEST:

In FY 2002, research continues to focus on the areas listed at the beginning of the GOALS section above. Data assimilation, analysis, and tool development continue in support of ASRA initiatives. The analysts work with government, industry, and academia aviation safety subject matter experts. This cooperation will ensure that risk management/decision support tools, including safety critical performance measures and risk indicators are properly defined, developed, tested, and evaluated prior to implementation. The program investigates, tests, and recommends improvements, including standardization, to the quality (and quantity) of data used in the performance measures. It also completes studies to identify and verify flight standards and aircraft certification safety information requirements.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 23,836
FY 2001 Enacted	6,642
FY 2002 Request	5,784
Out-Year Planning Levels (FY 2003-2006)	24,392
Total	$ 60,654

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Aviation Safety Risk Analysis	5,289	5,555	5,286	5,150	4,377
Personnel Costs	1,039	794	1,393	1,414	1,253
Other In-house Costs	213	122	145	78	154
Total	**6,541**	**6,471**	**6,824**	**6,642**	**5,784**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	6,541	6,471	6,824	6,642	5,784
Development (includes prototypes	0	0	0	0	0
Total	**6,541**	**6,471**	**6,824**	**6,642**	**5,784**

A06g - Aviation Safety Risk Analysis Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
060-110 Aviation Safety Risk Analysis							
Risk Management Decision Support	$3,313						
Design Flight Standards Next Generation Safety Critical Performance Measures and Indicators Based on System Engineering and System Safety Models based on FAR Parts 129, 142, and 145.		◆	◇	◇	◇	◇	
Develop, Test, Validate and Enhance Risk Analysis Models and Capabilities		◆	◇	◇	◇	◇	
Develop and Implement Safety Critical Performance Measures		◆	◇	◇	◇	◇	◇
Conduct a Decision Support System Requirements Study		◆	◇	◇	◇	◇	◇
Conduct Workshops with Industry to Discuss Aviation Risk Analysis and Safety Performance Measurement Methodologies and Tools		◆	◇	◇	◇	◇	◇
Develop Risk/Hazard/Accident Models and Tools based on FAR Parts 129, 142, and 145.		◆	◇	◇	◇	◇	
Develop the Aviation Safety Risk Management System		◆	◇	◇			
Develop System Engineering Models Based on FAR Parts 129, 142, and 145. 121,		◆	◇				
Design the Decision Support System Options Analysis Model		◆	◇	◇	◇	◇	◇
Released the Air Personnel Module		◆					
Release Repair Station Prototype				◇			
Aircraft Maintenance: Maintainability & Reliability	$591						
Establish Criteria for Utilizing Built-in Test Equipment (BITE)		◆	◇				
Enhance the Maintenance Malfunction Information Reporting (MMIR) System		◆	◇	◇			
Complete Research Materials Necessary to Support the Development of Advisory Circulars on Eligibility and Evaluation of U.S. FSCAP for Other Critical Aircraft Systems		◆	◇	◇			
Develop Web-based Information System for Aircraft Maintenance		◆	◇	◇			
Safety Analysis Methodology	$473						
Develop and Integrate an ACSEP Improvement Methodology		◆	◇				
Develop Methodology for Probabilistic Safety Assessment of Aircraft Systems		◆	◇				
Personnel and Other In-House Costs	$1,407						
Total Budget Authority	$5,784	$6,642	$5,784	$5,908	$6,024	$6,172	$6,288

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

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2.4 Aviation Security Program Area Description

Mission

The Federal Aviation Administration (FAA) Aviation Security Research and Development (R&D) Division maintains responsibility for R&D programs related to civil aviation security. The division's mission of performing R&D to prevent civil aviation security incidents provides programs that accelerate and expand R&D and supports the deployment of advanced technologies. Division products lead to equipment and methods designed to counteract criminal and terrorist attacks against civil aviation. This mission includes anticipating future threats and emphasizes the need to rely less on human intervention for detection and deterrence. Well integrated, automated, aviation security systems that leverage benefits from a variety of technologies will provide better operational performance.

Intended Outcomes

The main goal for the Aviation Security R&D Program is to detect, deter, and mitigate criminal and terrorist threats to civil aviation . Accomplishing this goal promotes public confidence and directly benefits the aviation industry. The increasing extent and sophistication of terrorism demands the identification and development of practical, effective technologies appropriate for aviation security systems. These systems must be comprehensive and flexible enough to address all potential vulnerabilities at the airport as well as in loading and servicing the aircraft itself.

The Aviation Security Program conducts extensive R&D to detect explosives and weapons, as well as other more sophisticated threats, and to prevent the placement of these items on board aircraft. This program focuses on automated aviation security systems and screening protocols that are the least intrusive, most effective, and enable the highest throughput. This minimizes passenger delays and inconvenience. The Program also conducts R&D 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 FAA develops technologically improved products and procedures in explosives detection, human factors, aircraft hardening, and airport security. Program outputs include:

- Developing and fielding effective and efficient explosives detection systems.
- Developing R&D test protocols and performance criteria for the operational deployment of improved aviation security systems.
- Defining standardized methods of security screener selection, training, and performance evaluation through data collection.
- Exploring blast mitigation techniques to ensure that potentially catastrophic criminal and terrorist acts do not result in the loss of lives and aircraft.
- Developing a structured, airport security system architecture and a concept of operations for security plannering.

Aviation Security R&D products include systems, devices, technologies, specifications, analysis tools, technology integration plans, and procedures. These products are used by airports, air carriers, airframe manufacturers, and screening companies to improve civil aviation security.

Program Area Structure

The Aviation Security R&D Program is divided into four interrelated areas: Explosives and Weapons Detection; Human Factors; Aircraft Hardening; and Airport Security Technology Integration. Each program area makes a significant contribution towards achieving a safe and secure air transportation system.

The *Explosives and Weapons Detection* program focuses on developing, or improving methods and technologies of detecting explosives and weapons in checked and carry-on baggage, on passengers, or in air cargo. This program promotes pre-board screening to prevent the armed takeover of aircraft. The Explosives and Weapons Detection program develops standards and specifications for test and certification or approval of detection equipment.

The *Aviation Security Human Factors* program aims to improve the human element of the aviation security system. Two approaches are used to increase human-machine performance. The first is to improve the performance of the human operator through enhanced training. The program develops screener selection methods, evaluates screener training, and develops procedures for measuring and improving screener performance. These improvements are especially important as aviation security components merge into future integrated systems.

The second human factors approach is to improve performance of the operator by designing equipment and interfaces that maximize perceptual, cognitive, and physical abilities of users while minimizing their errors. To address this approach, the Aviation Security Human Factors Program is becoming involved in the system definition or conceptual design phase — early stages while the program is developing human-machine performance evaluation criteria. By being involved earlier in the system life cycle, significant improvements can be made to equipment without a major impact on the schedule or budget. Furthermore, early involvement increases the likelihood that the system will be easier for the user to operate.

The program also conducts usability assessments on all new aviation security equipment and training systems to ensure they are free of deficiencies and capable of effective and efficient operation by the end user. During these assessments, emphasis is placed on the capabilities and constraints of the human operators and how they influence system operation.

The *Aircraft Hardening* program conducts research to increase civil aircraft survivability in the event of an in-flight explosion. Additionally, this program identifies the type and minimum weight of an explosive that must be detected in order to prevent catastrophic damage or aircraft loss. The Aircraft Hardening program also develops methods to protect aircraft avionics and systems from the damaging effects of false electromagnetic or high-energy signal interference.

The *Airport Security Technology Integration* program focuses on airport security technology development that encompasses a broad range of security devices and models to promote enhanced security within the confines of the airport. Currently, these activities include development of access control and other physical security technologies, passenger-baggage matching technology, and passenger-baggage flow modeling. Also, vulnerability and risk assessments, threat identification, software evaluation, and operational testing are being conducted to facilitate the development of technologies to ensure a safe airport environment. Major emphasis is on the development and life cycle management of system Reliability, Maintainability and Testability (RM&T) requirements of future system designs and recommending concepts of operation while promoting operational readiness and suitability. Technology products include analytical models and simulations that analyze and predict the effects of integrating new security technologies on airport operations. This emphasis includes systems and individuals and passenger/baggage matching technologies that prevent unaccompanied baggage from being loaded on board aircraft. Testbeds that minimize the risks associated with the integration and operation of security equipment being deployed into the airport environment are also included in the program focus.

The program looks both to the present and the future. Operational readiness and suitability are never slighted while research continues into future system designs and new concepts of operation. Technology products include analytical models, state-of-the-art perimeter control, and passenger-baggage matching technologies that prevent unaccompanied baggage from being loaded aboard aircraft. Part of this technology entails the development of simulation and modeling tools. One set of tools performs airport security analysis of vulnerability, risk and blast effects. The other set seamlessly integrates, improves, and reduces operating costs for technologies developed by other programs in the Security R&D Program area.

The FAA Aviation Security R&D Program conducts six R&D projects to achieve the goals of the four Aviation Security R&D budget line items. The three R&D projects (Checked Baggage, Cargo/Mail, and Checkpoint) support the Explosives and Weapons Detection budget line item. The remaining three areas (Aircraft Hardening,

Human Factors, and Airport Security Technology Integration) each have a dedicated budget line. Any one program will not solve all the issues. Technology development has not reached a point where it can operate autonomously. The Aviation Security R&D Program embraces a systems-oriented approach that balances the application of people, procedures, and technology to each threat and vulnerability.

Customer and Stakeholder Involvement

The Aviation Security Improvement Act of 1990 (Public Law 101-604) provides direction for the FAA's System Security Technology Program. The FAA's Office of Civil Aviation Security Policy and Planning requires research in the following areas:

- Checkpoint
- Checked Baggage
- Chemical and Biological Agents
- Explosives Detection by Canines
- Human Factors
- Airport Security Technology Integration
- Aircraft Hardening

In 1996, the White House Commission on Aviation Safety and Security emphasized continued R&D in all program areas, and recommended the deployment of existing explosives detection technology. Congress funded further R&D and the FAA's purchase and installation of Explosive Detection Systems (EDS) and Explosive Detection Devices (EDD). Each year, the FAA Security Equipment Integrated Product Team (SEIPT) purchases and deploys advanced security equipment at various airports throughout the United States.

Stakeholders with a major interest in Aviation Security include the National Academy of Sciences, the Aviation Security R&D Scientific Advisory Panel, the R,E&D Advisory Committee, and the Aviation Security Advisory Committee. These groups hold periodic reviews of R&D plans and progress. Efforts also include interagency work with the Technical Support Working Group. Their recommendations include changes in the direction or emphasis of research plans.

Accomplishments

The FAA Aviation Security R&D Program has been in effect since 1974, resulting in the following significant accomplishments:

- Certified the InVision CTX 5000 and established a demonstration effort that delivered four certified CTX 5000 EDS to air carriers for operational testing. FAA certification criteria examine three performance areas including detection, false alarms and throughput requirements. Upon completion of certification, data collection and analysis took place at airports in San Francisco, Atlanta, and Manila.
- Certified the L-3 Communications eXaminer 3DX6000 EDS. During second certification testing in January 2000, the production unit met certification criteria on detection, false alarm and throughput rate requirements. This is the second company to meet the FAA certification criteria for explosives detection.
- Certified the InVision CTX 9000 DSi Galileo prototype. The first production model was certified in March 2000 using a software version modified and adjusted to improve system performance.
- Awarded five grants for the development of a low cost Explosive Detection System (ARGUS) for use at smaller airports.
- Provided critical input for the effective deployment of the SEIPT beginning in January 1997. To date, 126 EDS have been installed in airports.
- Provided support for the deployment of over 615 explosives trace detection devices to U.S. airports with more scheduled in FY 2000.
- Initiated development and evaluation of trace detection prototypes (in laboratory and airport environments) for screening personnel through use of devices such as portals and document scanners.
- Conducted explosives testing on various aircraft to provide data to validate and refine explosives detection criteria. These tests included a Boeing 747 test performed jointly with the United Kingdom, a Lockheed L1011 test performed with the manufacturing com-

munity, and vulnerability testing on DC-9, 727, and 737 aircraft.

- Supported the 2000 Olympics in Sydney, Australia.
- Conducted a demonstration of hardened LD-3 baggage containers with three commercial air carriers.
- Completed a MANPAD study on the effectiveness of Infrared systems against external aircraft lighting.
- In cooperation with the U.S. Air Force Phillips Laboratory, completed a study on the vulnerability of commercial aircraft to High Powered Microwave and other directed energy weapons.
- Established criteria to limit cross-contamination of explosives used to train and certify explosives detection canine teams.
- Developed the Screener Readiness Test as part of effort to improve screener selection and performance. This government-owned test will determine when the screener has received sufficient initial training. Analyzed data to determine the appropriate cutoff score and prepared suggestions to be sent to FAA's Office of Civil Aviation Security Policy and Planning.
- Published "Checkpoint Effectiveness and Efficiency Evaluation." This report standardized the measurement of compliance with security requirements by establishing baseline performance criteria for determining the effects of interventions.
- Performed an international study of radio frequency identification tags. This technology will make positive passenger baggage matching (PPBM) cost effective and operationally feasible when deployed in the field.
- Completed the Blast/FX effects model and distributed it to over 250 Federal users in many government agencies. This model shows the structural effects of explosives on airport facilities and calculates casualties based on explosive weight and airport configuration scenarios.
- Performed an independent assessment of both the FAA and Alcohol, Tobacco, and Firearms canine explosives detection programs.
- Initiated a Quality Control Standards Development program for Trace Explosive Detectors deployed to American airports.
- Evaluated many approaches to assessing airport vulnerability and risk, adopted one approach for use by FAA agents at airports, and developed the tool and associated training for nationwide implementation.
- Facilitated completion of a signed agreement between Sandia National Laboratories and Barringer Inc. for the production of personnel portals that detect a wide range of explosives. Sandia developed the portal under an FAA contract supported by the Aviation Security R&D Systems Development Branch. The FAA anticipates the delivery of limited production models from Barringer in mid FY 2000.
- Completed standards and quality control development and testing in trace laboratory. Based on a dry transfer concept developed at the William J. Hughes Technical Center a patent is pending.
- Completed optimization and testing of a new version containing a mass spectrometer of Sandia Trace Explosives Detection Portal.
- Produced a laboratory prototype of the Interactive Terminal Interface (ITI)/Penn State Trace Explosives Detection Portal.
- Tested new and innovative explosive synthesis and identification of TATP/HMTD/NC (Triacetone Triperoxide/Hexamethylene Triperoxide Diamine/Nitrocellulose) on FAA fielded equipment.
- Completed acceptance testing for the Barringer 400B, IDS Orion, and the windows version of the Itemiser. These are all trace explosive detection devices.
- Developed Threat Image Projection (TIP) systems to measure screeners' on-the-job performance. The TIP system is now a standard requirement for all new X-ray machine deployments.
- Developed the Computer-Assisted Passenger Pre-screening System (CAPPS) to reduce the number of passengers needing special security screening.

- Developed a long-range cargo plan to evaluate new procedures and promising technologies.
- Published "Effectiveness of the Annistech PXR-1M System at Explosives Detection in Air Cargo" and "Effectiveness Testing of Checked Baggage Inspection Systems for Explosives Detection in Air Cargo: Baseline Test and Evaluation Plan."
- Assessed current EDS technology for detection of reduced threat quantities.
- Completed eighteen EDS certification tests resulting in the certification of six systems.

R&D Partnerships

Since its inception, the Aviation Security R&D Program has established productive relationships with many organizations that promote technology development for improved aviation security. These organizations include U.S. Government agencies, industry, academia, and foreign countries. Each of these partnering organizations contributes to the Aviation Security R&D mission by providing information, R&D, equipment, and/or facilities. The FAA uses these partnership agreements to enhance Aviation Security R&D project investments. Recent projects in partnering include:

- Bilateral agreements with the United Kingdom, France, Canada and Israel for exchange of information, development of new explosives detection technologies, and cooperation on joint ventures, as well as test and evaluation.
- Cost sharing agreements with manufacturers for additional sources of certified EDSs. Systems that are expected to come to market in the future, will increase the efficiency and effectiveness of available detection options while reducing cost through competition.
- Cost sharing agreements with Alaska, Northwest, Delta, and American Airlines to identify and develop methods utilizing advanced technologies to improve screener performance.
- Cost sharing agreements with Ancore, Control Screening, EG&G Astrophysics, and L-3 Communications for the development of ARGUS Explosive Detection System, a low cost system for smaller airports.
- Development and testing of hardened LD-3 containers for wide body aircraft in cooperation with the U.S. Air Force, Army, Navy, NASA, the Department of Energy, and several airlines.
- A partnership, through a U.S. Government organization and a foreign government, to investigate the practicality of developing hardened containers for use on narrow body aircraft.
- A cooperative agreement with the State of Illinois on the Security of Cargo Shipments.
- Cooperative Research and Development Agreements with Smart Approach Limited and Trainsoft Limited to complete the development of Computer-Based Training Systems for initial checkpoint screener training.

Long-Range View

The FAA envisions an integrated aviation security system for the 21st century that incorporates a variety of technologies. These technologies are continuously monitored and upgraded to respond to changes in the threat environment. This integrated system will enable aviation security professionals to perform at maximum levels of effectiveness. Major challenges are ahead for the R&D program to attain 100% EDS-level checked baggage screening to start phasing in implementation in 2009. The application of smaller, faster automated detection technologies will enhance screener performance by providing detection that is constantly vigilant and unaffected by the distractions or fatigue that affect human or canine screeners. This understanding of the aviation security system of the future provides guidance and direction for future Aviation Security R&D Program efforts and supports decisions for FAA investments.

Terrorist capabilities and techniques continue to increase and evolve. The world remains a dangerous place. The ever-changing threat requires continued R&D funding for the future of aviation security. Aviation Security R&D Program efforts will continue to focus on modifications and other technical improvements to deployed explosives detection equipment. In addition, identification

and evaluation of explosives mitigation techniques will continue to expand to include the entire aviation spectrum — airports, airplanes, and other areas of the National Airspace System.

A07a Explosives and Weapons Detection

GOALS:

Intended Outcomes: The mission of the FAA's Aviation Security Program is to develop and deploy advanced equipment capability enabling air carrier operations to comply with national security policies, meet national contingencies, and effectively enhance the security of the flying public.

This advanced capability is intended to significantly reduce, eliminate, and/or mitigate terrorist actions like the *Pan Am 103 Tragedy* through the availability of better detection and increased surveillance.

Recent studies and national security policies have led to sharply accelerated and steep requirements, such as:

- Significantly smaller quantities of explosives.
- New specific, emerging threats (explosives and weapons).
- Focused inspection sampling of passengers and bags by FY 2005.
- 100% screening of passengers and bags by FY 2010.

Agency Outputs: The FAA Aviation Security Program is the world leader in detection research and development. It leads and sponsors accelerated development of advanced technology to counter the ability of terrorists to artfully conceal improvised explosive devices and weapons in any state or form onboard aircraft. Specifically, this program:

- Develops low-cost, high throughput detection systems for inspecting passengers and their baggage for a wide diversity of civil aviation operations world wide.
- Adapts the best existing and emerging U.S. technologies to meet continually evolving threats.

Customer/Stakeholder Involvement: The Explosives and Weapons Detection program works closely with air carriers, U.S. and foreign agencies, oversight groups, special interest groups and the general public to understand and define system requirements in a team approach. The program interacts as follows with numerous private, academic, and national laboratories to focus research initiatives for "high gear" development and to ensure high quality:

- *Team Approach:* The FAA established an Integrated Product Team for Security Equipment that consists of FAA engineers, agents, human factors scientists, and senior security representatives from each of the major U.S. air carriers.
- *Tight Focus:* This program responds to congressional mandates such as Public Law 101-604, Aviation Improvement Act of 1990, White House Commission on Aviation Safety and Security, Aviation Security Advisory Committee Baseline Working Group, Guidance from the General Accounting Office, and Section 303 of the Federal Aviation Administration Reauthorization Act of 1997.
- *Quality Review:* the FAA sponsors respected special interest groups, including the National Academy of Science and the Committee on Civil Aviation Security of the National Research Council (NRC), to assess security research initiatives and to review explosives detection research priorities.

Accomplishments: Since 1991, the program has:

- Developed the world's first, detection-certified, checked bag inspection system, InVision CTX 5000, with an approximate mean effective throughput of 120 bags per hour.
- Certified an advanced user interface leading to an InVision CTX 5500 Explosives Detection System (EDS) with an approximate mean effective throughput of 160 bags per hour and a 50% lower false alarm rate. Deployed over 105 units in the U.S. Over 50 units have been purchased and deployed by International Civil Aviation Organization (ICAO) partners (abroad).
- Developed and certified two high throughput (~500 bags per hour) checked bag inspection systems: InVision CTX 9000 and L-3 Communications' Examiner 3DX6000. Deployed one unit for technology transition in the U.S. At least three units have been purchased and deployed by ICAO partners (abroad).

- Developed two prototype explosives detection walk-thru portals for screening passengers at checkpoints.
- Pioneered extensive nuclear quadrupole resonance (NQR) methods for bag and passenger inspection. Deployed two prototype units at major airports.
- Developed, produced and distributed inert, non-toxic, high fidelity, X-ray simulants (diverse primary & secondary explosives) for various agencies, foreign governments and vendors to support field testing and training. Developed prototype simulants for NQR detection methods.
- Developed two access control monitors that analyze the trace explosive residue transferred to a token or ticket.
- Evaluated over eight trace explosive detection devices and four carry-on baggage inspection devices with automated image analysis (operator assist) for acquisition and deployment decisions.
- Developed an internationally adopted, performance standard for trace detection on electronic items. Conducted an ICAO workshop on trace detection standards for electronics explosives detection.
- Deployed a suite of explosives detection equipment at five major airports to support 1996 Olympic games.
- Conducted year-long trial deployments of certified explosive detection systems for checked bag inspection at three major airports.
- Identified new potential threats to civil aviation and assessed their present detectability.
- Established test criteria and protocols for checked and carry-on baggage and cargo inspection systems.
- Held two international symposia on explosives detection. Sponsored over five additional conferences on domestic and international explosives detection.
- Developed a quality control aid to evaluate explosive trace detection systems located in airports.
- Evaluated the coordinated use of Trace and X-ray systems as an EDS alternative.
- Developed advanced image processing methods to improve detection capabilities.
- Measured background trace contamination levels on passengers' boarding passes and their bags.

The following accomplishments are expected in FY 2000:

- Enhanced performance of explosives detection canines.
- Evaluated and certified a lower cost (50% savings), lower throughput EDS, referred to as the InVision CTX 2500.
- Developed a "Directed Trace" screening protocol.
- Developed and evaluated a very high throughput (>900 bags/hour) explosives detection prototype.
- Established testbeds at five airports (four major, one minor) for checkpoint R&D and integration studies.
- Designed and field-tested at least two advanced, integrated checkpoint system designs based on commercially available equipment.
- Developed and tested at least one non-ionizing, passenger screening developmental prototype.
- Developed and evaluated an NQR wand developmental prototype.
- Developed and field-tested two portable, prototype liquid inspection devices for rapidly analyzing the contents of bottles carried in baggage.
- Evaluated commercially available screening systems for containerized/palletized cargo.
- Determined feasibility of using trace for cargo screening.
- Developed an automated cargo profiling system.
- Developed training protocols for the manual search of cargo.
- Developed and evaluated prototype systems to detect explosives within baggage and cargo, using nuclear technologies in accordance with congressional mandates.

R&D Partnerships: The explosives 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 90 contracts, grants, Cooperative Research and Development Agreements (CRDA), and interagency agreements are in place with industry, academia, and other government agencies. R&D partnership activities include:

- Joint funding agreements, cooperative research and development agreements, and consultation agreements through which Industry and the FAA collaborate to improve and develop carry-on, checked, and cargo scanning systems.
- Many projects supported through interagency partnerships, such as with DOE laboratories, DOD facilities, U.S. Department of Agriculture (USDA), DOD's Office of Science and Technology, U.S. Customs Service, Volpe National Transportation Systems Center, U.S. Food & Drug Administration, and National Institute of Standards and Technology.
- Bilateral agreements between the FAA and several international counterparts.
- Work with the Interagency Technical Support Working Group—a body that supports explosive 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.
- Sponsor the NRC Committee on Commercial Aviation Security—a body that regularly reviews the explosives/weapons detection program and makes recommendations supporting further developments.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Checked Baggage Screening Technology

- Developed and tested at least one low cost, low throughput (< 150 bags/hr) certified/qualified EDS for small airport applications.
- Evaluated a coherent X-ray scattering detection system.
- Explored the integration of QR and X-ray detection equipment.
- Completed optimization studies for certified EDS.

Checkpoint Technology

- Completed QR wand development.
- Developed and tested a combined alarm resolution protocol using vapor, metal, and QR detection wands for passenger screening.
- Evaluated liquid and container detection methods.
- Initiated competitive activity for concealed object detection.

Cargo Security Technology

- Completed evaluation of EDS technology for screening break bulk cargo.
- Completed guidelines for matching EDS technologies to cargo types.
- Completed training protocols for screening cargo.
- Completed threat assessment between cargo and other vectors.
- Developed guidelines for matching EDS technologies to cargo types.
- Conducted a demonstration of a dual-view x-ray, palletized cargo inspection system at Huntsville International Airport, AL.

KEY FY 2002 PRODUCTS AND MILESTONES:

Applied Research

- Optimize high sensitivity infrared spectroscopy detection systems.
- Determine detectability of newer terrorist threats including non-nitro explosives and chemical/biological warfare agents.
- Develop QR calibration aids and simulants for field testing and training.
- Develop diffraction-based simulated explosives.
- Explore advanced bulk detection methods.

Checked Baggage Screening Technology

- Evaluate trace-based automated EDS.

- Conduct operational test and evaluation of low cost low throughput, certified/qualified EDS system.
- Develop a set of functional specifications for multi-level multi-technology systems development for 100% screening.

Checkpoint Technology

- Complete field evaluation of a prototype non-invasive passenger screening portal system using available methods for a *Selectee* (<100% inspection) concept.
- Explore integrated passenger flow and information systems.
- Initiate integration of bulk object detection with molecular-specific detection techniques for passenger inspection.

Cargo Security Technology

- Enhance automated cargo profiling tool based on operational test findings.
- Complete research on enhanced security applications on ground transportation for air cargo.
- Evaluate advanced EDS systems for break-bulk cargo inspection.
- Initiate airport, airline, freight forwarder and equipment selection for integrated enhanced cargo security demonstration project.

FY 2002 PROGRAM REQUEST:

The explosives and weapons detection program has received significant policy redirection and aggressive objectives requiring substantial increases in funding. These changes include more difficult detection requirements, NAS systemwide deployment for Computer Assisted Passenger Pre-screening (CAPPS) selectees by FY 2005 for checked baggage, and 100% NAS systemwide deployment readiness by FY 2010 for checked baggage and checkpoint inspection.

Future needs, will only be met with substantial increases in research and development funding to focus leading-edge technology, such as nanotechnology, microtomography (MT), electron beam tomography EBT), micro-electro-mechanical systems (MEMS), Terahertz imaging, quadrupole resonance imaging, raman scatter spectroscopy, X-ray diffraction, advanced dielectrometry, and artificial intelligence.

Additional infrastructure, required to support the evaluation of advanced and emerging technologies, will also increase as more systems are developed and deployed.

Other future areas of key focus include critical developments in the nanotechnology arena. Research in this area will provide future systems that work at the micron to atomic scales, providing lower cost, ease of mass production, improvements in sensitivity and selectivity, and applicability to explosive, chemical and biological detection. One type of development in this area is with novel detection systems based on MicroElectro Mechanical Systems (MEMS). This technology provides micro-sized detectors and sensors, and utilizes existing detection technologies, like Gas Chromatography (GC) and Gas Chromatography/Ion Mobility Spectrometry (GC/IMS), Mass Spectrometry (MS), Infrared (IR), microbalance (cantilevers), active surface sensors, etc. Necessary teaming with other agencies on these efforts will involve current multiagency programs with “Mass-Spec-On-The-Chip,” “Super-Sniffers,” and miniaturized GC/MS. In addition, nanotechnology will permit significant reduction in detection equipment to be ubiquitous and nonintrusive to the flying public.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 383,946
FY 2001 Enacted	42,512
FY 2002 Request	38,438
Out-Year Planning Levels (FY 2003-2006)	161,426
Total	$ 626,322

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Explosives and Weapons Detection	30,832	37,696	32,299	36,992	31,199
Personnel Costs	2,796	3,462	4,827	4,682	6,039
Other In-house Costs	572	542	479	838	1,200
Total	**34,200**	**41,700**	**37,605**	**42,512**	**38,438**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	34,200	41,700	37,605	42,512	12,685
Development (includes prototypes)	0	0	0	0	25,753
Total	**34,200**	**41,700**	**37,605**	**42,512**	**38,438**

A07a - Explosives and Weapons Detection Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
071-110 Explosives/Weapons Detection							
Applied Research	$10,528						
Advanced Canine Detection and Biosensor Development		◆	◇	◇	◇	◇	◇
Test and Evaluation Chemical Engineering Support		◆	◇	◇	◇	◇	◇
Personnel Screening Equipment and Standards		◆	◇	◇	◇		
Microelectromechanical Systems Development			◇	◇	◇	◇	◇
Enhanced Infrared Detection Systems Development			◇	◇	◇	◇	
Portable mass Spectrometry Systems		◆	◇	◇	◇	◇	◇
Improved Detection for Chemical Warfare Agents			◇	◇	◇		
Bulk Research		◆	◇	◇	◇		
Checked Baggage Screening Technology	$9,509						
Developed Low-cost Low Throughout EDS Stations		◆	◇			◇	◇
Develop High Throughput EDS for 100% Screening		◆			◇	◇	◇
False Alarm Reduction		◆	◇		◇		◇
Alternative Technology Integration			◇	◇	◇		
Develop Trace-Based EDS		◆		◇			
Certification of EDS Upgrades		◆	◇	◇	◇	◇	◇
Test and Evaluation		◆	◇	◇	◇	◇	◇
Checkpoint Systems	$7,530						
Develop Trace Portals		◆	◇	◇	◇		
Develop Low-Cost Passenger Portals			◇	◇	◇	◇	
Develop Fast, Hand-held Explosive Detection Wands			◇	◇	◇	◇	
Develop Ticket Trace Scanners/Access Control		◆	◇	◇	◇		
Develop Integrated Bottle Contents Scanners		◆					
Develop Integrated Bag Inspection Systems			◇	◇	◇	◇	
Test and Evaluation and checkpoint Testbeds		◆	◇	◇	◇	◇	
Cargo Security Technology	$3,632						
Develop and Evaluate Automated Profiling System		◆	◇				
Investigate Matching EDS Technologies to Cargo Types		◆					
Conduct Threat Assessment of Cargo and Other Vectors		◆					
Evaluate Trace/Bulk Technologies for Cargo Screening		◆					
Complete Ground Transit Security Study		◆	◇				
Develop Training Protocols for Screening of Cargo		◆	◇				
Develop Trace Systems for Containerized Inspection		◆	◇	◇	◇	◇	◇
Develop Advanced EDS Systems for Break-Bulk Inspection		◆	◇	◇	◇	◇	◇
Enhance Cargo Security Demonstration Project				◇	◇	◇	◇
Personnel and Other In-House Costs	$7,239						
Total Budget Authority	$38,438	$42,512	$38,438	$39,199	$39,901	$40,822	$41,504

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A07b Airport Security Technology Integration

GOALS:

Intended Outcomes: The Airport Security Technology Integration (ASTI) program supports the mission goal of security in the FAA Strategic Plan: “Prevent security incidents in the aviation system." This multi-faceted program addresses integration issues associated with a broad spectrum of current and next generation security equipment and technology in the airport environment. These issues include personnel access, physical security, intrusion detection, positive passenger bag match, and passengers and baggage throughput at the various checkpoint sensors. The intended outcome of the ASTI program is the availability of fully integrated security systems that minimally impact the movement of passengers and baggage through related airport systems.

The ASTI program aims to address integration issues through incorporating engineering disciplines—such as reliability, maintainability, availability and suitability— early in the security technologies research and development process. Through modeling and simulation of different security technologies in varying configurations, the program strives to accent a design that meets specific security requirements. Quantitative data reinforces the achievement of this design, and operational evaluations at established testbed sites ensure a smoother transition of equipment from the laboratory into the field. Overall, ASTI’s goal is to reduce cost and time to develop security systems while improving quality and operability.

Agency Outputs: The ASTI program provides data and analyses of technical information, such as airport vulnerability assessments and threats to civil aviation, to aid the overall FAA rulemaking process. The program provides the civil aviation security community with improved methods and technologies. In addition, the ASTI program provides the systems engineering activities to ensure that equipment certified for detection of explosives will be more operationally suitable and transition rapidly upon certification or approval for initial airport use.

Customer/Stakeholder Involvement: The ASTI program responds to Public Law 101-604, the Aviation Security Act of 1990, the Aviation Security Advisory Committee (ASAC) recommendations, and the recommendations of the White House Commission on Aviation Safety and Security. These laws and recommendations provide impetus for the identification of security research requirements and the dissemination to industry of related research results.

The ASTI program priorities and plans are consistent with aviation security community recommendations, and they address industry needs while often involving industry participation in R,E&D efforts.

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 in the rulemaking process. Program accomplishments include:

- Sponsored and led the government-industry committee that developed the Recommended Security Guidelines for Airport Planning, Design and Construction document.
- Developed an automated, PC-based modeling tool with analytical capability for assessing the effects of explosions on buildings and the personnel in them. Over 350 copies of the software tool Blast/FX have been distributed to requesting airport authorities and military, federal, local and state government agencies .
- Obtained critical operational performance information to support airline efforts to develop an International standard for Radio Frequency Identification (RFID) baggage tag use.
- Developed a quantitative method and tool for airport vulnerability to be used throughout the nation by airport personnel and FAA agents.
- Established operational testbed sites, through partnering with industry and academia at major U.S. airports, to improve the operational suitability of security systems and throughput of passengers and baggage at checkpoints.
- Incorporated reliability, maintainability, and availability requirements into the next generation of explosive weapons detection system specifications.

- Completed the Toxic Agent Effects Analysis Program that identified chemical and biological agent threats, including associated countermeasures. This information will drive research requirements and guide current and future research trends relative to chemical/biological threats to civil aviation.
- 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 and on appropriate corrective action.
- Published guidelines for industry on security revolving doors for use at concourse screening points.
- Performed study on the feasibility of detecting unauthorized personnel access by means of existing ground surveillance radar.

R&D Partnerships: The ASTI program activities are closely coordinated and leveraged with industry, academia, and other government agencies. This is done directly through interagency agreements, cooperative research and development agreements, university grants and Memorandums of Agreements (MOA).

Through partnership with National Safe Skies Alliance (NSSA), FAA established an operational testbed site where evaluation results are transferred to industry to ensure smoother transition of security equipment from laboratory to operational environment.

Partnerships were established with the Association of American Airline Executives (AAAE), Airport Law Enforcement Association Network (ALEAN) and Airports Council International (ACI) throughout the development and evaluation of the airport vulnerability assessment tool.

Other principal relationships include Air Transport Association (ATA) and the Regional Aircarrier Association (RAA) to focus on the economic effects of Positive Passenger Bag Match (PPBM) on the industry. A year-long cooperative study culminated with a published project report that analyzes 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 also works with industry in the following areas:

- American Airlines at Dallas/Fort Worth International airport to study future checkpoint concepts, such as, carry-on remote bag examination and semi-automated gated portal. Measures of effectiveness (MOE) and measures of performance (MOP) are defined.
- State of Illinois for research on the security of cargo shipments in transit from the remote cargo facilities to the airlines' receiving points. Testing has determined the feasibility of a positive driver ID and cargo seal system. This project received national recognition as the leading innovative usage of technology.
- The National Center for Biometrics Testing at San Jose State University for expertise on security projects that involve positive human identity verification through the use of biometric devices (such as fingerprint, hand geometry, etc.).
- Coordination 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 Technical Support Working Group (TSWG) for representation on the Executive Oversight Committee for development of Automated Tools for Vulnerability Assessment and participation as task leads on specific projects.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Developed an infrastructure to support a focus on improved integration and operational suitability of pending and next generation security equipment including testbeds, model and simulation tools, and incorporating reliability, maintainability and availability requirements early in the R&D process.
- Published results of operational performance testing of RFID baggage tag use and recommendations for international standard.

- Incorporated critical reliability, maintainability, and availability requirements early in the development life cycle of security equipment.
- Contribute to the analysis of security system effectiveness and risk estimation in support of a total security system architecture.
- Publish and distribute the airport construction guidelines document that provides guidance to airport planners, designers, and architects relative to the integration of security into facility design.
- Publish results of the feasibility study regarding the use of the Airport Surveillance Detection Equipment (ASDE3) radar as an intrusion detection sensor at airport perimeters.
- Conducted operational evaluation of advanced security components and systems at established testbed site and transferred results to acquisition team and industry.
- Defined MOEs and MOPs of advanced screener and automated portal equipment at checkpoint of the future testbed site.
- Developed an analytical model for evaluating security effectiveness of various system architectures across all airport security vectors.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Obtain critical operational and performance data at operational testbed sites to aid in improving effectiveness and efficiency of next generation security equipment.
- Analyze critical reliability, maintainability and availability data at different phases of the security equipment development life cycle from conception through disposal.
- Apply the security effectiveness calculation tool to refine the analysis used to establish the second version of the security system architecture.
- Commence concept development for integrated security systems and operations to meet increased passenger and baggage checking requirements through FY 2010.
- Complete assessment of ASDE3 ground surveillance radar as airport perimeter intruder detection sensor.
- Develop new model and simulation tools for analyzing next generation equipment efficiency and effectiveness under various configurations.

FY 2002 PROGRAM REQUEST:

The FY 2002 ASTI program request covers infrastructure development activities. The development of this infrastructure supports the acheivement of fully integrated security systems with minimal operational impact to the airport system and its throughput of passengers and baggage. In addition, the FY 2002 period request utilizes that infrastructure to conduct evalulations and tests to obtain critical operational and performance data. The absence of this data creates a risk that security equipment will not be efficiently integrated into the airport environment.

Key FY 2002 program activities include:

- Operational evaluations in test-bed airports. This activity specifically supports the equipment transition activities of the Security Equipment Integrated Product Team (SEIPT), and will benefit from the lessons learned by field experience gained on SEIP- installed security equipment.
- Analyze equipment availability, reliability and maintainability with established parameters and procedures. As a result of these analyses, equipment that completes the development cycle will not only achieve the required performance levels, but also will be fully suitable operationally.
- Develop new model and simulations for improved integration and optimized operational suitability.
- Translate new concepts for integrated security systems and operations that meet increased passenger and baggage checking requirements through FY 2010 into requirements for advanced systems.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 25,914
FY 2001 Enacted	2,457
FY 2002 Request	2,084
Out-Year Planning Levels (FY 2003-2006)	9,024
Total	$ 39,479

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Airport Security Technology Integration	1,127	1,832	909	870	855
Personnel Costs	1,127	754	1,258	1,435	1,060
Other In-house Costs	231	122	118	152	169
Total	**2,485**	**2,708**	**2,285**	**2,457**	**2,084**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	2,485	2,708	2,285	2,457	2,084
Development (includes prototypes)	0	0	0	0	0
Total	**2,485**	**2,708**	**2,285**	**2,457**	**2,084**

A07b - Airport Security Technology Integration Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
073-110 Airport Security Technology Integration							
Domestic Air Travel	$0						
Transferred Assessments of Radio Frequency (RF) Technology for Baggage Tracking or Positive Passenger Bag Match (PPBM) to Industry		◆	◇				
Publish Threat Analysis Report for Advanced Threats to Civil Aviation Security			◇		◇		◇
Developed a Protocol Standard for EDS to Communicate with Baggage Handling Systems to Ensure Accurate Tracking of Alarmed Bags		◆					
Airport Security	$855						
Develop New Simulation Tools to Analyze Security Equip Efficiency/Effectiveness Under Various Configurations		◆	◇	◇	◇	◇	◇
Validate and Verify PBFM Data with Realistic Oper.Data				◇	◇		
Plan and Conduct Airport Operational Suitability Tests on Development–Proven Equipment		◆	◇	◇	◇	◇	◇
Developed Advanced Airport Vulnerability and Risk Assessment Tools and Methods		◆		◇	◇	◇	
Developed Internal FAA Capability for Airport Assess		◆					
Establish Testbed Policies and Procedures for Operational Evaluations		◆	◇	◇			
Construct/Refine Oper.Testbed Infrastructure at Selected Airports and Tech Center's Security Operations Center		◆	◇	◇	◇	◇	
Define Measures of Effectiveness and Measures of Performance of Advanced Screener and Automated Portal Equipment at Checkpoint of the Future Testbed Site		◆	◇	◇			
Continuously Evaluate EDS and Other Security Vulnerability Countermeasures in Operational Testbeds		◆		◇	◇	◇	◇
Revise and Update Airport Security Construction Guidelines			◇		◇		◇
Establish a Reliability-Engineering Program to Influence and Supplement Security Sensor Development		◆					
Incorporated Reliability, Maintainability and Availability Requirements into Security Equipment Development Phases		◆	◇	◇	◇	◇	
Analyzed Reliability, Maintainability and Availability Parameters Throughout Development Phases of Next Generation Security Equipment		◆	◇	◇	◇	◇	◇
Completed Assessment of ASDE3 Ground Surveillance Radar as Airport Perimeter Intruder Detection Sensor			◇				
Test Emerging Intrusion Detection Sensors and Systems for Low-cost Performance				◇	◇	◇	◇
Commence Concept Development for Integrated Security Systems and Operations to Meet Increased Passenger and Baggage Checking Requirements Through 2010				◇			
Personnel and Other In-House Costs	$1,229						
Total Budget Authority	$2,084	$2,457	$2,084	$2,151	$2,218	$2,293	$2,363

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A07c Aviation Security Human Factors

GOALS:

Intended Outcomes: The Aviation Security Human Factors program strives to optimize human operator capabilities and performance to ensure that advanced security technologies and procedures are maximally effective tools to combat terrorist threats. The program applies human-centered design principles to , leverage human abilities and avoid security personnel limitations in the development and integration of technologies and procedures for checkpoint, checked baggage, and cargo security. The program's efforts directly support the FAA's Strategic Plan security goal to improve the detection of explosives and weapons within the NAS. Specifically, the program focuses upon establishing the baseline level of security and addressing related vulnerabilities.

This program leverages funding for equipment development to improve aviation security system performance through the following means:

- Optimizse human performance contributions through better operator selection, training, and performance monitoring for the various detection technologies.
- Improves the design and person/machine interfaces of security technologies through usability assessment, laboratory testing, and airport testbed operational evaluation.
- Maximizes security system effectiveness by increasing operator threat detection performance while improving coordination, integration, and throughput by applying human-systems analysis.
- Create better security machine interfaces and integration by merging individual detection technologies into a combined system with optimized human performance contributions.
- **Agency Outputs:** The FAA establishes standards for security activities. This program contributes to satisfying this agency resposibility by conducting 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.
- Improve security screener certification.

Customer/Stakeholder Involvement:

The Aviation Security Human Factors 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).
- Responds to requirements from the Aviation Security Improvement Act of 1990, the White House Commission on Aviation Safety and Security, the Baseline Working Group on Aviation Security, and the General Accounting Office (GAO).
- Partners with multiple airlines to test and evaluate equipment, personnel, and procedures.

Accomplishments: The following results of Aviation Security Human Factors research were provided to the Office of Civil Aviation Security to assist them in their rulemaking process:

- Developed functional requirements for the Screener Proficiency Evaluation and Reporting System (SPEARS) components of screener selection, training, and performance monitoring.
- Measured baseline checkpoint security X-ray threat detection performance.
- Developed screener selection tests for estimating future performance to interpret both conventional X-ray and computed topography (CTX 5000) images.
- Developed computer-based training (CBT) for both checkpoint operations and checked baggage evaluation using the InVision CTX 5000 Explosives Detection System (EDS).
- Developed Threat Image Projection (TIP) for both conventional X-ray machines and the InVision CTX 5000.

- Developed and validated a computer-based test of screener initial training mastery, the Screener Readiness Test (SRT), in support of rulemaking to certify screening companies.
- Developed a Computer-Assisted Passenger Pre-Screening (CAPPS) system.
- Evaluated TIP-ready X-ray machines (TRX) for adherence to FAA functional requirements in support of FAA Security Equipment Integrated Product Team (SEIPT) procurement and nationwide deployment. Developed human-centered functional requirements to guide industry development of networked X-ray TIP.

R&D Partnerships: This program works closely with various agencies and groups, such as:

- The International Aviation Security Human Factors Technical Advisory Group, to ensure effective international communication of research results to avoid duplication of efforts.
- Lawrence Livermore National Laboratory — through an inter-agency agreement.
- Frontline International and International Consultants on Targeted Security/Trainsoft — through Cooperative Research Development Agreements (CRDA) with the FAA.
- The United Kingdom (U.K.) Defense Evaluation Research Agency (DERA), the U.K. Department of the Environment, Transport, and the Regions (DETR), and Canada'sTransport Canada —through Memorandums of Cooperation (MOC) with the FAA.
- The National Research Council (NRC) Committee on Commercial Aviation Security — through this body's regular review of the FAA human factors program and its recommendations regarding focus and initiatives.
- Domestic airlines and research organizations including:
  - Alaska Airlines
  - Delta Airlines
  - Perkins-Elmer / EG&G Astrophysics
  - Northwest Airlines
  - American Airlines
  - Public Computer Systems (Safe Passage)
  - Frontline
  - Heimann Systems Corporation
  - Rapiscan Security Products
- Airport testbeds for human factors research and development:
  - Atlanta Hartsfield International Airport (ATL)
  - Dallas/Ft. Worth International Airport (DFW)
  - Detroit Metropolitan Wayne County Airport (DTW)
  - Seattle-Tacoma International Airport (SEA)

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Enhance Human Operator Performance

- Improved screener selection, screener machine interfaces, CBT multimedia training, and performance monitoring systems for emerging detection technologies.
- Developed performance criteria, Instructional Systems Design (ISD), pedagogical approach, and subject matter content for cargo screener Improvised Explosives Device (IED) identification training.
- Performed a multiple vendor assessment (i.e., shoot-off test) of security screener computer-based training systems to determine effectiveness to train critical knowledge, skills, and abilities.
- Completed training protocols for manual search of cargo.
- Developed the ISD for a team training approach for checkpoint security screeners to enhance coordination, threat detection, and passenger processing/throughput.

Improve Security Technology Usability and Effectiveness

- Provided input to further enhance training, demonstration images, selection, testing, and the threat resolution protocol to optimize operator field performance on the InVision's CTX 9000 EDS.
- Evaluated the initial person/machine interface and operator training package for the L-3 Communications' Examiner 3DX6000 EDS.

- Developed human factor design input and criteria for the design and development of a low cost, low throughput ARGUS EDS.

Human Systems Integration (HSI)

- Developed functional requirements for the integration and networking of multiple X-ray machines with TIP capability.
- Conducted an extensive laboratory evaluation of human factors considerations, throughput, and effectiveness of the Directed Trace procedure. This evaluation assessed the efficacy of a human operator using an X-ray machine and an Explosives Trace Detector (ETD) to meet FAA EDS performance standards.
- Developed the design guidelines and criteria for an Elevated Podium of Integrated Checkpoint Security Supervision (EPICSS), in conjunction with Alaska Airlines, to enhance supervision and coordination at security checkpoints.
- Evaluated checkpoint effectiveness and throughput, focusing on person-machine integration, to determine baseline checkpoint performance at testbed sites.
- Integrated new and emerging detection technologies into the operational environment.
- Convened an ongoing panel of industry, academia, military, and government subject matter experts to develop human factors functional design guidelines for security checkpoints to further enhance threat detection performance and passenger throughput.

KEY FY 2002 PRODUCTS AND MILESTONES:

Enhance Human Operator Performance

- Establish criteria and data for rulemaking on screener selection, training, and proficiency assessment.
- Develop and validate certification standards for security personnel to support rulemaking.
- Enhance the predictive validity of psychometric tests to further improve industry accuracy to select job candidates with aptitudes for successful threat detection performance. This work will continue to support the rulemaking for certification of screening companies by providing selection tools to the security industry.
- Evaluate security screener effectiveness in threat detection, passenger processing, and checkpoint procedures to determine baseline performance in an ongoing longitudinal evaluation using four major airport testbeds.
- Develop valid, reliable, non-biased cargo screener IED identification training.
- Perform assessment of advanced security screener computer based training systems to determine its effectiveness on enhancing critical knowledge, skills, and abilities.
- Develop an interactive computer based test to assess screener mastery of on-the-job training (OJT) skill acquisition.
- Develop the Instructional Systems Design for a team training approach for checkpoint security screeners to enhance coordination, threat detection, and passenger processing/throughput.

Improve Security Technology Usability and Effectiveness.

- Determine knowledge, skills, and abilities required for screeners to use advanced threat detection technologies (e.g., X-ray personnel screening devices).
- Evaluate advanced checkpoint personnel screening passenger portals for training design, maintainability, effective throughput, usability, operability, and person-machine performance.
- Determine conformance of additional vendor's TIP equipped X-ray systems to FAA functional requirements for design, usability, and effectiveness.
- Provide continued input to further enhance training, demonstration images, selection, testing, and the threat resolution protocol to optimize operator field performance on InVision's CTX 9000 EDS.
- Conduct a field evaluation of the person-machine interface and operator training package for the L-3 Communications' Examiner 3DX6000 EDS.

- Conduct laboratory evaluations of usability, interoperability, effectiveness, and throughput of a low cost, low throughput ARGUS EDS.
- Develop and evaluate a prototype, integrated network of multiple vendor X-ray machines with TIP capability. This effort supports information requirements in the rulemaking for certification of screening companies.
- Construct and evaluate an Elevated Podium for Integrated Checkpoint Security Supervision prototype system. The EPICSS will be constructed in conjunction with Alaska Airlines at SEA to enhance supervision and coordination at security checkpoints.

Human Systems Integration (HSI) to Optimize Security System Effectiveness and Throughput

- Integrate new and emerging detection technologies into the operational environment by developing human factors functional requirements to integrate persons and machines at the checkpoint.
- Provide evaluations on the manpower, personnel, training, human factors engineering, health, and safety aspects of security systems, especially those involving EDS and weapons detection technologies.
- Evaluate checkpoint effectiveness and throughput, focusing on person-machine integration, to determine baseline checkpoint performance in an ongoing longitudinal evaluation using four major airport testbeds.
- Conduct additional field studies to determine the optimal presentation rate of TIP fictional threats to maximize operator threat detection performance at middle to low volume airports.
- Convene an ongoing panel of industry, academia, military, and government subject matter experts to develop human factors functional design guidelines for security checkpoints to further enhance threat detection performance and passenger throughput.

Long Term Human Factors Research to Improve Threat Detection

- Conduct laboratory and field research to evaluate human perceptual abilities for threat and target identification.

FY 2002 PROGRAM REQUEST:

The Aviation Security Human Factors program emphasizes R&D within the areas of enhancing human operator performance, improving security technology usability and effectiveness, and human systems integration.

This research provides the basis for establishing criteria and data for rulemaking. It evaluates detection systems involving advanced technologies (e.g., InVision's CTX 9000, L-3 Communications' Examiner 3DX6000, ARGUS, Trace Portals) for checkpoint, cargo, and checked baggage security system. The program also optimizes detection technologies through component integration within futuristic screener stations and integrates new and emerging detection technologies into the operational environment. Consideration of human factors is essential to meet FAA strategic security initiatives for 100% screening of selectees at checkpoints by FY 2005, and 100% hold baggage inspection by FY 2010. Finally, it provides Human Systems Integration evaluations on the manpower, personnel, training, ergonomics, health, and safety aspects of security systems, especially those involving EDS and weapons detection technologies.

The human operator continues to be a critical component of current and advanced technologies to counter the threat of terrorism. The human operator contributes flexibility and adaptability to the aviation security system; however, a mismatch between the person and the machine often results in sub-optimal detection performance. This performance decrement is increasingly important given reduced threat masses and increasing cognitive demands placed on the operator as security equipment increases in complexity.

As the number of air travelers increases, an integrated person-machine security system is the key to efficiently and expeditiously processing passengers. Human factors research addresses person-machine performance concerns for checkpoint, checked baggage, and cargo security systems (i.e., technology, people, procedures, and organizations). The results of this research should increase the probability of detection and decrease the false alarm rates over current levels.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 30,586
FY 2001 Enacted	5,134
FY 2002 Request	5,163
Out-Year Planning Levels (FY 2003-2006)	21,736
Total	$ 62,619

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Aviation Security Human Factors	4,723	4,078	4,114	4,106	4,029
Personnel Costs	679	1,064	1,032	921	955
Other In-house Costs	138	140	110	107	179
Total	**5,540**	**5,282**	**5,256**	**5,134**	**5,163**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	5,540	5,282	5,256	5,134	5,163
Development (includes prototypes)	0	0	0	0	0
Total	**5,540**	**5,282**	**5,256**	**5,134**	**5,163**

A07c - Aviation Security Human Factors Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
076-110 Aviation Security Human Factors							
Enhance Human Operator Performance	$856						
Establish Criteria and Data for 2005 Checkpoint Selectee Rulemaking regarding Screener Selection, Training, Testing, Certification, and Proficiency Assessment		◆	◇	◇	◇		
Establish Criteria and Data for 2010 Rulemaking for 100% Checked Baggage Screening Regarding Screener Selection, Training, Testing, Certification, and Proficiency Assessment		◆	◇	◇	◇	◇	◇
Develop IED Identification Training, Testing, Performance Monitoring, and Certification Program for Cargo Screeners		◆	◇	◇	◇	◇	◇
Establish Criteria and Data to Support Rulemaking for Screening Company Certification		◆	◇	◇	◇		
Develop Equipment-Based Type Rating System for Screener Certification		◆	◇	◇	◇	◇	◇
Improve Security Technology Usability and Effectiveness	$1,505						
Improve Screener Selection, Screener-Machine Interfaces, CBT Multimedia Training, and Performance Monitoring Systems for Advanced Explosives Detection Systems (EDS) Technologies		◆	◇	◇	◇	◇	◇
Evaluate Adv. Detection Systems for Checked Baggage Screening-Low Cost EDS for Low Throughout Stations (ARGUS)		◆	◇	◇	◇	◇	
Eval. Advanced Detection Systems for Checked Baggage Screening-L-3 Communication's Examiner 3DX6000		◆	◇	◇	◇	◇	
Optimize Screener Checked Baggage Field Performance-InVisions CTX 9000 EDS System		◆	◇	◇	◇	◇	
Human Systems Integration (HSI)	$1,588						
Provide HSI Evaluations on Manpower, Personnel, Training Human Factors Engineering, Health and Safety Aspects of Security Systems		◆	◇	◇	◇	◇	◇
Human Factors Performance Improvement of Deployed Checked Baggage, Checkpoint, and Cargo Security Systems to Reduce False Alarms and Increase Detection		◆	◇	◇	◇	◇	◇
Evaluate Advanced Trace Systems for Checkpoint Screening – Trace Portals, Passenger Portals, Ticket Scanners, Trace Wands			◇	◇	◇	◇	◇
Assess TRX Systems for Conformance to FAA Requirements in Support of SEIPT Deployment		◆	◇	◇	◇	◇	◇
Human Factors Airport Test Beds (ATL, DFW, DTW, ATL)		◆	◇	◇	◇	◇	◇
Integrate New and Emerging Technologies into Op. Envir.		◆	◇	◇	◇	◇	◇
Optimize Combined Detection Technologies through Component Integration within Futuristic Screener Stations		◆	◇	◇	◇	◇	◇
Develop Enhanced, Adaptive, Networked Threat Image Projection for X-Ray Detection Systems to Support Checkpoint Integration			◇	◇	◇	◇	◇
Long Term Human Factors Research to Improve Threat Detection	$80						
Laboratory and Field Research to Assess the Effects of Operator Fatigue on Visual Perception, Detection Performances, and Decision-making			◇				
Personnel and Other In-House Costs	$1,134						
Total Budget Authority	$5,163	$5,134	$5,163	$5,270	$5,370	$5,499	$5,597

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A07d Aircraft Hardening

GOALS:

Intended Outcomes: In accordance with the strategic FAA goal of preventing 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 spurious electromagnetic or high energy signal interference 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:

- Minimum size/type of threats that would result in aircraft loss.
- Methods and techniques that can be applied to the current and future fleet of commercial aircraft to decrease the level of vulnerability to explosive effects.
- Threats to aircraft from electromagnetic (EM), projected energy, surface-to-air missiles, and other emerging lethal threats and practical countermeasures.

Agency Outputs: The program is tasked with delivering documented 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 is divided into the following separate emphases:

- Threat vulnerability identification.
- Aircraft design related/procedural mitigation techniques.

Customer/Stakeholder Involvement: The aircraft hardening program was initiated in 1990 in response to the directives of the President's Commission on Aviation Safety and Security and the mandates set forth in the Aviation Security Improvement Act of 1990. The program was endorsed by the White House Commission on Aviation Safety and Security in 1996. The program is continually submitted to close scrutiny by by the Aviation Security Subcommittee of the R,E&D Advisory Committee. The General Accounting Office also assesses the program. The content of the program is in direct support of the customer, the Assistant Administrator for Civil Aviation Security, and complies with the aviation security requirements directives from the Office of Civil Aviation Security. Additionally, the program is required to periodically report technical progress directly to Congress.

Accomplishments: The Aircraft Hardening program has:

- Validated current detection standards for both checked and carry-on luggage through analysis and explosive testing on the minimum size, type, and location of explosives that could result in catastrophic failure of both wide and narrow body commercial aircraft.
- Proved the feasibility of and determined the standards for explosive resistant luggage containers used in wide body aircraft. Prototype containers were provided to the airlines to complete an operational assessment of the cost and improved security effectiveness of implementing hardened containers.
- Initiated research on the development and practicality of protective units for use in the baggage compartments of narrow body aircraft.
- Developed a process to assess the vulnerability of commercial aircraft to terrorist induced electronic and mobile missile threats with the Department of Defense and other government agencies.

R&D Partnerships: From the onset, the 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. Research efforts have been coordinated with the United Kingdom, Israel 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 2001 ACCOMPLISHMENTS:

Threat Vulnerability Assessments

- Validated, through explosive testing of DC-9, 727, 737, 747, and A-300 aircraft, the blast effects of a variety of different explosives and/or locations for the purpose of refining detection criteria.
- Determined the vulnerability of commercial aircraft to terrorist-induced electromagnetic projected energy threats.
- Refined the vulnerability of commercial aircraft to Man Portable Air Defense (MANPAD) Systems.

Threat Mitigation Techniques

- Continued testing of hardened container concepts developed through private industry investment.
- Completed operational assessment of LD-3 hardened containers with airlines.
- In concert with the International Civil Aviation Organization (ICAO) partners, identified methods of protecting aircraft cockpits from intruders.
- Initiated the development of specifications for other size standard containers (LD-2, LD-4, LD-6, etc.) used by the airline industry.
- Developed the specifications and tested protective luggage units for use on narrow body aircraft.
- Initiated an operational assessment on the cost and effectiveness of using hardened units on narrow body aircraft.
- Demonstrated the utility of protecting overhead compartments from explosive effects in both narrow and wide body aircraft.
- Transitioned container technologies to private industry.
- Identified possible mitigation techniques to counter projected energy and other threats.
- Developed MANPAD procedures/rules.

KEY FY 2002 PRODUCTS AND MILESTONES:

Threat Vulnerability Assessments

- Assess security implications associated with the introduction of new passenger aircraft designs.
- Assess commercial aircraft vulnerability to incendiaries, innovative explosives, hazardous materials and other emerging threats as identified through intelligence estimates.
- Assess aircraft design implications relative to chemical/biological threats.

Threat Mitigation Techniques

- Determine specifications, operational impacts and costs of explosive resistant luggage units on narrow body aircraft.
- Complete the development of specifications for other than LD-3 size standard containers.
- With the aircraft manufacturing industry, develop and validate specifications to harden overhead and cargo compartments to mitigate explosive effects.
- Develop procedures/rules to counter the threat from electromagnetic and projected energy sources.
- With DOD, determine costs and methodology for implementing countermeasures to the MANPAD threat to commercial aviation through leveraging DOD investments in the Civil Reserve Air Fleet (CRAF).
- Develop procedures/rules for chemical/biological threat.

FY 2002 PROGRAM REQUEST:

In FY 2002, the program continues to focus on the areas listed at the beginning of the GOALS section above. As the vulnerability assessments from the various threats evolve, ideas to mitigate threats either through retrofitting the current fleet, revising procedures, or instituting new design techniques and materials are being identified. These ideas and concepts, which include lining cargo bays and overhead compartments, are analyzed and tested in concert with our partners in industry (Boeing) and government (DOD and NASA) as well as ICAO and the Government of Israel. The recommendations for new

specifications are made as required. In addition, analysis is underway to identify vulnerability of commercial aircraft to new and emerging threats.

These research efforts are primarily investigative and involve both analytical and empirical assessments. This research will provide security alternatives that could help meet the difficult technical challenges and costs facing the detection community as it strives to meet a FY 2010 goal of 100% screening. By reducing aircraft vulnerabilities to explosives and other terrorist threats, detection standards could be eased thus reducing technical risks and costs.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 39,478
FY 2001 Enacted	4,297
FY 2002 Request	4,640
Out-Year Planning Levels (FY 2003-2006)	19,626
Total	$ 68,041

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Aircraft Hardening	1,393	1,139	3,371	3,415	3,338
Personnel Costs	504	754	1,497	801	1,089
Other In-house Costs	103	107	133	81	213
Total	**2,000**	**2,000**	**5,001**	**4,297**	**4,640**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	2,000	2,000	5,001	4,297	4,640
Development (includes prototypes)	0	0	0	0	0
Total	**2,000**	**2,000**	**5,001**	**4,297**	**4,640**

A07d - Aircraft Hardening Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
075-110 Aircraft Hardening							
Threat Vulnerability Assessment	$835						
Validated Through Explosive Testing, the Blast Effects of a Variety of Different Explosives for the Purpose of Refining Detection Criteria		◆					
Assess Security Implications Associated with the Introduction of New Passenger Aircraft Designs			◇	◇			
Assess Commercial Aircraft Vulnerability to Incendiaries, Innovative Explosives, Hazardous Materials and Other Emerging Threats as Identified through Intelligence Estimates		◆	◇	◇	◇	◇	◇
Assess Aircraft Design Implications Relative to Chemical/Biological Threats		◆	◇	◇	◇	◇	◇
Threat Mitigation Techniques	$2,503						
Completed Operational Assessment of LD-3 Hardened Containers with Airlines		◆					
Publish Specifications for Other Than LD-3 Size Standard Containers		◆	◇	◇			
Identify and Test Methods for Protecting Aircraft Cockpits from Intruders		◆	◇				
Determine Specifications, Operational Impacts and Costs of Explosive Resistant Luggage Units on Narrow Body Aircraft		◆	◇				
Develop Rules for Narrow Body Protective Units			◇	◇			
With the Aircraft Manufacturing Industry, Develop Specifications to Harden Overhead and Cargo Compartments to Mitigate Explosive Effects		◆	◇	◇	◇	◇	
Transition Container Technologies to Private Industry		◆	◇	◇			
Develop Procedures/Rules to Counter the Threat from Electromagnetic and Projected Energy Sources		◆	◇	◇			
With DOD, Determine Costs and Methodology for Implementing Countermeasures to the MANPAD Threat to Commercial Aviation through Leveraging DOD Investments in the Civil Reserve Air Fleet (CRAF)			◇	◇	◇		
Develop New Aircraft Certification Criteria		◆	◇	◇	◇	◇	◇
Develop Procedures/Rules for Chemical/Biological Threat			◇	◇	◇	◇	◇
Personnel and Other In-House Costs	$1,302						
Total Budget Authority	$4,640	$4,297	$4,640	$4,745	$4,844	$4,969	$5,068

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

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2.5 Human Factors and Aviation Medicine Program Area Description

Mission

The Human Factors and Aviation Medicine Program relies upon:

- *Applied research*
  - To identify methods that can contribute to the goal of reducing the fatal accident rate by 80%;
  - To develop enhanced guidelines for protective equipment and procedures; and
  - To provide recommendations for FAA regulatory and medical certification personnel to enhance safety of aircraft crewmembers and aircraft cabin occupants.
- *Innovative research and management initiatives*
  - To ensure that human factors policies, processes, and best practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications.

The rapid evolution toward increased operational demand, diversity of aircraft and systems, changing technology, and globalization of the airline/aircraft industry challenges the Human Factors and Aviation Medicine Offices to meet these goals by:

- Ensuring that research is focused on those areas directly impacting aviation safety.
- Forming partnerships with research and university laboratories.
- Capitalizing on opportunities to leverage government and industry resources in order to rapidly transfer the results of research to the aviation community.
- Undertaking major efforts to ensure that human factors expertise is represented across functional disciplines and that human factors considerations are addressed throughout 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 carrier crews, general aviation pilots, aviation maintenance and inspection personnel, air traffic controllers, and NAS system maintenance specialists. 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." Human Factors research is also initiated in support of the FAA goal to "reduce the costs of flying by making the air traffic management system more efficient to use."

Human Factors research supports the development of human-centered flight controls and displays, and identifies aircrew training innovations that enhance safety and reduce performance inefficiencies. This research is increasing consideration of human factors in aircrew training. This research also explores prospects for safety enhancement through automated analysis of flight-recorded data and through application of human factors in certification of new aircraft and equipment design and modification.

In aviation maintenance, human factors research develops more effective methods for maintenance technician and inspector training, and improves aviation maintenance technician and inspector task performance. Aviation maintenance human factors research efforts are exploring the application of human factors interventions to improve aviation inspection performance, evaluating the effects of Maintenance Resource Management, and examining human error risk analyses in aviation maintenance and flightline operations. Research is also producing programs used for improving aviation maintenance and inspector team communication to prevent shift change communication errors.

In general aviation, safety is enhanced through the application of human-centered principles to the development of advanced displays and controls and to procedures that improve pilot decision making and performance.

In air traffic control, human factors research will provide design guidance and findings and recommendations from assessments of human perfor-

mance to guide the development of human-centered automation and procedures that will enhance controller decision making and reduce error-prone conditions. These efforts will also guide the development of tools and procedures to support Collaborative Decision Making in Air Traffic Management required for the future NAS to meet increased demand. An improved approach to classifying the human factors associated with operational errors/incidents will result in improved investigation techniques leading to recommendations such as in procedures and training for decreasing the frequency of those events.

Aviation Medicine research improves the health, safety, and survivability of aircraft passengers and aircrews through its identification of human failure modes and development of formal recommendations for counteracting human failure conditions. Through this research, the FAA develops bioaeronautical guidelines, standards, and models for aircraft cabin equipment, procedures, and environments as a basis for regulatory action to enhance appropriate human performance. New medical criteria, standards, and assessment/certification procedures are also developed to ensure full performance capability. By assessing flight attendant and passenger behavior and disease issues, guidelines will be proposed for actions to improve the health and safety of cabin occupants.

Program Area Outputs

The Human Factors research program:

- Identifies operational needs and problems involving human performance.
- Funds and guides research projects to address operational priorities.
- Forms partnerships with industry and academia.
- Elicits participation by the nation's top scientists and professionals.
- Provides Human Factors guidance to the FAA for development and implementation of new technologies, training and procedures.
- Facilitates transfer of research products to the operational community.
- The Aviation Medicine research program:
- Produces data and other forms of information which support notices and regulations applicable to aircraft occupant health and safety.
- Develops output options in response to a public demand (e.g., better restraints for children in aircraft settings).
- Assesses disease transfer and other aircraft occupant health factors.

The FAA is concerned with ensuring 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 with human performance information and guidance critical to the design, operation, regulation, and certification of equipment, training, and procedures. The human factors program does the research that provides the technical information needed to generate these products and services.

Automation has been cited as a contributing factor in aircraft accidents (e.g., Cali AA965). Human factors research is examining flight deck automation design, operation, use and training, and has developed a prioritized research agenda 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 that addresses issues related to automated systems. The Automated Performance Measuring System will provide airlines the ability to analyze routine operations for dangerous trends and tendencies. It also will provide insight into the details of daily carrier line operations, uncovering automation usage problems that occur while operating in a complex environment.

Validated pre-hire assessments for air traffic controllers, electronics technicians, and transportation system specialists will enable the FAA to select persons with appropriate knowledge, skills, and abilities for each occupation, thus reducing training required after employment as well as attrition due to poor person-job fit. Human factors assessments will be conducted to evaluate safety and efficiency gains associated with automated decision aids in air traffic control.

Scientists from the Office of Aviation Medicine and the National Institute for Occupational Safety and Health are examining cabin environmental quality issues and their effect on passengers and flight crews. Aviation Medicine is also developing bioengineering criteria to support aircraft seat and restraint system certification, human performance and ergonomic data to support emergency evacuation regulations and standards, 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.

Protecting humans in decelerative environments, existing radiation 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. A program to survey the nature of in-flight medical emergencies, particularly the effectiveness of defibrillators carried on airlines, new vision corrective methods for aviation personnel, aircraft cabin environmental hazards, air ambulance medical requirements, and development of protocols for safe use of lasers in laser light shows to prevent incapacitation of pilots, represent current investigations under the aviation medicine program support initiative.

Program Area Structure

The human factors program addresses operational requirements through research in the following five technical thrust areas as agreed to by the FAA, NASA, and DOD in the *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*:

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. The research in this area addresses the identification and application of knowledge concerning the relative strengths and limitations of humans 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; enhances the measures and methods for the prediction of current and future job/task performance; establishes a scientific basis for the design of training programs, devices, and aids for individuals and teams; defines criteria for assessing future training requirements; and identifies new ways to select aviation system personnel.

Human Performance Assessment: Within this thrust area, research identifies the intrinsic cognitive and decision-making factors for 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: Under this thrust area, research 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 what, when, and how one might best display and transfer information to system components; designs a system to reduce the frequency of information transfer errors and misinterpretations; and strives to minimize the impact when such errors do occur.

Bioaeronautics: Research in this area involves the bioengineering, biomedicine, and biochemistry associated with performance and safety. The objective is enhancement of personal performance and safety by maximizing crew and passenger protection, health, and physiological integrity. The program consists of three research initiatives: human protection and survival; medical and toxicological factors in accident investigation; and support for aeromedical certification and in-flight aeromedical applications through aviation medicine program support.

Customer and Stakeholder Involvement

The Human Factors program directly supports a range of aviation community initiatives and congressional mandates, including research into the effects of shift work and fatigue (also the distribution of educational materials on fatigue), and the

effects of English language proficiency upon the work of international controllers.

The FAA 2000 Performance Plan has identified areas of human factors research concentration that have led to collaborative efforts between the agency and industry. These include efforts to reduce operational error as a factor in aviation accidents and to integrate human factors into system acquisition.

The Mission Goal for Safety identified in the 1998 FAA Strategic Plan ("by 2007 reduce the U.S. aviation fatal accident rate by 80% from 1996 levels") has fostered collaboration with the aerospace community in efforts that include: building on currently successful efforts to identify the individual, organizational, and system factors associated with past accidents; using new data sources in a more proactive analytical approach to identifying and reducing key human factors risks; and working with NASA, DOD, and other public and private organizations, in studying issues and technologies with potential to improve policies, procedures, and equipment.

Achievement of the first two goals identified in the Office of the Associate Administrator for Research and Acquisitions Performance Plan has resulted in collaborative research. Goal 1: Contribute to the FAA goal to reduce the fatal aviation accident rate by 80 percent by 2007, as compared to 1996 baseline data. Goal 2: Ensure that policies, processes, and best Human Factor practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications.

A wide range of additional collaborative research efforts that have been mandated through many government and private sources have been undertaken through the program. These include:

- Issues addressed by the Runway Safety Program, including memory enhancement techniques, training for tower controllers, pilot/controller communications phraseology, runway markings and lighting, air traffic control teamwork enhancement training, and improved procedures designed to avoid runway incursions.
- Human factors research associated with the Safer Skies program, which employs the latest technology to help analyze U.S. and global data to determine root causes of accidents and identify appropriate actions to break the chain of events that lead to accidents.
- A coherent national agenda to ensure an adequate human factors emphasis in bioaeronautics research and apply resulting insights to making significant improvements in NAS safety and efficiency. These concerns were identified through extensive aviation community participation and were listed in 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.
- Research into priority issues associated with crew training, the collection and use of safety data, the application of emerging technologies, and aircraft maintenance procedures and inspection as identified in The Aviation Safety Plan.
- The application of insights derived from human factors research in the Implementation of the FAA report on "The Interfaces between Flight Crews and Modern Flight Deck Systems."
- Public Law 100-591 — establishes requirements for human factors research and its application.
- The FY 1998 Department of Transportation Appropriations Act — cites human factors as the greatest cause of aviation accidents and calls for high priority research.
- The Aviation Safety Research Act of 1988 — requires that human factors research be conducted to "enhance air traffic controller performance, develop a human factors 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."
- The RTCA "Free Flight Action Plan" — addresses recommendations to: establish more flexible decision support systems involving Collaborative Decision Making; 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.

- On-site, realistic research made possible through access to the personnel and facilities of airline and aviation maintenance organizations. These organizations have benefited from research products such as electronic job aids, intelligent tutoring systems, guidance on work site environmental conditions, shift-work studies, and advanced training methods.

The Aviation Medicine program also directly supports a number of aviation community initiatives and congressional mandates, including:

- Research in the protection and survival of aircraft occupants; medical accident investigation and airman medical certification; toxicology and the effects of drugs on human performance; and the impact of disease and disability on human performance, as required by Public Law 100-591 [H.R. 486]; November 3, 1988 (known as the Aviation Safety Research Act of 1988).
- Toxicological analyses on specimens from, and special pathologic studies on, aircraft accident fatalities as required by DOT Order 8020.11A, Chapter.4, Paragraph 170.
- Investigations of selected general aviation and air carrier accidents and searches for the biomedical clinical causes of accidents, including evidence of disease and chemical abuse, as required by DOT Order 1100.2C, Chapter 53, Paragraph 53-15.
- State-of-the-art toxicological tests on the blood, urine, and tissue of pilots involved in fatal accidents to determine the levels of both licit and illicit drugs at both the therapeutic and abnormal levels, as requested by National Transportation Safety Board Safety Recommendations A-84-93.
- The Aviation Medicine Program is an integral participant and research provider under the FAA, Joint Aviation Authorities, and the Transport Canada Aviation Aircraft Cabin Safety Research Plan (established in 1995), which sets forth long-term research goals and ensures coordination between international aviation agencies. Programs within Aviation Medicine that study aircraft cabin environmental quality and the nature and extent of in-flight medical emergencies are a direct result of specific congressional mandates to study these topics.

Accomplishments

Information Management and Display

- Developed human factors guidelines for air carrier use in constructing operating documents.
- Determined the effectiveness of delivering technical information to line aircraft technicians using wireless, portable, pen-based computers.
- Developed a process to improve work documentation in repair stations.
- Completed a human factors audit of the Converging Runway Display Aid (CRDA) installed at St. Louis Airport. CRDA is a decision support tool that helps terminal radar controllers efficiently space aircraft arriving on separate, converging runways.
- Identified the priorities, organization, and sources of information accessed by pilots during various phases of flight.
- Provided recommendations to the Advanced General Aviation Transport Experiment Working Group regarding pilot performance and human factors issues associated with using highway-in-the-sky displays.
- Completed a project to observe en route controllers' utilization of flight progress strips.
- Designed, developed, and administered the FAA employee attitude survey.

Human-Centered Automation

- Completed human factors assessments of advanced controls and displays for Advanced General Aviation Transport Experiment air-

craft. Provided recommendations to guide certification of those devices.

- Directed a large-scale effort to identify and resolve the significant human factors issues inherent in the STARS display.
- Developed a pocket certification guide for human factors evaluation of multifunction displays.

Human Performance and Assessment

- Developed and field tested (with several airlines) a prototype Automated Performance Measurement System (APMS) which allows for gathering and analysis of data from aircraft flight data recorders. This information and analysis capability is utilized by the Flight Operations Quality Assurance program, a joint FAA and airline venture to enhance aviation safety.
- Validated human performance transfer functions for level B full flight simulators.
- Developed the Human Factors Design Guide for system acquisitions by Integrated Product Teams.
- Initiated a process to integrate shift-change error identification and mitigation processes into the aircraft maintenance error-detection and reporting system.
- Developed pilot performance data through flight simulation for use in establishing certification standards for general aviation autonavigation and control systems.
- Developed the Post-Operations Evaluation Tool that has now been deployed nationally as a common framework for assessing coordinated strategic responses to ATM restrictions.
- Initiated collaborative research with EUROCONTROL scientists to develop a harmonized model to investigate human error in air traffic management.
- Completed evaluation of the application of a human factors analysis and classification taxonomy to Part 121/135 air carrier accidents contained in the NTSB database.
- Completed the congressionally-mandated survey of shift work and fatigue in air traffic controllers.
- Completed a report on the allocation of visual attention for air traffic monitoring and avoidance: baseline measures and implication for Free Flight.
- Completed development of a tool to assess controller communication and coordination and evaluated its effectiveness in a field and laboratory study.

Selection and Training

- 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.
- Validated use of simulator parameters and flight data for evaluating Advanced Qualification Program effectiveness.
- Developed error mitigation training for cockpit crews.
- Provided Crew Resource Management procedure guidelines for regional airlines.
- Developed preliminary training guidelines for cockpit distractions and interruptions.
- Produced and presented the FAA Human Factors Course to increase understanding of the importance of considering the “human factor” in design/acquisition of FAA systems.
- Produced and distributed a handbook for Advanced Crew Resource Management training.
- Identified and documented the best practices for engine nondestructive training and related inspections.
- Developed an automated system of self instruction for specialized maintenance training.
- Completed evaluation and recommendations for using PC-based aviation training devices in pilot instrument flight training.
- Validated and approved a new computerized test battery for operational use in selecting air traffic controllers.
- Validated the Basic Electronics Screening Tool for operational use in selecting electronics personnel.

- Developed guidance on situation awareness, error mitigation, and teamwork to support the NAS Infrastructure Management Maintenance Concept and its transition to centralized maintenance management.

Bioaeronautics

- Provided aeromedical accident analysis for evaluation and enhancement of medical certification standards.
- Evaluated autopsy and toxicological data from fatal aviation accidents to recommend protective equipment and design practices, and to determine the incidence of licit and illicit drug use.
- Initiated development of an advanced consolidated data base that integrates accident/incident information with medical certification data to establish a methodology for continuous evaluation or airmen medical certification standards.
- Assessed potential for flight attendant reproductive health hazards by integrating flight data, measurements of radiation, and other aircraft cabin environmental parameters and information from epidemiological studies.
- Evaluated applicability of analytical modeling on dispersion and removal of gaseous and aerosol contaminants in different types of aircraft heating, ventilation, and air conditioning systems.
- Updated educational material and improved access to information on potential exposure to air contaminants and other environmental parameters in aircraft.
- Provided assistance in review and updates of bulletins, reports, and regulations on air quality in aircraft cabins.
- Reported on the suitability of component tests for showing regulatory compliance with crashworthiness standards for aircraft.
- Completed evaluation of child restraint systems and initiated proposed regulations for optimum safety.
- Developed fit and comfort standards for aviation oxygen mask systems.
- Assessed operational hazards of in-flight laser exposure.
- Utilized new DNA probes for determining the existence of post-mortem alcohol in accident fatalities.
- Evaluated the success of automatic external defibrillators and in-flight medical kits utilized in commercial aviation.
- Conducted side-facing sofa crash dynamic tests to evaluate neck loads on occupants, inflatable torso restraint systems, and methods to reduce crash-related injuries.

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, crew resource management, team decision making, air-ground shared separation authority, and decision support automation. DOD joint efforts involve fatigue, team performance, and decision-making research. Additionally, the Human Factors Office maintains a membership in the DOD Human Factors Engineering Technical Advisory Group that 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 and air/ground integration research. The Office maintains an active membership on all Society of Automotive Engineering G-10 Human Factors subcommittees related to ongoing and future research areas to ensure transition of the results to standards and guidelines. The Human Factors Office places grants with universities supporting research on air carrier training, flight deck automation, general aviation, aviation maintenance technician training, and air traffic management. Coordinated research efforts are conducted with NASA Ames in free flight. An Interagency Agreement with the U.S. Navy Air Warfare Center focuses on development of training and performance measurement strategies to enhance teamwork in flight deck crews. Special attention is being paid to training enhancements that develop aviation teamwork skills and

the utility of advanced technologies for delivering team training.

The Human Factors Office participates in collaborative research with EUROCONTROL on the reduction and management of human error in Air Traffic Management, human performance issues in the design of decision support tools, and on developing a human-centered approach to integrating technologies to ensure aircraft separation. An effort is underway with the Joint Aviation Authorities and Transport Canada to identify and coordinate human factors research in areas of joint interest.

The Office of Aviation Medicine collaborates with the National Institute for Occupational Safety and Health on a study addressing the cabin environment and flight attendant and passenger symptomatology and diseases. In addition, a liaison is 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 also represented on appropriate subgroups of organizations such as the Aerospace Medical Association, the Society of Automotive Engineers, 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 Atlantic Treaty Organization (NATO) aerospace medical advisory group.

Long-Range View

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

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. For example, methods will be developed to identify interventions to address human performance issues in aviation maintenance and air traffic operations. With regard to partnership strategies, a five-year integrated safety research plan will be developed with NASA, addressing 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 in the maintenance of a healthy and comfortable environment for each category of civil aviation's participants is not abating. The five-year interagency agreement between FAA and NIOSH initiated in FY97 addresses infectious disease and other health considerations in the aircraft cabin environment.

The Aviation Medicine program will continue to emphasize the mitigation of accidents, and reduction in the severity of injuries encountered in such precautionary events as evacuation of passengers from an aircraft after recognition of a safety concern by the flight crew. Through this approach, the program will remain a critical component of FAA efforts to meet its safety and survivability goals.

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. This information will be used in the development of internationally harmonized aviation standards and regulations. Aeromedical research will be increasingly necessary to interpret data derived from around the world, and to assess

whether the data are appropriate or require additional investigation prior to use in regulatory or other actions.

A08a Flight-Deck/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 improved human-centered flight controls and displays.
- Increasing human factors considerations in the certification of new aircraft and equipment design and modification.
- Improving aircrew, inspector, and maintenance technician task performance.

Agency Outputs: The FAA ensures the safety and efficiency of operator performance 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. With this in mind, the Human Factors Program conducts and manages research that 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:

- *FAA Strategic Plan Mission Goal for Safety.* By FY 2007, reduce U.S. aviation fatal accident rates by 80% from 1996 levels.
- ARA FY 2000 Performance Plan: Goal 1. Contribute to the FAA goal to reduce the fatal aviation accident 80% by FY 2007 as compared to 1994 -1995 baseline data.
- The FAA/Industry *Safer Skies* initiative, which will use the latest technology to help analyze U.S. and global data to find the root causes of accidents and determine the best actions to break the chain of events that lead to accidents.
- 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. 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 FAA report entitled "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 Advanced Qualification Program (AQP), which has been adopted by every major U.S. carrier, incorporating human factors training into pilot qualification and recurrent training programs.
- Crew Resource Management (CRM) training procedures, a variant of which has been adopted by virtually every major domestic air carrier.

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

Information Management and Display

- Developed a manual that addresses appropriate human factors considerations in designing flight deck operating documents. This manual has been adopted by International Civil Aviation Organization (ICAO) for distribution to its member states.
- Published the *Aviation Maintenance Human Factors Guide.*
- Developed and implemented the Agency's first virtual collaborative research team to communicate and disseminate information in real time regardless of distance or other constraints on research team members
- Developed (with industry) the first industry standard and guidance document on implementing an Aviation Maintenance Human Factors Program.
- Developed the Aviation Maintenance Document Design Aid incorporating simplified English and utilizing advanced technology to standardize aviation maintenance documentation.

- Developed guidance and recommendations on human factors best practices in flourescent penetrant inspection. This project provided a more systematic view of human/system interaction.
- Completed human factors guidelines for assessing advanced general aviation transportation experiment (AGATE) cockpit controls/ displays.
- Developed human factors design and evaluation considerations for Electronic Flight Bags, Version 1.0.
- Completed assessment of human factors issues and current knowledge concerning use of head-up displays in air transports.
- Completed Data Link lessons learned compendium for inclusion in RTCA DO-238A, "Human Factors Requirements and Guidance for Controller/Pilot Data Link Communications Systems."

Human-Centered Automation

- Completed human factors Certification Job Aid Version 1.0 for FAR Part 25 flightdeck displays.
- Developed aircraft certification human factors and operations checklist for stand-alone global positioning system receivers.

Human Performance Assessment

- Developed a prototype Automated Performance Measurement System (APMS) that allows air carriers to gather and analyze flight data from aircraft data recorders. This information and analysis capability provides the backbone for the Flight Operations Quality Assurance Program (FOQA), a joint FAA, industry and labor initiative to enhance aviation safety.
- Provided industry and FAA with preliminary reports on the antecedents of flightdeck error.
- Validated human performance transfer functions for full flight simulators.
- Completed the Job Task Analysis of the Aviation Maintenance Technician Workforce.
- Developed guidance and standardized shift turn over procedures for use in aviation maintenance.
- Developed pilot performance profile, through flight simulation, for use in establishing certification standards for General Aviation autonavigation and control systems.

Selection and Training

- Developed and validated a proceduralized pilot CRM training and assessment system.
- Developed the Model AQP to support regional air carrier participation. AQP is a proficiency-based approach to pilot training that is considered to be highly effective and efficient for aircrew training.
- Developed air carrier training data analysis tools used by carriers and the FAA for quality assurance efforts.
- Provided Flight Standards guidance for developing pilot training regulations based on data from a study of 40,000 domestic air carrier pilots. The study examined pilots' perceptions of training effectiveness across the entire U.S. aviation industry.
- Developed Line Audit Methodology used by air carriers to help determine safety vulnerabilities. This methodology has been adopted by ICAO and was distributed to member states.
- Provided industry and FAA with preliminary guidelines on training for flight deck interruptions and for the performance of concurrent critical tasks.
- Provided industry and FAA with training guidelines for pilot decision making, addressing first officer's hesitancy to challenge the captain in potentially high risk situations.
- Developed a system to allow air carriers to reconfigure FAA approved flight scenarios to unique training segments and developed a generic line oriented evaluation event set database to be used by any air carrier.
- Incorporated air carrier and FAA user comments into an enhanced reconfigurable event set scenario development system.
- Through innovative training schedules, provided FAA and Industry preliminary guidelines on managing pilot skill degradation.
- Provided Industry and FAA preliminary training guidelines for automated flight decks.

- Provided FAA and Industry guidance on approaches to incorporating realistic radio communications into simulators to train pilots for the complex operating environment.
- Developed the Maintenance Resource Management (MRM) handbook for use by industry.
- Completed the prototype MRM distance learning project that will be implemented and used by the U.S. Navy for training their Naval Aviation Maintenance Technicians. Further application can be applied to U.S. Coast Guard Aviation Maintenance Technicians.
- Developed an Advisory Circular on Training, Qualification, and Certification on Nondestructive Inspection Personnel.
- Developed a prototype automated system of self instruction for specialized training for the industry aviation maintenance inspector workforce.
- Developed a CD-ROM training program that guides General Aviation pilots through the creation of a personal checklist that incorporates minimum operating conditions and procedures based upon their own personal capabilities and experience.
- Developed a CD-ROM training program that describes the structured decision-making style of experienced General Aviation pilots compared to less experienced pilots. The program stresses situational awareness, diagnosis, resolution, and vigilance.
- Developed a CD-ROM training program that teaches General Aviation pilots to recognize the cues associated with deteriorating weather while in-flight, and to take appropriate action to avoid weather.

R&D Partnerships: Collaboration has continued between the FAA and industry partners to develop intervention strategies and reduce aviation accidents through the various Joint Safety Awareness Teams (JSAT) developed as part of the Safer Skies agenda. 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, CRM, team decision making, air-ground communication, and aviation maintenance. DOD joint efforts are in team performance, decision making, aviation MRM, distance learning, and human error risk analysis. 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.

Through aviation maintenance partnerships with industry, the FAA and industry are receiving real world applied research results. Aviation maintenance human factors is also working with other countries (such as Transport Canada) for globalization of aviation maintenance and inspection human factors. The FAA participates on all of the Society of Automotive Engineers G-10 human factors subcommittees related to human factors research areas, ensuring transition of the results to standards, guidelines, etc. The FAA also has extended seventeen grants to universities supporting research on air carrier training, flight deck automation, aviation accident analysis, general aviation, and aviation maintenance technician and inspector training.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Information Management and Display

- Completed software tools for enhanced maintenance documentation.
- Developed human factors design and evaluation considerations for Electronic Flight Bags, Version 2.0.
- Developed general aviation “head up” display information/symbology recommendations.
- Addressed human factors issues for Cockpit Head Motion Box associated with air transport head-up displays.

Human-centered Automation

- Provided industry and FAA guidance addressing training for automated cockpits. These guidelines will encompass the performance difficulties associated with increased coupling, complexity, and autonomy of modern cockpit technology.

- Completed human factors Certification Job Aid Version 2.0 for FAR Part 25 flightdeck displays.

Human Performance Assessment

- Provided expanded Automated Performance Measurement System (APMS) methodologies and analysis capabilities in order that air carriers can collect and analyze increasing amounts of flight and simulator data.
- Developed mapping of flight data parameters onto AQP qualification standards.
- Completed assessment of the utility of PC-based aviation training devices in maintaining General Aviation pilot instrument proficiency.
- Completed a comprehensive human factors analysis of scheduled air carrier and general aviation fatal accidents using the human factors analysis and classification system (HFACS).
- Identified human factors trends in aviation accident/incident data to produce data driven research initiatives.

Selection and Training

- Developed methods to incorporate automation-specific training scenarios into the system that reconfigures event sets for unique training sessions.
- Validated simulator motion training requirements.
- Developed advanced data analysis methods for linking FOQA and simulator training data.
- Refined and validated training guidelines and training schedules for degradation vulnerable flight tasks.
- Refined training guidelines for automated flight decks.
- Expanded Realistic Radio Communications in simulator training to include data link and other forms of nonverbal communication.
- Analyzed data from line observations and laboratory studies to provide training guidance on human error management.

KEY FY 2002 PRODUCTS AND MILESTONES:

Information Management and Display

- Develop and implement guidelines for maintenance error investigating and reporting systems.
- Develop flight data recording and analysis capability for flight simulators.
- Complete human factors design and evaluation considerations for Electronic Flight Bags, Version 3.0.
- For general aviation aircraft, conduct comparative analyses to determine if any substantial degradation in visual search is concurrent with the presence and/or use of the “head up” or “head down” display, and which tasks benefit most from each type of presentation.
- Complete initial computational model to assess information accessability for air transport head-up display/head-down display combinations.
- Determine operational criteria and training guidance for night vision goggles in rotorcraft operations.
- Determine type of information to be presented to develop adequate situational awareness required to avert Controlled Flight Into Terrain (CFIT) in general aviation.
- Define display location boundaries that correspond to established eye position/head position for general aviation aircraft during actual operations.

Human-centered Automation

- Provide industry and the FAA expanded guidance addressing training for automated cockpits. These guidelines will encompass the performance difficulties associated with increased coupling, complexity, and autonomy of modern cockpit technology.
- Develop certification guidelines for integrated technology in general aviation cockpits.
- Complete human factors Certification Job Aid, version 3.0 for FAR Part 25 flightdeck displays.

Human Performance Assessment

- Refine flight and simulator data analysis tools.
- Provide guidance on the effectiveness of realistic radio communications in line oriented evaluations.
- Define general aviation pilot decision-making skills required for training module development.
- Provide expanded APMS methodologies and analysis capabilities in order that air carriers can collect and analyze increasing amounts of flight and simulator data.
- Develop improved human factors guidelines for aircraft accident investigation and reporting systems.
- Examine simultaneous non-interfering operations for visual flight rules (VFR) helicopter and fixed wing visual flight rules/instrument flight rules (VFR/IFR) to determine human performance implications.

Selection and Training

- Provide guidance to FAA Flight Standards for training regulations on simulator motion requirements for recurrent pilot training.
- Validate training guidelines for seldom practiced flight tasks.
- Develop training guidelines for flight deck error management.
- Distribute advanced analysis methods linking FOQA and simulator data.
- Develop materials to increase general aviation pilot skills to intervene in the causable chain of events leading to accidents.
- Develop proactive error avoidance and prevention strategies to reduce negative responses by aviation maintenance and inspection personnel whether by commission, omission, inadequate training, or timing.
- Demonstrate and validate the effectiveness of the MRM change program.
- Determine the application of military aviation maintenance training and experience based on FAA requirements.

FY 2002 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 on developing human factors tools to ensure that human performance considerations are adequately addressed in the design and certification of flight decks and equipment.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 137,980
FY 2001 Enacted	10,078
FY 2002 Request	9,906
Out-Year Planning Levels (FY 2003-2006)	42,067
Total	$ 200,031

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Flightdeck/Maint/System Integration Human Factors	10,365	8,497	6,289	7,016	6,617
Personnel Costs	1,814	1,940	2,367	2,283	2,398
Other In-house Costs	371	563	486	779	891
Total	**12,550**	**11,000**	**9,142**	**10,078**	**9,906**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	12,550	11,000	9,142	10,078	9,906
Development (includes prototypes)	0	0	0	0	0
Total	**12,550**	**11,000**	**9,142**	**10,078**	**9,906**

A08a - Flight-Deck/Maintenance/System Integration Human Factors Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
081-110 Flightdeck/Maintenance/System Integration Human Factors							
Selection and Training	$2,654						
Develop Automation Reconfigurable Event Sets		◆	◇	◇			
Provide Guidance for Simulator Motion Requirements		◆	◇	◇	◇		
Develop.Distribute Advanced Data Analysis Methods Linking FOQA and Simulator Data		◆	◇	◇	◇		
Develop Training Guidelines for Flight Deck Error Management		◆	◇	◇	◇		
Develop Materials to Increase General Aviation Pilot Skills to Intervene in Accident Chain to Events		◆	◇	◇	◇	◇	◇
Develop Error Avoidance Strategies in Aviation Maintenance and Inspection		◆	◇	◇	◇	◇	◇
Demonstrate and Validate Effectiveness of MRM		◆	◇	◇	◇		
Human Performance Assessment	$450						
Provide Expanded APMS Methodologies and Analysis Capabilities		◆	◇	◇	◇	◇	◇
Provide Guidance on Effectiveness of Realistic Radio Communications in Line-Oriented Evaluations		◆	◇				
Develop Improved Guidelines for Accident Investigations		◆	◇	◇			
Human Centered Automation	$1,806						
Provide Industry and FAA Guidance Addressing Training for Automated Cockpits		◆	◇	◇			
Complete Certification Job Aid Version 2.0/3.0 for FAR Part 25 Flight Deck Displays		◆	◇	◇	◇		
Develop Certification Guidelines for Integrated Technology in General Aviation Cockpits		◆	◇	◇			
Information Management and Display	$1,707						
Complete Software Tools for Enhanced Maintenance Documentation		◆	◇				
Complete Human Factors Design and Evaluation for Electronic Flight Bags, Version 2.0/3.0		◆	◇	◇			
Develop/Analyze General Aviation "head-up" Display Information/Symbology Recommendations		◆	◇	◇			
Address Human Factors Issues in Cockpit Head Motion Box in Air Transport "head-up" Displays; Complete Computational Model to Assess Information Accessibility		◆	◇	◇	◇	◇	
Determine Operational Criteria/Training Guidance for Night Vision Goggles in Rotorcraft Operations		◆	◇	◇			
Determine Information Requirements in Situational Awareness to Avert CFIT in General Aviation		◆	◇	◇	◇		
Define Display Location Boundaries that Correspond to Eye/Head Position for General Aviation Aircraft		◆	◇	◇			
Personnel and Other In-House Costs	$3,289						
Total Budget Authority	**$9,906**	**$10,078**	**$9,906**	**$10,146**	**$10,376**	**$10,656**	**$10,889**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A08b Air Traffic Control/Airway Facilities Human Factors

GOALS:

Intended Outcomes: The FAA intends to improve air traffic control safety by:

- Developing more effective methods for investigating, reporting, and analyzing operational errors and deviations.
- Developing human factors educational aids to mitigate runway incursions and underlying human performance issues.
- Developing human factors educational aids to mitigate controller fatigue resulting from shiftwork.
- Increasing human factors considerations in the acquisition and design of air traffic control automation systems.
- Improving techniques for identifying workforce requirements and selecting applicants for Air Traffic and Airway Facilities positions.

Agency Outputs: Human factors problems in today's operations involve human performance constraints and other complications that pose risk to the acquisition of Air Traffic Control (ATC) systems. The study of the relationship between shiftwork schedules and fatigue is identifying techniques for mitigating impacts on controller performance. Taxonomic analysis of operational errors is identifying improvements in how errors are investigated and reported, which in turn is leading to more effective safety interventions. Human factors research provides guidelines and other information for the design and development of ATC systems and product improvements. Tests and criteria for the selection of operational personnel improve applicant screening efficiency and validity.

Customer/Stakeholder Involvement: The ATC/Airways Facilities (AF) Human Factors Research Program Research Program is directly tied to the following ARA Safety Performance Goals:

Goal 1. *Aviation Safety:* Contribute to the FAA goal of reducing the fatal aviation accident rate 80% by FY 2007 as compared to 1994-1996 baseline data.

Goal 2. *Human Factors:* In support of FAA's performance goals, ARA will, by FY 2005, ensure human factors policies, processes, and best practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications. Two implementation strategies entail research on NAS integration and human error that contribute to acquisition programs and acquisition activities associated with the analysis, design, development, testing, deployment, and implementation of FAA systems and applications.

The ATC/AF Human Factors Research Program is the product of continued cooperation and collaboration between the Office of the Chief Scientific and Technical Advisor for Human Factors (AAR-100) and its customer base, the Air Traffic Requirements Service (ARS). The detailed research portfolio is coordinated with several organizational elements:

- Plans and Performance Directorate (ARX-20)
- Resource Management Program (AFZ-100)
- NAS Operations (AOP-30)
- Air Traffic Procedures (ATP-400)
- The Air Traffic Services Office of Evaluations and Investigations (AAT-20)

In addition, Integrated Product Teams in the Office of Communication, Navigation, and Surveillance Systems (AND), and the Office of Air Traffic Systems Development (AUA) share in identifying research requirements through AAR-100 representatives. Projects are coordinated with the Offfice of System Architecture and Investment Analysis (ASD-130).

Human Factors research is grounded in addressing issues that emerge from the FAA's Operations Concept for 2005. The program draws on the NAS Architecture Version 4.0 call for "a broad range of research activities regarding the implications of human factors." Research activities will develop the information necessary to understand human capabilities and limitations in each functional area. Human factors engineering will then be applied to identify and resolve risks, and to assess costs, benefits, and trade-offs.

The ATC/AF Human Factors Research Program is responsive to the recommendations of the congressionally-mandated Research, Engineering, and Development Advisory Committee (REDAC). The REDAC has recommended that the program concentrate its efforts on "broader, more fundamental issues: effects of stress with increased workload; introducing new systems in the heavily-loaded ATC environment; sharing responsibility between controller and pilot; and the human as a monitor of highly-automated systems."

Central to this research program is the joint FAA, NASA, and DOD *National Plan for Civil Aviation Human Factors: An Initiative for Research and Application*, published in 1995. This document outlines a coherent national agenda for human factors research and application leading to significant improvements in NAS safety and efficiency. Human factors research is organized around the following four thrusts:

- *Information Management and Display* - Determine what, when, and how one might best display and transfer information to system components; design the system to reduce the frequency of information transfer errors; and minimize the impact when such errors do occur.
- *Human-Centered Automation* - Keep the operator in-the-loop and situationally aware of automated system performance while balancing operator workload; resolve issues related to the degradation of basic skills should the automation fail.
- *Human Performance Assessment* - Identify the intrinsic characteristics of individuals and teams that determine how well they are able to perform tasks; characterize the impact of environmental and individual factors on human performance; and improve and standardize methods for measuring human performance.
- *Selection and Training* - Assess the knowledge and skills needed to excel in highly automated environments, including impacts of new technology.

Accomplishments: The program has supported the following research with resulting products:

Information Management and Display

- Standard Terminal Automation Replacement System (STARS) - Conducted comprehensive assessment of the STARS operational radar display and maintenance control workstations. A related initiative yielded a definitive process to integrate human factors in other NAS acquisitions.
- Guidelines on use of Color in ATC Displays – Provided Integrated Product Teams (IPT) reference guidance on the most effective uses for color coding operational information in new system displays.

Human-Centered Automation

- Flight Strip Studies – Identified operational functions in controller use of paper flight progress strips to support transition to Free Flight Phase 1 decision-support automation.
- Auditory Alarm Database – Developed database of alarms for use in the design of future AF alerting systems for centralized maintenance centers.

Human Performance and Assessment

- Air Traffic Control Specialist (ATCS) Shift Work Schedules – Completed first element of congressionally-mandated study through a survey addressing controller shiftwork, fatigue, and performance.
- Runway Incursion Human Factors Workshop – Completed workshop involving government, industry, and academic pespectives leading to the definition of research needs addressing performance risks and airport complexity factors.
- Flight Service Station Operational and Supportability Implementation System (OASIS) Study – Conducted virtual reality ergonomic evaluation of proposed workstations.
- Impact of Shared Separation on ATCS Situation Awareness – Conducted study of impacts from distributed air/ground separation responsibility on air traffic controller performance.
- Human factors booklet for controllers. This brochure provides controllers with helpful in-

formation about human factors they can use to enhance job performance.

- Report on the impact of airspace restructuring on air traffic controller performance.

Selection and Training

- Variable Item Generator (VIGOR) for Personnel Selection – Prototyped proof-of-concept computer tool to generate knowledge test items for screening applicants for Airway Facilities positions.
- Basic Electronic Screening Tool (BEST) – Developed screening test for selection of AF new hires, with an estimated savings of $3-5 million/year in reduced training costs.

R&D Partnerships: Coordinated research is conducted with NASA Ames in the areas of distributed air/ground separation responsibility and human error, and with the Naval Research Laboratory regarding enhanced vision technology for towers. Internationally, part of the joint FAA-EUROCONTROL Action Plan 12 for the management and reduction of human error involves harmonizing research methods for operational errors.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Information Management and Display

- Human Factors Design Guide (HFDG) – Update of the HFDG provides Integrated Product Teams with guidelines for effective human factors design of automation and communication/navigation/ surveillance technologies.
- Computer-Human Interface (CHI) Integration – Report for Integrated Product Teams on identified CHI inconsistencies between designs of legacy systems and anticipated product improvements and other subsystems to be integrated as part of NAS evolution.
- AF Visual Symbology – Report to AOP on human factors design guidance and CHI inconsistencies in the NAS Infrastructure Management System (NIMS).

Human-centered Automation

- Flight Strip Replacement – Assess controller operational requirements in use of paper flight progress strips in en route and approach transitions in support of Free Flight Phase 1 decision-support automation.
- Enhanced Vision Systems – Demonstration of enhanced vision technology under reduced visibility conditions to support tower controller information requirements.

Human Performance and Assessment

- Controller Alternative Work Schedules – Complete the second element of the Congressionally mandated study through field biomedical studies of controller work schedules and rest cycles.
- Runway Safety Booklet – Booklet of informative human factors information for controllers and pilots to help prevent runway incursions addressing communications, attention and memory, and threats to performance.
- Display System Replacement (DSR) Comparison - Report on comparison of task load and performance measures for pre- and post-DSR implementation.
- Sector Team Communications - Baseline assessment of sector team communication and controller coordination from transition to conflict probe.

Selection and Training

- Prototype Air Traffic Applicant Screening System – Development of a prototype biographical assessment tool for screening job applicants.
- Validation of Airway Facilities BEST – Completion of a formal BEST validation relative to available criteria to screen job applicants. The resulting screening tool could save $3-5 million/year in reduced training costs.

KEY FY 2002 PRODUCTS AND MILESTONES:

ATS-related research within the National Plan research thrusts include:

Information Management and Display

- CHI Integration – Detailed assessments of CHI inconsistencies between designs of en route and oceanic legacy systems and anticipated product improvements and other subsystems to ensure compatibility with design

guidelines and human performance considerations.

- Information management in AF systems - Assessment for improving information transfer and display to support system specialist and team performance in the AF environment.

Human-centered Automation

- Reduction in use of paper flight progress strips - Refinements to automation, procedures and training to facilitate reducing the operational need for paper flight progress strips will be developed.
- Situational awareness in centralized monitor and control - Determine what information and feedback is necessary for AF System Specialists to stay aware of automated processes in relation to workload, performance, and error mitigation.

Human Performance and Assessment

- Examination of causal factors related to operational errors - This project is targeted at reducing operational errors and deviations through the understanding and mitigation of causal factors.
- ATC sector teamwork and Collaborative Decision Making (CDM) - Assess how enhanced decision support and automated coordination tools affect intra- and inter-sector communications and coordination.
- Shift work and fatigue - This research will assess the fatigue countermeasure recommendations developed by the Scientific Steering Group as based on findings from the congressionally-mandated research on shift patterns.
- POWER task load and performance baseline assessments – Assess the utility of POWER's objective metrics to define and assess expert controller performance with baseline systems.
- Team processes in centralized monitor and control systems - Develop team and organizational guidelines to enhance effective team operations.
- Organizational assessment - Assess human factors issues and successful organizational practices in developing a Model Work Environment.

Selection and Training

- Develop and validate computerized application evaluation systems – Develop new, make technical enhancements, and continue longitudinal validation of screening and text tools for selection of applicants into ATC, En Route Traffic (ET), and Air Traffic Services (ATS) positions.
- Develop a prototype workforce analysis tool - This application will support the identification and analysis of gaps between current and future workforce skills and staffing profiles.

FY 2002 PROGRAM REQUEST

The FY 2002 program supports ATS with research to address human performance over the next several years. Research projects will focus on providing timely information to answer critical human factors questions.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 100,785
FY 2001 Enacted	7,982
FY 2002 Request	9,900
Out-Year Planning Levels (FY 2003-2006)	42,836
Total	$ 161,503

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Air Traffic Control/Airway Facilities Human Factors	5,454	5,711	1,661	2,277	4,156
Personnel Costs	3,773	3,117	5,034	3,984	4,071
Other In-house Costs	773	1,172	1,305	1,721	1,673
Total	**10,000**	**10,000**	**8,000**	**7,982**	**9,900**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	10,000	10,000	8,000	7,982	9,900
Development (includes prototypes)	0	0	0		0
Total	**10,000**	**10,000**	**8,000**	**7,982**	**9,900**

A08b - Air Traffic Control/Airway Facilities Human Factors Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
082-110 Air Traffic Control/Airway Facilities Human Factors							
Human Performance Assessment	$895						
Examination of Causal Factors Related to Operational Errors		◆	◇	◇	◇	◇	◇
Runway Safety Analysis and Guidance/Booklet		◆		◇			
Sector Team Communications		◆	◇	◇			
ATC Sector Teamwork and Communications		◆	◇	◇	◇	◇	◇
Controller Shift Work, Work Schedules, and Fatigue		◆	◇	◇			
POWER Task Load and Performance Assessment of the Display System Replacement		◆	◇	◇			
Team Processes in Centralized Monitor and Control Systems		◆	◇	◇	◇	◇	◇
Organizational Assessment		◆	◇	◇	◇	◇	◇
Integrate Human Performance Modeling		◆	◇	◇	◇	◇	◇
Human Centered Automation	$1,463						
Flight Strip Replacement and Electronic Flight Data		◆	◇	◇	◇	◇	◇
Enhanced Vision Systems		◆	◇				
Situational Awareness in Centralized Monitor and Control		◆	◇	◇	◇	◇	◇
Controller Decision Making		◆	◇	◇			
Information Management and Display	$1,298						
Human Factors Design Guidance		◆	◇	◇	◇	◇	◇
Computer-Human Interface Integration		◆	◇	◇	◇		
AF Information Display and Management		◆	◇	◇	◇	◇	◇
Selection and Training	$500						
Prototype Air Traffic Applicant Screening System		◆	◇	◇			
Validation of AF Basic Electronics Screening Tool		◆	◇	◇			
Develop and Validate Computerized Application Evaluation Systems		◆	◇	◇	◇	◇	◇
Prototype Workforce Analysis Tool Development and Analysis		◆	◇	◇	◇	◇	◇
Personnel and Other In-House Costs	$5,744						
Total Budget Authority	$9,900	$7,982	$9,900	$10,213	$10,528	$10,882	$11,214

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A08c Aeromedical Research

GOALS:

The FAA safety mission dictates that:

- Injury and death patterns in civilian flight accidents be investigated and meticulously analyzed to determine cause and prevention strategies.
- Recommendations for protective equipment and procedures be developed.
- Options be evaluated on behalf of FAA regulatory and medical certification staff charged with the proposal of safety and health regulations addressing all aircraft cabin occupants.
- Pilot, flight attendant, and passenger medical conditions be identified that are incompatible with in-flight physiological and performance demands – these conditions could exist either in the absence or the presence of emergency flight conditions. The resulting bioaeronautical data is to be effectively shared using advanced, user-friendly modeling and visualization technologies.

Intended Outcomes: The outcomes addressed by this research program are improved health, safety, protection, and survivability of aircraft passengers and aircrews. This research program identifies human tolerances, capabilities, and failure modes (physiological, psychological, and performance) both in uneventful flight, and during aircraft incidents and accidents. Formal recommendations for protective and supportive counter-measures and techniques are derived from in-house research.

The FAA is able to exploit new and evaluate existing bioaeronautical guidelines, standards, and models for aircraft cabin equipment, procedures, and environments. This work serves as a base for new regulatory action and the evaluation of existing regulations to enhance appropriate human performance at a minimum cost to the aviation industry. By reviewing pilot medical histories, flight histories along with information from accidents and incidents, existing and advanced biomedical criteria, standards and assessment/ certification procedures can be proposed to ensure optimal performance capability. By assessing pilot, flight attendant, air traffic controller, and passenger work, environmental, behavioral, and disease issues, guidelines for actions to improve the health and safety of the aircraft occupant can be proposed based on rigorous scientific criteria.

Agency Outputs: The program has developed the following guiding principles to support regulatory and certification processes:

- Quantitative bioengineering criteria to support optimum aircraft seat and restraint system certification.
- Quantitative biomedical and performance criteria to support protective breathing equipment, emergency medical equipment, and operational procedures certification.
- Quantitative bioaeronautical criteria to support flotation and onboard life support/rescue equipment certification.
- Quantitative biomedical and performance criteria to support development of optimum protective breathing equipment, emergency medical equipment, and operational procedures certification.
- Identification of biomedical/toxicological factors in aviation incidents and accidents.
- Recommendations for aircrew medical criteria, standards, assessment/certification procedures, and special issuance.
- Quantitative data about the occupational health risks of flight attendants to support regulatory oversight.
- Quantitative data about passenger behavior and health to support regulatory oversight.
- Quantitative data about the aerospace radiation environment and its threats to aircraft occupants.

Customer/Stakeholder Involvement: This program contributes to meeting the FAA Strategic Plan Mission Goal for Safety and ARA FY 2000 Performance Plan Goals for Safety and Human Factors. The program provides the primary bioaeronautical research called for in the *National Plan for Civil Aviation Human Factors*. [Note: The subject of this research is defined as the bioengineering, biomedicine, and biochemistry issues associated with safety and performance.]

This program contributes significantly to the application of emerging technologies, as highlighted in the 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 that was 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 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 (CAMI), the FAA Administrator announced in FY 2000 the Agency's intention to proceed with regulations for the requirements concerning the performance and use of child restraints in aircraft. Standards and test criteria developed at CAMI are currently being considered for adoption by the Society of Automotive Engineers (SAE). Specialized quantitative crashworthiness assessments for aircraft continued, inclusive of side-facing aircraft seats, and included the use of new state-of-the-art anthropomorphic test dummies with enhanced injury assessment capabilities.

Data are 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 bioaeronautical roles in accident/incident causation. Specialized clinical evaluations have been applied to cases associated with aircraft decompression. Medical and other factors indicative of pilot incapacitation and inability to perform optimally are under continuous evaluation. To promote radiation safety in civil aviation, instructional materials on radiation exposures in-flight were provided to the aviation industry.

R&D Partnerships: In addition to the previously described partnerships (e.g., FAA/JAA/TCA; FAA/NIOSH), academic, industrial, and other governmental coordination and cooperation are maximally leveraged in all research activities. 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 (ASHRAE) 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 is maintained with the all military branches either through direct project collaboration (e.g., crashworthiness, aerospace medicine, eye injury from lasers, exposure to cosmic radiation), through participation in the North Atlantic Treaty Organization aerospace medical advisory groups, the European Union, or collaborations in scientific organizations.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS

The following program results have been achieved or are expected to be achieved in FY 2001:

- Performed epidemiological assessment of biochemical and toxicological factors from fatal civilian aviation accidents.
- Assessed the results of automatic external defibrillators on commercial aircraft.
- 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).
- Identified key factors affecting safety associated with child restraints in aircraft.
- Developed a performance-based standard for Crew Protective Breathing And Vision Equipment (CPBVE).
- Proposed changes to regulations for operational aviation hazards of laser exposure to humans.

KEY FY 2002 PRODUCTS AND MILESTONES

- The following program results are being scheduled in FY 2002:
- Develop medical data that will support aeromedical certification aimed at reducing in-flight sudden/subtle incapacitation.
- Evaluate autopsy data from fatal aviation accidents to determine protective equipment and design practices and aircrew medical certification standards.
- Provide guidelines for aircraft cabin occupant health maintenance, including verifying the CARI-6 radiobiologic computer program that covers large solar particle events.
- Assess optimum wide-body exit distribution and access using the 747 evacuation simulator (if simulator construction is completed.)
- Develop improved fit and comfort standards for oxygen mask systems.
- Evaluate pilot reported medication usage with actual toxicology findings to detemine the accuracy of self reporting.
- Evaluate the safety record of pilots with a Statement Of Demonstrated Ability (SODA) in support of aeromedical certification standards.

FY 2002 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 or risks.

Ongoing research projects will:

- Support safer aircraft cabin evacuation approval guidelines and safer field applications under routine and emergency operational conditions.
- Reduce head, neck, torso, and extremity injuries in aircraft crash environments.
- Evaluate trends in toxicological, biochemical, physiological, and clinical findings from all major civil aviation aircraft crashes.
- Assess guidelines for aircraft cabin crew and passenger environmental management.
- Assess performance of new cabin aisle marking systems for use during emergencies.
- Assess effectiveness of new programs dedicated to the enhancement of passenger performance in emergencies.
- Evaluate the use of Automatic External Defribrillators (AED) and make rulemaking recommendations.
- Evaluate in-flight use of medical kits and determine the adequacy of those kits.
- Track special medical issuance pilots to evaluate relative risk and the continuance of specific aeromedical certification standards.
- Provide recommendations for limits to radiation exposure (laser and ionizing).

- Develop an advanced aeromedical research accident database that is user friendly, has rapid response, and produces advanced statistical and graphics analysis.
- Develop dynamic modeling capabilities in support of cabin safety research, biodynamic protection/ survivability research arnd aircraft accident investigation research.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 71,616
FY 2001 Enacted	5,987
FY 2002 Request	6,121
Out-Year Planning Levels (FY 2003-2006)	27,161
Total	$ 110,885

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Aeromedical Research	0	313	394	938	491
Personnel Costs	3,320	3,155	3,858	3,893	4,268
Other In-house Costs	680	597	577	1,156	1,362
Total	**4,000**	**4,065**	**4,829**	**5,987**	**6,121**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	4,000	4,065	4,829	5,987	6,121
Development (includes prototypes)	0	0	0	0	0
Total	**4,000**	**4,065**	**4,829**	**5,987**	**6,121**

A08c - Aeromedical Research Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
086-110 Aeromedical Research							
Cabin Health and Environmental Guidelines	$0						
Assessed of Aircrew Health Risks During a Flying Career		◆	◇	◇	◇	◇	◇
Model of Disease Transmission in Aircraft Cabins			◇	◇	◇		
Human Protection/Survival in Civil Aviation	$175						
Analyze the Suitability for Component Tests as an Alternative for Showing Regulatory Compliance with Crashworthiness Standard for Aircraft		◆	◇	◇	◇	◇	◇
Assess Impact Protection Performance of Aircraft Seating Systems, Including Child Restraints		◆	◇	◇	◇		
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 Subjects		◆	◇	◇	◇	◇	
Development of Improved Oxygen Mask Fit, Comfort, and Performance Standards		◆	◇	◇	◇	◇	
Analyzed the Influence of Cabin Crew Duty Stations on Evacuation Performance of Passenger Aircraft in Panic Situations		◆	◇	◇			
Develop Dynamic Modeling Capabilities in Support of Cabin Safety, Protection, and Aircraft Accident Research			◇	◇	◇	◇	◇
Medical/Toxicology Factors of Accident Investigations	$316						
Perform Epidemiological Assessment of Toxicology Factors from Fatal Civilian Aviation Accidents		◆	◇	◇	◇	◇	◇
Develop Guidelines to Reduce In-Flight Sudden/Subtle Incapacitation		◆	◇	◇	◇		
Evaluate Autopsy Data from Fatal Aviation Accidents to Determine Protective Equipment and Design Practices		◆	◇	◇	◇	◇	◇
Develop Biochemical Tests to Distinguish between Ingested and Post-Mortem Alcohol		◆	◇	◇	◇		
Develop Instructional Material on the Radiation (Cosmic and Visual) Environment during Air Travel		◆	◇	◇	◇	◇	◇
Survey of In-Flight Medical Emergencies and Defibrillator Usage on Commercial Airline Flights		◆	◇	◇	◇		
Determine an Advanced Aeromedical Accident Research Database			◇	◇	◇	◇	◇
Personnel and Other In-House Costs	$5,630						
Total Budget Authority	$6,121	$5,987	$6,121	$6,378	$6,644	$6,925	$7,214

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

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2.6 Environment And Energy Program Area Description

Mission

The 1995 “National Science & Technology Council Report, Goals for a National Partnership in Aeronautics Research and Technology,” predicted that: "Environmental issues are likely to impose the fundamental limitation on air transportation growth in the 21st century." Thus, the scientific assessment and development of safe and affordable options for mitigating the impacts of aircraft noise and emissions are important not only to protect the environment but also to sustain the growth of aviation. In response, the FAA 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

Through an optimal mix of aircraft and engine certification standards, operational procedures, compatible land use, and abatement technology, the FAA intends to minimize the global, regional, and local impact of aircraft noise and exhaust emissions.

Program Area Outputs

FAA aviation environmental research produces:

- Guidance for 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, and composed of the following major elements:

- Aircraft noise control
- Engine exhaust emissions control
- Aviation noise analysis
- Aviation emissions analysis

These topics form a cohesive system of research projects that support federal actions to identify, control, and mitigate the environmental consequences of aviation activity.

Customer and Stakeholder Involvement

To mitigate potential adverse impacts to the environment, the FAA works closely with other federal agencies, industry, and foreign governments through a unified regulatory-R&D approach 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. The agency utilizes the following arenas to promote 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's recommendations, advice, and information applicable to 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 inconsistent standards in participating countries.

The International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) — a standing committee that establishes and assesses the adequacy of international aviation environmental standards, especially in the areas of aircraft noise and engine exhaust emissions. The FAA participates as the United States member along with representatives of other civil aviation authorities and observers from aviation industry.

The Federal Interagency Committee on Aviation Noise (FICAN) — a permanent body that conducts annual public forums in different geographic regions of the nation to solicit general input on aviation noise. FICAN was established by the FAA and other federal agencies with ongoing interests in better aligning R&D with the public's concerns.

Accomplishments

In recent years, the program has produced the following:

- Six reports to Congress on the annual progress of the FAA/NASA subsonic jet noise research program.
- 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 $1.3 billion in airport noise compatibility grants.
- Five public forums on aviation noise research in Atlanta, Minneapolis, San Diego, Seattle, and Washington. Public participation has resulted in four FICAN annual reports, one report on federal aviation noise research projects, a report to Congress on the effects of aircraft noise, a federal finding on the relationship between aircraft noise and sleep awakenings, and various new federal research projects on commuter airplane noise impacts and the influence of ambient noise on community annoyance.
- Publication of a study conducted to assess the impact of NAS modernization on aircraft emissions.
- Development of Advisory Circular (AC) 34-1, which is a companion document to the regulation, 14 CFR part 34, that specifies acceptable processes and procedures to be used to implement the regulation.
- Development of the FAA Aircraft Engine Emission Database (FAEED).
- Contributions to the publication of the Intergovernmental Panel on Climate Change (IPCC) special report on Aviation and the Global Atmosphere.
- An aircraft overflight noise exposure prediction model for Grand Canyon National Park.
- A new aircraft noise and performance database for use in FAA's Integrated Noise Model (INM).
- A new Advisory Circular containing guidance on the procedures to demonstrate compliance with aircraft noise standards.
- Harmonization of the FAA jet noise certification regulations with those of the European Joint Aviation Authorities.

R&D Partnerships

FAA participates with others in the aviation community in the following joint R&D efforts:

- A series of Memorandums of Understanding enabling the FAA to work with NASA and U.S. industry to identify source noise and emissions abatement technologies.
- Collaboration with the EPA, NASA, industry, and academia to assess the local and global impacts of aircraft engine exhaust emissions.
- Support of the Volpe National Transportation Systems Center's (VNTSC) continuing efforts to provide substantial technical assistance in aircraft noise measurement and assessment.

In addition to the FAA, the U.S. Air Force, the U.S. Army, the U.S. Navy, the Department of Interior, the Department of Transportation, the U.S. Environmental Protection Agency, NASA, and the Department of Housing and Urban Development participate on FICAN, the recognized forum for partnership among all federal agencies concerned with aviation noise. FICAN has led to expanded coordinated and cooperative research efforts among the individual agencies and, thus, results in more efficient use of federal funds. Agencies have signed a letter of understanding formally documenting their participation on the committee and defining its purpose, scope, membership, process, and products.

Long-Range View

Planning for environmental research needs requires a look at key indicators. These are generally described as driving forces for change, targets of opportunities, or future (environmental) threats. Some key indicators that may influence aviation environmental research include:

- Scientific findings
- Air transportation growth

- New aviation technologies
- Increased globalization of aviation
- Reduced federal resources

FAA predicts steady growth of the demand for aviation services through the first decade of the new millennium. The growth in aircraft operations required to meet this demand will result in increased environmental impacts and thus create barriers to further growth.

The key to successful environmental planning is to identify operational mitigation options for those sectors of the growing aviation markets that are most likely to reach environmental critical mass. The FAA will need to continue to determine where best to target its research to achieve noise mitigation.

Major NASA aeronautics research programs, most notably the AST program, have come to an end. Several technologies from these NASA research programs will enter the marketplace within 10-15 years for use by U.S. industry in the next generations of aircraft. With the end of the AST program, FAA will close its companion research program on subsonic noise reduction. The agency will use its research findings to consider 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 toward other research programs and emphasize rotorcraft and general aviation, but also begin a collaboration with the new NASA Quiet Aircraft Technology program.

The solution to controlling the environmental consequences of new aircraft technologies is through a coordinated regulatory and R&D approach involving the FAA with other federal agencies, such as EPA, NASA and DOD, from the early stages of the technology research. While human (animal) behavioral research is generally not the responsibility of the FAA, the agency must devote research resources to apply pertinent scientific findings on environmental impacts into federal guidance and policy.

Technologies, such as the Global Positioning System (GPS), are already beginning to have a profound effect on the aviation system. As these technologies are being introduced to improve system efficiency and flexibility, a new FAA paradigm is emerging under the general term, “Free Flight.” As the FAA builds more user flexibility into the NAS, the agency must expand the current suite of environmental analysis tools in all domains to determine the likely environmental impacts and improvements stemming from its support of Free Flight.

The findings of earlier FAA and NASA scientific studies have now been incorporated in the IPCC “Special Report on Aviation and the Global Atmosphere,” and ICAO is studying measures for reducing greenhouse gas emissions, as well as emissions that affect local air quality.

As stated in FAA's 1998 Strategic Plan, "The globalization of aerospace, U.S. business, and travel is another factor driving change." FAA must plan research efforts to support continued international harmonization and standardization of the aviation environmental certification standards and procedures.

The prospect of reduced resources has driven FAA to reorganize and streamline in order to operate more productively and to identify mission-critical services. Historically, environmental research has accounted for only about 2% of the R,E&D budget. Funding constraints and further reductions are expected to continue to put a premium on identifying the research projects that are critical to FAA's environmental mission. FAA must continually assess the situation in order to effectively target its diminishing resources. Projects that will best address the agency's prime environmental responsibilities through the promulgation of new or improved aviation environmental standards must be given top priority.

To more effectively channel the diminished research resources, FAA sponsored the Aviation Environmental Research Beyond 2000 project. Through a series of public meetings and workshops, FAA identified environmental issues and needs that could be addressed through research. The proposed FY 2002 research program addresses the R&D effort to support an effective environmental mitigation strategy and to identify the best approaches for addressing current environmental concerns.

A09a — Environment and Energy

GOALS:

Intended Outcomes: The FAA intends to:

- Optimize the mix new aircraft certification standards, operational procedures, compatible land use, and abatement technology in order to prevent any increase in the impact of aircraft noise upon the population exposed to Day/Night operating conditions. Through previous actions, the FAA reduced this impact by 80 percent from the 1992 Level (65dB).
- Define and minimize the impact of aircraft emissions, through an optimal mix of new aircraft certification standards, operational procedures, and abatement technology.
- Improve analytic and planning tools in order to provide a better understanding of aviation's enviromental impacts, and give insight into the consequences of alternative courses of action.

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 aircraft noise and engine exhaust emissions.
- Technical reports, handbooks, Advisory Circulars (AC), 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 R&D approach—working closely with other federal agencies, industry, and foreign governments—to guide R&D efforts into the impact of aviation upon the environment. Lessons learned from this research identify and shape technologies, regulations, and certification criteria that offer 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, advice, and information to be considered in the full range of FAA rulemaking activities. ARAC harmonization working groups have been tasked to ensure that the aircraft noise certification regulations that 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 the aviation industry. The purpose of CAEP is to establish and assess the adequacy of international aviation environmental standards, especially in the areas of aircraft noise and engine exhaust emissions standards.

The 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 (GA) action plan in demonstrating noise abatement technologies for light propeller driven airplanes.

Accomplishments:

- Produced reports to Congress—
  - Report on quiet aircraft technology for light propeller driven airplanes and helicopters. The finding of this report has led to a joint FAA/NASA research project on general aviation noise.
  - Report on the effects of aircraft noise.
  - Five reports on the annual progress of the FAA/NASA subsonic jet noise research program.
- Developed advanced computer models—Used for airport and heliport noise analysis.

Have resulted in over 1000 copies sold around the world. In the United States, these models have been used in over 160 airport studies involving more than $1.3 billion in airport noise compatibility grants. This program has also produced an aircraft overflight noise exposure prediction model for Grand Canyon National Park.

- Public forums on aviation noise research:
  - Atlanta
  - Minneapolis
  - San Diego
  - Seattle
  - Washington, DC
- Special reports and findings:
  - Four FICAN annual reports
  - One report on federal aviation noise research projects
  - One federal finding on the relationship between aircraft noise and sleep awakenings

Funding has also led to enhancements to the computer model used for airport air quality analysis and formal acceptance by the Environmental Protection Agency (EPA) as a preferred guideline mode, EPA's highest ranking, and to the development of a handbook on the procedures for airport air quality analysis for use by civil and military aviation authorities. Standardizing the civilian and military analytical procedures will improve the quality of environmental assessments that are reviewed by the Federal Government.

R&D Partnerships: The FAA works closely with NASA through a series of Memorandums of Understanding to identify source abatement technologies. The FAA also participates with NASA, industry, and academia to assess the possible global impact of aircraft engine exhaust emissions. The Volpe National Transportation Systems Center (VNTSC) 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 2001 ACCOMPLISHMENTS:

Aircraft noise reduction and control

- Submitted final report to Congress on the joint FAA/NASA subsonic jet noise reduction technology program.
- Harmonized FAA helicopter noise certification regulations with those of the European Joint Aviation Authorities that govern the procedures used by airframe manufacturers.

Engine emissions reduction and control

- Updated the FAA Engine Exhaust Emissions Database to be consistent with the ICAO databank.
- Continued to examine alternative, simplified engine exhaust emissions measurement procedures to reduce manufacturers certification test costs.
- Published the FAA Advisory Circular (AC) 34-1, including field practices and technical guidance related to engine emissions certification.

Aviation environmental analysis

- Released Integrated Noise Model (INM) Version 6 for use in airport noise assessments.
- Completed the first phase of the validation of the Grand Canyon National Park aircraft overflight noise model.
- Continued to examine and validate methodologies used to assess aircraft noise exposure and impact.
- Finalized the release of the new Emissions And Dispersion Modeling System (EDMS) version 4.0, including new dispersion algorithms, airplane performance data, and updated databases for aircraft engine and ground support equipment (GSE).
- Initiated development of the prototype modeling System For Assessing Aviation Global Emissions (SAGE).

KEY FY 2002 PRODUCTS AND MILESTONES:

Aircraft noise control

- Publish an update of the noise certification handbook (replacement for AC 36-4).

Engine emissions control

- Develop harmonized, simplified engine exhaust emissions certification test procedures and technical guidance materials that will increase efficiency and reduce costs of the tests.

Aviation noise analysis

- Continue to examine and validate methodologies used to assess aircraft noise exposure and impact.

Aviation emissions analysis

- Continue to examine and validate methodologies used to assess aviation emissions and their impact on air quality.
- Complete development of the prototype SAGE model for assessing aviation's global emissions.

FY 2002 PROGRAM REQUEST:

Major NASA aeronautics research programs have come to an end. Several new source technologies will emerge from NASA's research. This will be the basis, in five to seven years, for the next generation of U.S. industry aircraft. The FAA will close its companion research program on subsonic noise reduction and use its research findings to identify new environmental certification standards and procedures for the next generation of transport aircraft. The FAA will shift future environmental research towards development of new and of improved computer models that will be used to assess aircraft noise, local air quality, and global climate change. In accordance with the National Environmental Policy Act, the FAA must consider and mitigate the environmental consequences of its actions. A variety of methodologies and research are necessary to support and properly assess the environmental impact of aviation. The objective is to enhance and advance computer modeling techniques to better estimate environmental impacts. The FAA will continue to work with NASA, the manufacturing industry, and foreign authorities to provide technical support for development and implementation of aircraft environmental certification regulations through proactive response to changes in technology, measurement/analysis technology, regulatory policy, and international regulatory initiatives.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 54,254
FY 2001 Enacted	3,473
FY 2002 Request	7,602
Out Year Planning Levels (FY 2003-2006)	31,986
Total	$ 97,315

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Aircraft Noise Control	2,035	1,307	1,329	678	1,241
Engine Exhaust Emissions Control	233	400	900	55	688
Aviation Environmental Analysis	623	532	627	2,060	0
Aviation Noise Analysis	0	0	0	0	2,727
Aviation Emissions Analysis	0	0	0	0	1,330
Personnel Costs	0	607	589	653	1,432
Other In-house Costs	0	45	36	27	184
Total	**2,891**	**2,891**	**3,481**	**3,473**	**7,602**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	2,891	2,891	3,481	3,473	7,602
Development (includes prototypes)	0	0	0	0	0
Total	**2,891**	**2,891**	**3,481**	**3,473**	**7,602**

A09a - Environment and Energy Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
091-110 Aircraft Noise Reduction & Control							
Reduction Technology, Certification Standards & Procedures	$1,241						
Harmonized FAA/European Noise Certification Regulations		◆					
Report to Congress on FAA/NASA Subsonic Jet Noise Reduction Research		◆	◇				
Final Assessment of FAA/NASA Light Propeller-Driven Airplane Noise Reduction Technology Research		◆					
Publish Advisory Circular (AC) 36-4d		◆			◇		◇
New Noise Standard for Large Subsonic Airplanes				◇			
Complete Rulemaking to Amend Helicopter Certification Requirements in 14 CFR Part 36					◇		
091-111 Engine Emissions Reduction & Control							
Engine Exhaust Emissions Reduction Technologies, Standards and Procedures, and Impact Assessments	$688						
Updated the FAA Engine Exhaust Emissions Databank to be Consistent with the ICAO Data Base			◇		◇		◇
Assessment of ICAO Emission Standards Taking into Account the Required Technological and Scientific Bases						◇	
Develop a Harmonized, Simplified Engine Exhaust Emissions Certification Test Procedure		◆					◇
Complete Development of Advisory Circular 34-1A, Including Harmonization of Regulatory and Guidance Material Differences with the European Joint Aviation Authorities				◇			◇
Update Certification Regulation and Guidance Document, AC 34-1, for Consideration of Climb/Cruise Conditions							◇
091-114 Aviation Noise Analysis							
Develop Noise Assessment Methodologies	$2,727						
Released Integrated Noise Model (INM) Version 6		◆					
Completed the First Phase of the Validation of the Grand Canyon National Park Aircraft Overflight Noise Model		◆					
Validation of the Methodologies Used to Assess Aircraft Noise Exposure and Impact			◇		◇		◇
Release INM Version 7						◇	
New Helicopter Modeling Methodology and Expanded Helicopter Database					◇		
091-115 Aviation Emissions Analysis							
Develop Air Quality Assessment Methodologies	$700						
New Emissions and Dispersion Modeling System		◆	◇			◇	
Publish Revised Handbook on Procedures for Airport Air Quality Analyses			◇				◇
Draft Guidance Document for Reducing Emissions from Ground Support Equipment and Auxiliary Power Units			◇				
Develop Global Emissions Assessment Methodologies	$630						
Complete Prototype Model-System for Assessing Aviation's Global Emissions (SAGE)			◇				
Forecast of National and Global Emissions Burden					◇	◇	
Personnel and Other In-House Costs	$1,616						
Total Budget Authority	**$7,602**	**$3,473**	**$7,602**	**$7,758**	**$7,903**	**$8,091**	**$8,234**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

2.7 Commercial Space Transportation Program Area Description

Mission

The overall mission of Commercial Space Transportation (AST) is to protect public health and safety, the safety of property, and U.S. foreign policy and national security interests; to encourage, facilitate, and promote U.S. commercial space launches; to enhance the international competitiveness of the U.S. commercial space transportation industry; to ensure compliance with international obligations of the U.S., and to facilitate new or improved U.S. space transportation infrastructure. AST continuously seeks to improve its services by undertaking initiatives to meet current and future demands.

AST has recently joined the R&D Executive Board in order to facilitate two-way synergies between the aviation and space transportation research programs of the FAA. The proposed AST R&D program is an initiative to provide structured and evolutionary services that keep pace with the global growth incommercial space transportation. The program's mission is to develop technology, practices, processes, and procedures that will continually improve the delivery of AST services.

Intended Outcomes

The AST R&D program is the nation's primary vehicle for anticipating the evolution of a rapidly changing global industry. It applies stable, and minimal regulation fairly and expeditiously to help achieve, not only the AST mission, but also the FAA safety and system efficiency goals. The program contributes to the performance outcomes described below and represents increased value to the American public.

Space Transportation Vehicle Safety

The primary AST mission is to protect public health and safety and safety of property. Together with with many federal and state agencies, the U.S. commercial space transportation industry is developing advances in vehicle technology and in associated infrastructure. The program plans and develops regulations, guidance, licensing approaches and methods to assess the safety of evolving space transportation vehicles. Since some new vehicles are likely to have some aircraft-like characteristics, AST intends to work closely with the aviation lines of business to develop these approaches and methods. Partnerships are developing in the areas of Evolved Expendable Launch Vehicles, Reusable Launch Vehicles, and spaceports that can accommodate new or improved vehicles. The cooperative development and deployment of safe, capable, operable, reliable, and economical space transportation vehicles will enhance the international competitiveness of U.S. providers.

Space Transportation Infrastructure

A number of State agencies and private companies are planning to develop new or improved space transportation infrastructure to accommodate new space transportation vehicles. Some of these efforts also involve DOD or NASA, agencies which have generally constructed, owned, and operated a U.S space transportation infrastructure. FAA will need to play an increasingly important role, however, in protecting public health, safety, and the safety of property – especially at those sites where DOD and NASA have little or no involvement. Accordingly, AST will work to enhance its ability to assess safety of operations at non-Federal space launch and landing sites.

Space and Air Traffic Management System

In order to accommodate increasing numbers of launches and landings of space vehicles at increasing numbers of sites, AST is cooperating with ATS in the development of an integrated Space and Air Traffic Management System (SATMS). This system will help to manage our airspace to accommodate vehicles traveling to or from space in safe, efficient combination with other aircraft. AST has already prepared an initial Concept of Operations and has refined it to reflect public comments. AST will undertake to develop a detailed SATMS plan, based on the work already completed.

Programs Area Outputs

The developmental outputs of the proposed AST R&D program vary in composition among operational concepts; modeling and simulation

studies; emergent technology evaluations; and procedures, standards, and guidance. Some specific examples of expected outputs from the AST R&D Program include:

- Protect Public Health and Safety and Safety of Property – The U.S. commercial space transportation industry has experienced no fatalities, serious injuries, or significant property damage. AST seeks to contribute to the continuation of this exemplary record.
- Enhance the International Competitiveness of the U. S. Commercial Space Transportation Industry – AST regulates commercial space launches, reentries, landings, and sites only to the extent necessary to protect public health and safety and the safety of property.

Program Area Structure

The proposed AST R&D program is structured to systematically encourage, promote, and facilitate the U.S. commercial space transportation industry while enhancing the International Competitiveness of the U.S. Commercial Space Transportation Industry.

The program strives to make the most effective and efficient use of available R&D resources in order to benefit U.S. commercial space transportation providers; the producers, owners, and operators of U.S. satellites; and the American public.

Customer and Stakeholder Involvement

The AST R&D program reaches and supports a broad spectrum of the space transportation community. The primary example of customer and stakeholder involvement is the Commercial Space Transportation Advisory Committee (COMSTAC). The full committee and its working groups on Technology and Innovation, Launch Operations and Support, Reusable Launch Vehicles, and Risk Management include senior executives from U.S. commercial space transportation entrepreneurial firms; large aerospace companies; the developers and providers of reusable and expendable launch vehicles; representatives of the satellite, space insurance, space law, and space finance industries; state government officials; and space advocacy organizations. COMSTAC has assisted AST in developing commercial launch forecasts and in reviewing the concept of operations for the Space and Air Traffic Management System.

Accomplishments

AST has yet to participate officially in the R&D program. The following is a partial listing of recent past accomplishments of the existing AST Operations and Research program:

- Developed a Concept of Operations for an integrated Space and Air Traffic Management System.
- Developed criteria for RLV Operations and Maintenance.
- Developed criteria for space medical standards affecting passengers and/or crew.

R & D Partnerships

The AST Operations research program has established partnerships with diverse U.S. and international agencies, organizations, institutions, and industrial groups. A list of some recent and current partnerships follows:

- U. S. Government Agencies
  - Department of Commerce
  - Department of Defense
  - Department of State
  - Federal Communications Commission
  - National Aeronautics and Space Administration
  - National Oceanic and Atmospheric Administration
- International Organizations
  - International Maritime Satellite Organization
  - International Telecommunications Satellite Organization
  - United Nations Committee on the Peaceful Uses of Outer Space
- Academic Institutions
  - International Space University
  - Massachusetts Institute of Technology
  - Virginia Polytechnic Institute and State University
- Non-Profit Organizations

  - RTCA Inc.
  - Commercial Space Transportation Industry
  - Space Transportation Association
  - Satellite Industry
  - Satellite Industry Association
- Industry Groups
  - Aerospace Industries Association
  - American Institute for Aeronautics and Astronautics

Long-Range View

The essence of the proposed AST R&D program is to maintain a long-range view of the research requirements for safe, capable, operable, reliable, and economical space transportation provided by the U. S. private sector. As the newest mode, commercial space transportation is now – and is likely to remain for some time – a research-intensive industry. Technological advances in expendable and reusable launch vehicles, as well as increasing numbers of launches and launch sites, will require increasing attention to research.

Commercial Space Transportation Safety

GOALS:

Intended Outcomes:

Commercial Space Integration into the NAS

The FAA intends to investigate and analyze means to integrate commercial space transportation operations seemlessly into the National Airspace System (NAS) in order to minimize impacts on overall NAS efficiency. Specifically, the FAA's Space and Air Traffic Management System initiative, as led by the Commercial Space Transportation (CST) line of business, seeks to examine methods to integrate new spaceport and vehicle operations in the NAS in a safe and efficient manner.

Reusable Launch Vehicles Operation and Maintenance

The FAA intends to investigate and analyze standards and processes applicable to commercial Reusable Launch Vehicle (RLV) Operations and Maintenance (O&M) activities to ensure these activities are conducted with adequate protection of public safety. A thorough review of the Space Shuttle operations and maintenance activities will be conducted to determine the "best practices" used by the world's only reusable launch vehicle and their applicability to commercial RLV O&M activities. The FAA will also study the airline industry to determine which "best practices" and "lessons learned" from the aircraft industry could be applicable to commercial RLV activities in terms of their operations and maintenance activities and the effects on safety.

Criteria for Determining "Unproven" vs. "Proven" RLVs

The FAA intends to improve public safety regarding the operation of unproven and proven commercial RLVs by the development of criteria that formulate a basic methodology to assist in the determination of when an RLV progresses from an "unproven" to "proven" status. The major objectives of this program are to:

- Continue public safety that is associated with RLV activities by providing additonal criteria for the safe operation of RLVs.
- Ensure that for proven RLV the projected instantaneous impact point (IIP) for any RLV mission or reentry shall not have substantial dwell time over densely populated areas.
- Ensure that for unproven RLVs:
  - The projected instantaneous impact point (IIP) of the vehicle does not have substantial dwell time over populated areas; or
  - The expected average number of casualties to members of the public does not exceed 30×10^{-6} ($E_c \leq 30 \times 10^{-6}$) given a probability of vehicle failure equal to 1 ($p_f=1$) at any time the IIP is over a populated area.
- Provide criteria that can be used to assist in judging the public safety relevance of methodologies associated with proven RLV.

Reetry Vehicle Maneuverabililty and its Effect on Public Safety

The FAA intends to improve public safety regarding reentry of RLVs and reentry vehicles (RV) by understanding the safety issues associated with the level of maneuverability of the vehicle reentering earth. The foremost issue is the differentiation between maneuverable and non-maneuverable reentry vehicles. Although many trajectory analyses should be performed for both maneuverable and non-maneuverable RVs/RLVs, the results of the analyses and their relative importance toward public safety may differ greatly depending upon the maneuverability capability of the vehicle. The major outcomes from this program include:

- Continue improvement of public safety from RLV activities.
- Refine the RLV regulations to improve public safety and keeping with development of regulations that are not overly burdensome.
- Establish guidance and understanding of a vehicle's reentry 3σ left and right, minimum, and maximum Instantaneous Impact Point (IIP) trajectories that will indicate where a non-maneuverable vehicle will start its landing cycle (i.e., deploy its parachute) and land.
- Establish guidance and understanding of a maneuverable vehicle's reentry 3σ limiting

trajectories and the "maneuverability landing-ellipse" for the vehicle.

- Develop criteria that address maneuverable vehicles landing ellipse borders defined as a group of termination (impact) points for trajectories from which the vehicle could still maneuver sufficiently to attain a nominal landing location.
- Determine what trajectory information would be required to evaluate non-maneuverable and maneuverable RLVs/RVs.

Agency Outputs:

Commercial Space Integration into the NAS

- Develop a study of launch/reentry impacts from Kennedy Space Center on air traffic.
- Investigate policy options for improving "user access" to airspace.
- Develop a Spaceport Simulation and Assessment Model (SSAM).

Reusable Launch Vehicles Operation and Maintenance

The FAA establishes licensing criteria for reusable launch vehicle activities and Advisory Circulars (AC) to provide guidance for meeting these rules. The results of these commercial RLV O&M studies will be utilized to provide inputs to a draft Notice of Proposed Rule Making (NPRM) for commercial RLV operations and maintenance.

Criteria for Determining "Unproven" vs. "Proven" RLVs

FAA maintains public safety affiliated with RLV launch and reentry activities by the development of regulations that identify the requirements for safe RLV operations. FAA published on September 19, 2000, the following documents that are related to RLVs:

- Commercial Space Transportation Reusable launch Vehicle licensing regulations.
- Advisory Circular 431.35-1: Expected Casualty Calculations for Commercial Space Launch and Reentry Missons.
- Advisory Circular 431.35-2: Reusable launch and Reentry Vehicle System Safety Process.

This research program provides the resources to address the concerns regarding how to determine when an RLV is a proven vehicle. To establish that an RLV has been proven is highly depended upon such issues as the vehicle design, launch environment, ascent and decent environment, operational process, and test programs (vehicle and operations). Furthermore, it may not, at this time, be beneficial to develop a set of requirements that could be applied to all RLVs without AST obtaining a broad knowledge of commercial RLV designs and operations. To accomplish this, a commercial RLV industry similar to the present aircraft industry must exist. However, a research program could be developed to frame the type of criteria and/or methodology that can be applied to today's RLV concepts. These criteria could provide a method for determining, on a case by case basis, if a particular RLV should be upgraded to proven status.

Reetry Vehicle Maneuverabililty and its Effect on Public Safety

FAA maintains public safety associated with RLV launch and reentry activities by the development of regulations that identify the requirements for safe RLV operations. FAA published on September 19, 2000, the following documents that are related to RLVs:

- Commercial Space Transportation Reusable launch Vehicle licensing regulations.
- Advisory Circular 431.35-1: Expected Casualty Calculations for Commercial Space Launch and Reentry Missons.
- Advisory Circular 431.35-2: Reusable launch and Reentry Vehicle System Safety Process.

This research program provides the resources to address the concerns regarding how to address the public safety issues associated with reentry of vehicles that are non-maneuverable and maneuverable. The research program could develop and frame the type of criteria and/or methodology that can be applied to the RLV concepts to provide a method for determining, on a case by case basis, the vehicle reentry maneuverability safety issues.

Customer/Stakeholder Involvement:

Commercial Space Integration into the NAS

In response to the projected growth and increased complexity of the commercial space transportation industry, the Commercial Space Transportation Space Systems Development Division has been actively leading an effort to integrate new operations seamlessly into the NAS. The Space and Air Traffic Management System Project is a key Systems Integration effort in support of the FAA's strategic goals.

Reusable Launch Vehicles Operation and Maintenance

The FAA Commercial Space Transportation Advisory Committee (COMSTAC) provides industry expertise to the Administrator and the Associate Administrator for Commercial Space Transportation (AST). The COMSTAC Reusable Launch Vehicle Working Group gives the FAA insight into the members' backgrounds and knowledge of systems and methodologies capable of protecting the public safety from the hazards associated with operations of RLVs.

The FAA Commercial Space Transportation Integrated Product Team (CST IPT) brings together the different FAA Lines of Business that will ensure the safety aspects of commercial RLV activities gets proper FAA corporate wide review and coordination.

Criteria for Determining "Unproven" vs. "Proven" RLVs

Criteria for determining unproven versus proven RLVs research includes:

- Support the FAA Associate Administrator for Commercial Space Transportation (AST) by providing a foundation to address and improve the process to determine the public safety issues regarding upgrading an RLV from unproven to proven.
- Provide the RLV industry with a less burdensome approach to classifying an RLV as a proven vehicle.
- Provide the customer with guidelines to furnish AST with the appropriate data regarding upgrading its RLV to a proven vehicle status. AST would evaluate and address the data public safety validity.
- The research and development project for "Criteria for determining unproven versus proven RLVs" might involve researching the following areas:
  - The Space Shuttle operation
  - Aircraft air worthiness
  - Automobile testing
  - Other related items that require approval for operation

Reetry Vehicle Maneuverabililty and its Effect on Public Safety

The reentry vehicle's maneuverability and its effect on public safety research:

- Supports the FAA Associate Administrator for Commercial Space Transportation (AST) by providing a foundation to address and improve the process to determine the public safety issues regarding reentry of maneuverable vehicles.
- Provide the RLV industry with a possibly less burdensome approach to regulate reentry of maneuverable vehicles.
- Provide customer guidelines to furnish AST with the appropriate data regarding reentry of maneuverable vehicles.
- The research and development project for "Reentry vehicle maneuverability and its effect on public safety" might involve researching the following areas:
  - The Space Shuttle operation
  - Aircraft air worthiness
  - Automobile testing
  - Other related items that require approval for operation

Accomplishments:

Commercial Space Integration into the NAS

The following R&D projects were accomplished in FY2000:

- Completed version 1.1 of the Comercial Space Transportation Concept of Operations in the National Airspace System.

- Completed a Space and Air Traffic Management System (SATMS) needs assessment.
- Completed phase III of a study to examine efficiency impacts of alternative policy options for accommodating space vehicle launch operations in the National Airspace System (NAS).
- Completed development of a SATMS Program Management Plan.

Reusable Launch Vehicles Operation and Maintenance

The FAA has produced a White Paper on "Commercial Reusable Launch Vehicle Operations and Maintenance Considerations." After this paper was reviewed by the FAA's CST IPT it was provided to the COMSTAC RLV Working Group for review and comment. Later, the paper was published by the American Institute of Aeronautics and Astronautics (AIAA) and presented by the FAA at the AIAA Space 2000 Conference and Exposition.

Criteria for Determining "Unproven" vs. "Proven" RLVs

The following results are from a previous research conducted to understand the general public safety issues associated with RLV operations. The earlier reseach, minimally, included unproven and proven RLV issues:

- Commercial Space Transportation Advisory Committee (COMSTAC) RLV Working Group developed an RLV Licensing Approaches report that included a discussion of unproven and proven RLVs.
- Develped for the RLV rulemaking effort a Technical Issues Memorandum (TIM) titled "The Risks Associated with Reentry Operations." The TIM addressed general safety issues pretaining to vehicle reentry.
- Refined the definition for RLV mission.
- Developed functional requirements for operation of an unproven and proven RLV.
- Published report: Critical Parameters for Successful Reentry From Earth orbit
- Published report: Reusable Launch Vehicle/ Reentry Vehicle Flight Safety System Issues.

Reetry Vehicle Maneuverabililty and its Effect on Public Safety

The following results are from a previous research conducted to understand the general public safety issues associated with RLV operations:

- Commercial Space Transportation Advisory Committee (COMSTAC) RLV Working Group developed an RLV Licensing Approaches report that included a discussion of unproven and proven RLVs.
- Develped for the RLV rulemaking effort a Technical Issues Memorandum (TIM) titled "The Risks Associated with Reentry Operations". The TIM addressed general safety issues pretaining to vehicle reentry.
- Published report: Critical Parameters for Successful Reentry From Earth orbit Report: Critical Parameters for Successful Reentry From Earth orbit.
- Published report: Reusable Launch Vehicle/ Reentry Vehicle Flight Safety System Issues.
- Published report: Reusable Launch Vehicle/ Reentry Vehicle Flight Safety System Issues.

R&D Partnerships:

Commercial Space Integration into the NAS

- International Center for Air Transportation, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology (NEXTOR).
- Space and Air Traffic Working Council (SATWC).
- NAS Architecture Core Team.

Reusable Launch Vehicles Operation and Maintenance

The FAA and NASA have a Memorandum of Understanding (MOU) Concerning Future Space Transportation Systems. It describes the FAA/ NASA cooperative activities that will be conducted under the category of future space transportation systems and reusable launch vehicle technology, research and development.

The FAA is actively involved with NASA and DoD activities that involve RLV technology demonstrations through programs such as X-40A,

X-37, X-34, and X-33, especially as related to public safety and environmental concerns.

Criteria for Determining "Unproven" vs. "Proven" RLVs

This program will work closely with various agencies and groups, such as:

- NASA Headquarters (HQ)
- NASA Kennedy Space Center (KSC)
- NASA Johnson Space Center (JSC)
- NASA Marshall Space Flight Center (MSFC)
- Aircrift certification (AIR)
- Flight standards (AFS)

Reetry Vehicle Maneuverabililty and its Effect on Public Safety

This program will work closely with various agencies and groups, such as:

- NASA HQ
- NASA KSC
- NASA JSC
- NASA MSFC
- Aircrift certification (AIR)
- Flight standards (AFS)
- Air traffic (AAT)

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

Commercial Space Integration into the NAS

- Developed commercial space transportation operation scenarios
- Impacted the analysis of Free Flight Phase 1 tools on commercial space transportation operations.
- Updated NAS Architecture to reflect CST changes.
- Identified schedule and cost impacts of CST requirements on NAS Architecture.

Reusable Launch Vehicles Operation and Maintenance

- Reviewed and analyzed the Space Shuttle operations and maintenance activities to determine "best practices" applicable to commercial RLV O&M activities.
- Conducted a study to review the airline industry operations and maintenance activities to determine the "best practices" and "lessons learned" that may be applicable to commercial RLV O&M activities.

Criteria for Determining "Unproven" vs. "Proven" RLVs

- Determined the resources required to conduct the research program.
- Developed a white paper addressing some of the public safety issue regarding unproven and proven RLVs.
- Reetry Vehicle Maneuverabililty and its Effect on Public Safety
- Determined the resources required to conduct the research program.
- Developed a white paper that addresses some of the public safety issues regarding non-maneuverable and maneuverable reentry vehicles.

KEY FY 2002 PRODUCTS AND MILESTONES:

Commercial Space Integration into the NAS

Prepare the SATMS Requirements Baseline Document.

Reusable Launch Vehicles Operation and Maintenance

Develop a draft NPRM to initiate the rule making activity for commercial RLV O&M activities to ensure that the public receives adequate protection during the course of these activities.

Criteria for Determining "Unproven" vs. "Proven" RLVs

- Develop a methodology that could lead to criteria for judging whether an unproven RLV can be upgraded to proven status.
- Develop a report on the research findings.

Reetry Vehicle Maneuverabililty and its Effect on Public Safety

- Develop a methodology that could lead to criteria for judging the public safety validity resulting from the reentry vehicle maneuverability.
- Develop a report on the research findings.

FY 2002 PROGRAM REQUEST: Authorized commercial space transportation research is currently being funded out of the Operations budget.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$0
FY 2001 Enacted	0
FY 2002 Request	0
Out-Year Planning Levels (FY 2003-2006)	0
Total	$0

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Commercial Space Transportation Safety	0	0	0	0	0
Personnel Costs	0	0	0	0	0
Other In-house Costs	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	0
Development (includes prototypes)	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**

Notes:

- Commercial Space Transportaion Safety funding is included in the Operations Appropriation.

- Programs and projects are not separately budgeted in Operations Appropriation.

- Out year funding is under review.

Commercial Space Transportation Safety Products and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
Commercial Space Integration into the NAS							
Execute SATMS Program Management Plan	*						
Validate near term CST operational scenarios		◆	◇				
Develop mid and far term CST operational scenarios		◆	◇	◇			
Examine impacts of Free Flight tools on CST		◆	◇	◇	◇	◇	◇
Reusable Launch Vehicle Operations & Maintenance							
Conduct Studies on Aerospace Operations &Maintenance	*						
Investigate Space Shuttle O&M for Best Practices		◆	◇	◇			
Analyze Airline O&M Activities for Best Practices		◆	◇	◇	◇	◇	
Study Airline O&M Activities for Lessons Learned		◆	◇	◇	◇	◇	◇
Criteria for Determining "Unproven" versus "Proven" RLVs							
Program Management Plan	*						
Establish and implement near term research approach		◆	◇				
Develop draft criteria		◆	◇	◇			
Develop mid term report		◆	◇	◇	◇		
Final report		◆	◇	◇	◇	◇	
Reentry Vehicle Maneuverability and its Effect on Public Safety							
Program Management Plan	*						
Establish and implement near term research approach		◆					
Develop draft criteria		◆	◇				
Develop mid term report		◆	◇	◇			
Final report		◆	◇	◇			
Total Budget Authority	*	*	*	*	*	*	*

Note:

– Commercial Space Transportation Safety Funding is Included in the Operations Appropriation.

– Programs and Projects are not separately budget in the Operations Appropriation.

* Funding requests for all years are under review.

2.8 National Aviation Research Plan Program Management

Mission

The program provides leadership and services for both internal and external customers. First, we provide for the effective and responsible stewardship of the funds that users of the NAS have entrusted to the FAA for research and development. Second, we provide for our share in the sustainment and maintenance of the Air Traffic Management Laboratories at the William J. Hughes Technical Center. Third, we provide for the long-term research needs of the FAA in the Air Traffic Management arena through the Center for Advanced Aviation System Development (CAASD). Finally, we provide for the future protection of the FAA's critical information technology systems. We strive to provide our customers the outputs and outcomes they most need in return for their investment.

Intended Outcomes

This area supports FAA strategic goals and objectives in industry vitality, global leadership, business practices, and communications. Specifically, work in this area is directed towards better serving the interests of the nation and the flying public by:

- Increasing knowledge of the R,E&D program among the agency's customers and stakeholders.
- Increasing the participation of R,E&D customers and stakeholders in the program's formulation.
- Better managing limited R&D resources through more efficient and effective processes for the development and management of the FAA R,E&D investment portfolio.
- Fostering U.S. aviation industry leadership through international cooperation and harmonization in developing and implementing technologies that improve air traffic safety and efficiency.
- Achieving higher quality research and greater value though increased collaboration (partnerships) with the best academic and industrial R&D talent, both within the United States and internationally.
- Vitalizing the U.S. aviation industry by supporting R&D efforts toward the future technological and operational needs of NAS users.

Program Area Outputs

- The (annual) *National Aviation Research Plan (NARP)*, formerly known as the *Federal Aviation Administration Plan for Research, Engineering & Development*.
- Periodic and special R,E&D Advisory Committee reports and recommendations.
- The annual FAA R,E&D Budget.
- International planning and implementation documents providing for world-wide aviation research harmonization and interoperability.
- Agreements with other international civil aviation authorities for the cooperative development of aviation systems research programs.
- Cooperative research agreements with academia, other government agencies, and industry.
- Modern, available Air Traffic Management (ATM) laboratories needed to meet the needs of the individual ATM research programs.
- New information systems security tools and techniques.

Program Area Structure

The NARP Program Management effort is divided into the following areas:

- R &D Portfolio Strategic Management
- R,E&D Financial Management
- R,E&D Advisory Committee
- International cooperative research and development programs
- Collaboration with NASA on aviation research and development
- R,E&D Partnerships
- Center for Advanced Aviation System Development (CAASD)

- William J. Hughes Technical Center (WJHTC) Laboratories
- Information Systems Security Development

Effective stewardship of the FAA R,E&D program requires that all NAS users receive the best systems and services achievable for their investment. In the first four elements just listed, the FAA ensures that its R&D program effectively targets the needs of those who rely on the NAS, that the agency provides for R&D in its budget and R,E&D Plan, and that it properly accounts for its R,E&D financial resources

The next three elements are to ensure that the agency's research and development program is fully coordinated with other aviations research programs and that others conducting research and development are cognizant of FAA needs and direction. With limited resources available to virtually all the enitities conducting aviation-related research and development, it is incumbent upon all of us to collaborate in the conduct of our programs and share in the results.

The final three elements provide the in-house component of our air traffic management research program. CAASD, FAA's federally funded research and development center, is engaged in providing fundamental, cutting-edge research and development of future ATM systems and procedures. The WJHTC laboratories provide the test beds for proposals for new systems, processes, or procedures. The Information Systems Security is concerned with safeguarding the systems and data from either accidental or deliberate intrusions.

Customer and Stakeholder Involvement

The FAA relies upon the R,E&D Advisory Committee (REDAC) for guidance on its research and development programs. The REDAC includes representatives of associations, users, corporations, other government agencies, universities and research laboratories—all either customers or stakeholders of FAA products and services. The REDAC is actively involved in shaping, reviewing, and questioning what the agency is presently doing or considering for the future.

Additional customer guidance comes from the various committee of RTCA, Inc., a non-profit standards organization for ATM systems.

Accomplishments

NARP Strategic/Financial Management and Portfolio Analysis

- The 2000 FAA *National Aviation Research Plan*, February 2000.
- The FY 2001 R,E&D Budget, February 2001.
- R,E&D Portfolio Development Process Re-engineering - Update, July-September, 2000.

R,E&D Advisory Committee

(See Appendix A.)

R&D Excellence

- Completed a standards-based review of the management of the R&D program and execution of a representative sample of R&D projects using the FAA-developed integrated Capability Maturity Model (iCMM).
- Developed a process improvement plan to make improvements to both management and execution of R&D programs as noted during the review.
- R,E&D Coordinated Efforts and Partnerships.

Joint University Program (University Research Program Group):

- Presentation of 15 RTCA Jackson Awards for excellence in aviation electronics.
- Presentation of the first FAA Excellence in Aviation Award, two Aerospace Industries Association of America (AIAA) Major Field Awards in aviation meteorology, and oneInstitute of Electrical and Electronics Engineers (IEEE) Major Field Award in control systems.

R&D Partnerships

- Received and incorporated the R,E&D Advisory Committee’s guidance on the R,E&D Program.
- Established 125 research and development agreements with 19 countries and with a single air traffic organization representing 17 member states.

- Established an agreement with EUROCONTROL to do cooperative research and development in air traffic management programs.

Long-Range View

Work in this area will continue as long as the FAA performs research and development. Expected resource requirements in the "out-years" will remain at about 3-5% of the total 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 further intends to increase customer and stakeholder involvement in its programs by fostering greater proliferation of U.S. standards and technology to meet worldwide aviation needs.

Agency Outputs: The FAA prepares the annual R,E&D budget submission to Congress and publishes the annual *National Aviation Research Plan (NARP)*. The agency hosts three R,E&D Advisory Committee (REDAC) meetings per year as well as a number of subcommittee meetings. REDAC produces periodic and special reports providing advice and recommendations on the R,E&D program to the FAA. The Agency intends to start developing and publishing a research and development strategic plan.

Customer/Stakeholder Involvement: REDAC reviews FAA research commitments annually and provides guidance for future R,E&D investments. The Advisory Committee is limited to a maximum of 30 members. These members represent customer and stakeholder groups including subject matter experts from various associations, user groups, corporations, government agencies, as well as universities and research centers.

Accomplishments: Each year, the agency provides R,E&D program status information through the *NARP* and submits the R,E&D budget requests to the Office of Management and Budget (OMB) and Congress. REDAC has provided the FAA with an independent strategic view on the agency's research commitments. In a recent report, the committee has reviewed the FAA's planned FY 2002 R,E&D Investments (April 2000). The Committee has also participated in a joint meeting with NASA's Aero-Space Technology Advisory Committee (April 2000) and has formed a new subcommittee to examine the Small Aircraft Transportation System (SATS) initiative.

R&D Partnerships: The FAA's R&D partnerships are described in each budget line item.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

R,E&D plans and programs

- Published the National Aviation Research Plan.

R,E&D advisory committee

- Submitted Committee review of and recommendations for FY 2002 R,E&D Program.
- Submitted Committee guidance for FY 2003 R,E&D Program.
- Participated in joint meetings with NASA's Aero-Space Technology Advisory Committee.

KEY FY 2002 PRODUCTS AND MILESTONES:

R,E&D plans and programs

- Publish the National Aviation Research Plan.

R,E&D advisory committee

- Prepare recommendations on planned R,E&D investments for FY 2003.
- Prepare other reports as requested by the Administrator.
- Participate in joint meetings with NASA's Aero-Space Technology Advisory Committee.

FY 2002 PROGRAM REQUEST:

This request will be used to further FAA's R,E&D program strategic management of its R&D activities.

Specifically, the agency will pursue the development of a research and development strategic plan to more closely link the agency's R&D program with its corporate strategic goals and to establish a performance-measurement-oriented baseline to track R&D contributions to agency strategic goals. The agency will engage the service of the REDAC in the preparation of this plan.

The agency will continue to support the work of the REDAC in its task to advise the Administrator on the FAA R&D Program. In particular, the agency will seek the counsel and guidance of the committee for the FY 2003 program, review the proposed FY 2003 program prior to submission of the budget requirements to the Department of Transportation, and seek the committee's guidance during the execution of our R&D program.

The agency will continue to publish, as required by Congress, the National Aviation Research Plan and submit it annually to Congress as part of the President's Budget Request.

The agency will continue to provide cross-functional management team support for the FAA R&D Strategic Plan, ensure that programs planned in response to that plan are balanced across FAA strategic objectives, and ensure the most important and beneficial work is accomplished within the available resources.

The agency will continue to provide the following core, essential services across all the service areas to produce the following:

- Financial management of the R,E&D program.
- Financial support for REDAC, a body of customers and aviation experts drawn from outside the FAA who provide guidance to the Administrator on R,E&D program planning and execution.
- 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 systems procedures.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 32,419
FY 2001 Enacted	1,162
FY 2002 Request	1,458
Out-Year Planning Levels (FY 2003-2006)	6,060
Total	$ 41,099

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
R,E&D Plans and Programs	1,164	385	1,164	886	1,388
Personnel Costs	0	685	0	246	49
Other In-house Costs	0	94	0	30	21
Total	**1,164**	**1,164**	**1,164**	**1,162**	**1,458**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	1,164	1,164	1,164	1,162	1,458
Development (includes prototypes)	0	0	0	0	0
Total	**1,164**	**1,164**	**1,164**	**1,162**	**1,458**

A01a - System Planning and Resource Management Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
011-130 R,E&D Plans and Programs							
R,E&D Plans and Programs	**$1,176**						
Publish Annual Plan for R&D		◆	◇	◇	◇	◇	◇
R,E&D Financial Management		◆	◇	◇	◇	◇	◇
Prepare Annual Budget Submissions		◆	◇	◇	◇	◇	◇
R,E&D Advisory Committee Reports	**$212**						
Recommendations on FAA, RE&D Investments		◆	◇	◇	◇	◇	◇
Joint Meetings with NASA's Aerospace Technology Advisory Committee		◆	◇	◇	◇	◇	◇
Personnel and Other In-House Costs	**$70**						
Total Budget Authority	**$1,458**	**$1,162**	**$1,458**	**$1,481**	**$1,501**	**$1,530**	**$1,548**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A01b —William J. Hughes Technical Center Laboratory Facility

GOALS:

Intended Outcomes: The FAA testbeds located at the William J. Hughes Technical Center (WJHTC) support R,E&D program goals to:

- Reduce the number of accidents and accident risk.
- Perform airspace studies and improve airspace design.
- Increase airport capacity.
- Reduce delays due to weather and system outages.
- Reduce unnecessary flight restrictions.
- Reduce user costs.

The WJHTC maintains and operates the agency testbed laboratories utilized by R,E&D programs in achieving the above goals. These centralized testbeds 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 their testbeds to emulate and evaluate various field conditions. Human factor 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 testbeds directly support agency projects and integrated product teams in the following areas:

- Capacity and air traffic management technology
- Communications, Navigation, And Surveillance (CNS)
- Operation concept validation
- Free Flight Phase 1/Phase 2
- Weather
- Airport technology
- Aircraft safety technology
- System security technology
- Human factors
- Information Security
- Capstone
- Environment and Energy
- Automated Dependent Surveillance-Broadcast (ADS-B)
- Global Positioning System (GPS)
- Terminal Instrumentation Procedures (TERPS)
- Wide/Local Area Augmentation System (WAAS/LAAS)

Accomplishments: The technical laboratory facilities provide the testbed 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 2001 ACCOMPLISHMENTS:

The following programs have been supported by the laboratories:

- Runway Incursion
- Information Security
- Separation Standards
- GPS/WAAS/LAAS
- TERPS
- Satellite Communication
- Data Link
- TCAS/ADS-B
- Acquisition Human Factors
- Delay Reduction
- Runway Pavement Testing
- Aircraft Security
- Airport Movement Area Safety System (AMASS)

KEY FY 2002 PRODUCTS AND MILESTONES:

The testbeds at the WJH Technical Center provide the necessary infrastructure for R,E&D programs to achieve their goals. Specific milestones and products are contained within individual programs.

FY 2002 PROGRAM REQUEST:

The WJHTC will maintain and operate technical laboratories/facilities that support R,E&D programs.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 59,449
FY 2001 Enacted	12,223
FY 2002 Request	12,545
Out-Year Planning Levels (FY 2003-2006)	54,745
Total	$ 138,962

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
WJHTC Laboratory Facility	3,341	3,268	3,300	2,710	3,835
Personnel Costs	3,905	6,462	6,988	8,044	8,046
Other In-house Costs	800		787	1,469	664
Total	**8,046**	**9,730**	**11,075**	**12,223**	**12,545**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Enacted
Basic	0	0	0	0	0
Applied	8,046	9,730	11,075	12,223	12,545
Development (includes prototypes)	0	0	0	0	0
Total	**8,046**	**9,730**	**11,075**	**12,223**	**12,545**

A01b - William J. Hughes Technical Center Laboratory Facility Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
011-140 WJHTC Laboratory Facility							
Systems Support Laboratory (En Route, Terminal, Automated Flight Station, Communications, and Scan Radars)	$500						
Free Flight Phase 1		◆	◇	◇	◇		
Operational Concept Validation		◆	◇	◇	◇	◇	◇
Capacity Initiatives (Airspace, Procedures)		◆	◇	◇	◇	◇	◇
Information Security		◆	◇	◇	◇	◇	◇
Research & Development Laboratory (Target Generator Facility, Cockpit Simulator, Auto Tracking, Tech Center Data)	$453						
Approach Procedures (SOIA)		◆	◇	◇	◇	◇	
Free Flight Phase 1		◆	◇	◇	◇		◇
Separation Standards		◆	◇	◇	◇	◇	◇
Operational Concept Validation		◆	◇	◇	◇	◇	◇
GPS/WAAS/LAAS		◆	◇	◇	◇	◇	◇
CDT/ADS-B		◆	◇	◇	◇	◇	◇
Data Link		◆	◇	◇	◇	◇	◇
STARS		◆	◇	◇	◇	◇	
Aviation Support Laboratory (Aircraft)	$2,432						
Satellite Communications and Navigation Programs		◆	◇	◇	◇	◇	◇
Separation Standards		◆	◇	◇	◇	◇	
Capstone		◆	◇	◇			◇
GPS/WAAS/LAAS		◆	◇	◇	◇	◇	◇
TERPS		◆	◇	◇	◇	◇	◇
Data Link		◆	◇	◇	◇	◇	◇
Runway Incursion		◆	◇	◇	◇	◇	◇
ADS-B		◆	◇	◇	◇	◇	◇
Aircraft Safety		◆	◇	◇	◇	◇	
Human Factors Laboratory	$450						
Air Traffic Control Human Factors		◆	◇	◇	◇	◇	◇
Airway Facilities Human Factors		◆	◇	◇	◇	◇	◇
Operational Concept Validation		◆	◇	◇	◇	◇	
Personnel and Other In-House Costs	$8,710						
Total Budget Authority	$12,545	$12,223	$12,545	$12,985	$13,433	$13,924	$14,403

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A01c — Center for Advanced Aviation System Development (CAASD)

GOALS:

Intended Outcomes: The FAA intends to apply expertise from the Center for Advanced Aviation System Development (CAASD) resources to air traffic service research to produce a safer, more efficient global air transportation system. Because it augments the agency's in-house resources in conducting research for the Air Traffic Services (ATS) line of business, CAASD is an essential component of the FAA's research program.

Agency Outputs: The CAASD research program provides detailed reports, briefings, and concept demonstration systems for use in the evaluation of new Air Traffic Management (ATM) and control operating concepts and/or infrastructure replacements. These products are critical elements in the initial development of a more efficient, more available, and safer next generation ATM and control system.

CAASD provides 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 system stakeholder as well as FAA issues and needs. Collaborative traffic flow management is 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 affordable NAS Architecture that satisfies those needs.

Additionally, the CAASD R,E&D effort supports the International Civil Aviation Organization (ICAO) in its efforts to develop worldwide navigation capabilities, including: a wide-area augmentation system; a local-area augmentation system; and a worldwide air-ground communication capability using very high frequency air-ground digital radio. ICAO is the principal venue for international standards development and validation.

Accomplishments: CAASD has supported the following accomplishments:

- Development of longer-term operational concepts that move the ATM system closer to achieving free flight objectives.
- Development of procedure changes to improve runway safety and efficiency in the en route, terminal and oceanic domains.
- Conduct of Safe Flight 21 demonstrations in the Ohio Valley and Alaska that show how Communication, Navigation and Surveillance (CNS) technologies can be integrated with procedural changes to enhance service to airspace users.
- Development of information system requirements for capabilities in the en route and Traffic Flow Management domains to allow ATC specialists to provide a higher level of service to airspace users.
- Determined the expected level of performance (in terms of NAS delay, capacity, safety, predictability, flexibility, and/or access) of the future ATM, taking into account anticipated changes in areas such as: airspace user operations; previously committed ATM/airport system improvements; direction contained in the Operational Concept and the NAS Architecture; NAS modernization; and changes in user operations (traffic levels, location, characteristics).

R&D Partnerships: In accomplishing the outcomes in the CAASD work program, extensive partnerships have been forged with industry suppliers, aircraft operators, and other non-profit research institutions. These relationships include:

- George Mason University and NASA, on Wake Vortex, ADS-B and surface issues related to capacity.
- EUROCONTROL, on future ATM developments

- NASA Ames, on Multi-Center Traffic Management Advisior (TMA).
- Cargo Airlines Association, Florida Institute of Technology, and the University of Virgina, on ADS-B and its use for situational awareness (traffic and weather information in the cockpit) and self-spacing.
- UPS Aviation Technologies, on the Universal Access Transceiver.

In the modeling arena, CAASD has activities with Georgia Tech on Detailed Policy Assessment Tool (DPAT) and The Preston Group with Total Airport and Airspace Simulator and the Santa Fe Institute on agent based modeling. CAASD also is working with Catholic University on human factors stress monitoring techniques.

CAASD is working with the Volpe National Transportation Systems Center on TFM infrastructure modernization. Together, the centers are working with the NATCA Aviation Research Institute to obtain operational expertise on CAASD evaluations of new procedures and equipment. On its own, CAASD is working with Airbus, Boeing and Honeywell on path object concepts for future aviaonic systems and with Lockheed-Martin on enroute ATM modernization concepts.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

- Defined and developed requirements for Free Flight Phase 2 capabilities.
- Developed an integrated detailed next-generation air/ground communication system program plan that has wide-spread buy-in from the airspace user community.
- Conducted evaluations of Free Flight Phase 1 capabilities to gather information on their utilization and on the system benefits derived from their use.

KEY FY 2002 PRODUCTS AND MILESTONES:

- Analyses that will contribute to the definition of requirements for the modernization of the en route domain system architecture. This modernization will result in enhancements to decision-support system functionality and improvements in the quality and cost-effectiveness of operations and maintenance.
- Detailed guidance on the integration of Free Flight Phase 1 tools, i.e., User Request Evaluation Tool (URET), TMA, passive Final Approach Spacing Tool (pFAST), and Collaborative Decision Making (CDM) capabilities needed for full implementation of associated programs.
- Continued to develop metrics and evaluation plans to assess the benefits associated with Free Flight Phase 2 capabilities.
- Evaluated Safe Flight 21 results that support the development of requirements for the implementation of key CNS improvements and operational procedure changes.
- Determined the future navigation architecture and develop a consensus transition strategy, including the appropriate Global Positioning System (GPS) augmentation capability needed to enable a successful transition to a more effective navigation architecture for the NAS.

FY 2002 PROGRAM REQUEST:

Funding is requested for the following items:

- Additional research and development of Free Flight Phase 2 capabilities and potential enhancements.
- Continued support of Safe Flight 21 demonstrations.
- Analyses that support the definition of requirements for the modernization of the en route domain system architecture.
- Continued analysis of the expanded use of GPS and the implementation of advanced navigation systems.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 20,434
FY 2001 Enacted	3,991
FY 2002 Request	5,143
Out-Year Planning Levels (FY 2003-2006)	21,361
Total	$ 50,929

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Center for Advanced Aviation System Development	5,444	4,890	4,900	3,991	4,895
Personnel Costs	0	0	0	0	173
Other In-house Costs	0	0	0	0	75
Total	**5,444**	**4,890**	**4,900**	**3,991**	**5,143**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	5,444	4,890	4,900	3,991	5,143
Development (includes prototypes)	0	0	0	0	0
Total	**5,444**	**4,890**	**4,900**	**3,991**	**5,143**

A01c - Center for Advanced Aviation System Development (CAASD) Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
011-160 Center for Advanced Aviation System Development (CAASD)							
Research, Engineering and Development	**$1,510**						
Developed an integrated Detailed Next-Generation Air/Ground Communications System Program Plan		◆	◇	◇	◇	◇	
Define Relationships Among Safety, Separation Standards, & Operational Capability to Enhance Safety Management		◆	◇	◇	◇	◇	
Investigate the Expanded Use of GPS and Advanced Navigation Systems		◆	◇	◇	◇	◇	◇
Continue Investigating Procedures, User Needs, System Requirements, and Architecture Implications for Enhanced Information Systems		◆	◇	◇	◇	◇	◇
Traffic Flow Operations Research	**$1,010**						
Conduct Evaluations of Airspace Redesign Enhancements in All Operational Domains to Improve System Performance and Utilization of Resources		◆	◇	◇	◇	◇	
Continue Investigating Procedures, User Needs, System Requirements, and Architecture Implications for Enhanced Information Systems		◆	◇	◇	◇	◇	
Research New Air Traffic Management and Control Operating Concepts Evaluation and/or Infrastructure Replacements		◆	◇	◇	◇	◇	◇
Incorporate GPS Technology into Ongoing Work in Area of Low Cost Avionics to Make Full Use of Traffic Alert and Collision Avoidance System (TCAS)		◆	◇	◇	◇	◇	◇
Special Situation Support	**$2,375**						
Define and Develop Requirements for Advanced Free Flight Concepts and Capabilities That Will Be Needed Beyond Free Flight Phase		◆	◇	◇	◇	◇	◇
Deliver and Evaluate a Core Set of Operational Capabilities (SMA, CDM, CTAS, and URET) at a Limited Number of Sites		◆	◇	◇			
Develop Alternative Methods for Using GPS Technology Inclusion of Free Flight Concepts in Domestic Airspace		◆	◇	◇	◇	◇	◇
Integrate DSS Requirements with FAA and Industry Technology Applications		◆	◇	◇	◇	◇	◇
Personnel and Other In-House Costs	**$248**						
Total Budget Authority	**$5,143**	**$3,991**	**$5,143**	**$5,222**	**$5,291**	**$5,393**	**$5,455**

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A01d —Information Systems Security

GOALS: The increasing growth of cyber attacks and terrorism on critical infrastructures such as the National Airspace System (NAS) calls for a national-level effort to protect the increasingly vulnerable and interconnected U.S. computer and communications infrastructure. Executive Order 13010 identifies aviation transportation among one of the key protection areas. This budget submission focuses on extraordinarily difficult and challenging technical problems that must be addressed as a part of protecting the FAA's system infrastructure.

Intended Outcomes: The FAA will improve information systems security by developing and evaluating new technologies, technical information, and procedures that can be applied in both NAS and system support information systems, both new and legacy to improve the security posture of FAA systems against both active and passive attacks.

Agency Outputs: The research will transition into both future and legacy information systems used for all aspects of agency business, including the NAS, mission support, and administrative. Those systems will be more secure as a result of applying the new technology, improving the safety of the flying public, better protecting the nation's critical infrastructure, and enabling uninterrupted operations of the FAA.

Customer/Stakeholder Involvement:

- Internal stakeholders include all agency personnel since everyone routinely uses information systems for their business. Of special note are air traffic controllers (system availability and integrity), maintenance personnel (response to intrusions including system recovery), Aviation Security (incident analysis and enforcement), Regulation and Certification, Research and Acquisition, and the FAA Chief Information Officer (security system oversight).
- Federal stakeholders such as the President's Commission on Critical Infrastructure Protection, and the General Accounting Office have raised concerns about protecting the NAS information infrastructure in formal reports.
- External stakeholders include airlines and passengers (safety, efficiency, equipage, and maintenance); aircraft operators (safety, efficiency, equipage, and maintenance); pilots (safety); and International Civil Aviation Organization (standards and recommended practices).

Accomplishments: This is a new research, engineering and development program.

R&D Partnerships: Intended partners include: Lincoln Laboratory, Massachusetts Institute of Technology; the Computer Emergency Response Team – Coordinating Center (CERT-CC) at the Software Engineering Institute (SEI) of Carnegie-Mellon University; the University of Maryland; the National Security Agency; DOD entities (including AFRL, NRL, and DARPA), the Department of Treasury, and NASA.

MAJOR ACTIVITIES AND ANTICIPATED FY 2001 ACCOMPLISHMENTS:

This is a new research, engineering and development (R,E&D) program. FY 2001 activities and accomplishments are done in anticipation of inauguration of a funded R,E&D program in FY 2002.

- Initiated cooperative relationships with potential R&D partners (Lincoln Labs, SERC-CC, NIAP, AFRL, NRL, DARPA and NASA)
- Analyzed and determined Computer Security Incident Response Center (CSIRC) critical advanced technology requirements that can not be met by either commercial products or other on-going R&D efforts.
- Ascertained unique FAA R&D needs in Public Key Infrastructure (PKI) and other encryption technologies demanded by unique FAA mobile environments and situational awareness requirements.

KEY FY 2002 PRODUCTS AND MILESTONES:

- **Real Time Intrusion Detection and Monitoring—**Significant engineering shortfalls complicate the building and deployment of Intrusion Detection (ID) systems for large, heterogeneous systems such as the NAS.

Current ID systems cannot effectively function within the unique NAS environment due to the system's unique traffic flows and heavy demand for integration with a large number of partners and stakeholders such as the airlines, airports, etc. Current technology results in high false alarm rates and missed detection of actual intruders. The volume of audit data for the NAS requires a large personnel staff to analyze the reports and determine and develop effective ID algorithms. Integrating security data from the very large number of separate NAS subsystems will provide an unparalleled technical challenge. A research and development program is needed to develop intrusion detection technology tailored to FAA requirements and to integrate and tailor state-of-the-art commercial intrusion detection technology into FAA information systems. This effort will leverage on-going efforts by the USAF and the SEI and accelerate technology insertion into both legacy and new FAA systems.

- **Architecture—**FAA's information infrastructure is one of the largest and most complex in the world. Current techniques to architect the security of information systems need to be significantly improved to ensure that the points of greatest vulnerability have the greatest protection and that those protections remain as the information systems evolve. A research and development program is needed to develop new architectural approaches and to integrate those state of the art approaches into the FAA's information systems security architecture. According to our interactions with the National Information Assurance Partnership (NIAP) and MITRE, the FAA has been judged to be in the forefront of these efforts and cannot depend on commercial efforts to continue to provide the best protection to our future networks without continued R,E&D funding.
- **Public Key Infrastructure (PKI)—** The FAA will improve information systems security by researching and developing technologies, technical information, and procedures for public key infrastructure. Such improvements will enable secure transactions over the internet, intranet, and in non-TCP/IP based networks such as used in air-to-ground communications via the Controller Pilot Data Link Communications program. Current concern is to develop new PKI concepts that can meet FAA unique requirements due to the mobile environment and situational awareness needs demanded by the agency's safety and security goals.

FY 2002 PROGRAM REQUEST:

The field of Information Systems Security (ISS) and Information Assurance (IA) is changing so rapidly that continued vigilance in evaluating and developing new ISS technologies is critical. Such technologies have a short "shelf-life." As soon as one threat has been discovered and new protection mechanisms have been developed to address it, more lethal threats are developed requiring newer and more robust mechanisms. The FY 2002 program will broaden the set of technologies evaluated and mature the technologies developed so they can be rapidly inserted into operational information systems.

In FY 2002, a small number of information systems will be selected to prototype the application of emerging ISS technologies. For example, emerging neural net and intelligent agent technologies may soon enable the analysis of large complex networks for vulnerabilities and can detect attacks in real-time. It is not clear yet, however, whether these technologies can scale to the size and complexity of the FAA's information systems infrastructure. Experiments will determine their robustness, scalability, and accuracy in finding vulnerabilities and detecting attacks.

As another example, a relatively new but very powerful way to specify information systems security requirements is through a standard product called "Common Criteria" (CC). These requirements become an integral part of an overall systems architecture, making it much easier for developers to understand how to build in protections when creating new information systems. A challenge facing the FAA is determining how to apply the CC to correctly allocate security requirements to the various parts of the FAA's architecture. Research will determine how to best apply the CC and make the necessary allocations to the FAA ISS architecture

and to use the outputs of the Protection Profiles developed in accordance with the CC in future FAA system acquisitions.

The FAA is currently investigating cooperative relationships with the Air Force Research Laboratory in Rome, NY, the Naval Research Laboratory in Washington, DC, the National Security Agency, the SEI, the University of Maryland, and Lincoln Laboratory at MIT to address these and other potential R&D efforts. Our aim is to leverage, to the highest degree, on-going R&D efforts from other government agencies and Federally Funded Research and Development Centers and to focus our investments to address unique FAA issues and requirements that would not be addressed without additional R,E&D funding, and that cannot be met by commercial products. The three key ISS R,E&D areas of Intrusion Detection and Monitoring, Architecture and Public Key Infrastructure have the best potential for major payoffs to the FAA when leveraging other on-going R&D efforts. The FAA provides a critical infrastructure for the nation and has unique ISS needs that will not be met by the commercial community, due to the unique traffic and communication flows within the NAS and the needs for heightened protection against active cyber terrorism focused on the FAA.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ -
FY 2001 Enacted	0
FY 2002 Request	2,581
Out-Year Planning Levels (FY 2003-2006)	10,722
Total	$ 13,303

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Information System Security	0	0	0	0	2,457
Personnel Costs	0	0	0	0	87
Other In-house Costs	0	0	0	0	37
Total	**0**	**0**	**0**	**0**	**2,581**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	0	0	0	0	2,581
Development (includes prototypes)	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**2,581**

A01d - Information System Security Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
011-170 Information Systems Security							
Real Time Intrusion Detection and Monitoring	$957						
Develop and Tailor Intrusion Detection Algorithms to the NAS and Other FAA System Requirements			◇	◇	◇		
Build and Test a New Proof of Concept Intrusion Detection System				◇	◇	◇	
Develop and Test Effectiveness of Intelligent Agents in Improving Intrusion Detection			◇	◇	◇	◇	◇
Identify Countermeasures			◇	◇	◇	◇	◇
Architecture	$650						
Techniques to Improve Effectiveness Against Unauthorized Access			◇	◇			
Integrate State of the Art Architectural Approaches in the Information Systems Security (ISS) Architecture			◇	◇			
Integrate ISS into the FAA Architecture				◇	◇		
Public Key Infrastructure	$850						
Research and Develop Technologies, Technical Information and Procedures for PKI			◇	◇	◇		
Integrate and Test Developed PKI Technology into the FAA Architecture for Secure Transactions Over the Internet, Intranet, and in Non-TCP/IP Based Networks Such As Used in Air to Ground Communications via the Controller-Pilot Data Link Communications (CPDLC) Program			◇	◇	◇	◇	◇
Personnel and Other In-House Costs	$124						
Total Budget Authority	$2,581	$0	$2,581	$2,621	$2,656	$2,707	$2,738

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

A10a —Strategic Partnerships

GOALS:

Intended Outcomes: Focused in three, relatively narrow partnership areas the agency seeks to:

- Foster and facilitate FAA and NASA coordination and collaboration as a means of leveraging the resources of both agencies in producing research results that meaningfully meets the needs of the FAA.
- Pursue and support the transfer of technology between government and industry as a means of leveraging limited agency research resources.
- Provide a continuing source of cutting-edge ideas from leading aviation research universities that can be used by FAA and NASA project offices in adressing agency needs.

Agency Outputs:

University Research Programs

Joint University Program

Through quarterly technical review meetings, the universities present their research results in such diverse areas as:

- Design methods for robust and failure-tolerant flight control systems.
- High-accuracy global positioning system (GPS) navigation and altitude determination, e.g., Local Area Augumentation System (LAAS).
- Aircraft crew situational awareness.
- Pilot and controller situational awareness through common weather and traffic information.
- Guidance and control for wake vortex encounters.

Industry Research Programs

Technology Transfer Awards

- Award agency personnel for exceptional contributions to technology transfer projects.

FAA Field Offices at NASA Research Centers

- Provides NASA researchers on-site access to knowledgable FAA personnel who can:
  - Foster an FAA knowledge-base on FAA needs and requirements.
  - Assist NASA researchers in focusing their research efforts in areas where work is needed.
  - Foster and facilitate coordination and collaboration between NASA researchers. FAA personnel will ultimately use the products of that research.

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:

University Research Programs

Joint University program

- Received the 1999 RTCA William E. Jackson award.
- Received two Aerospace Industries Association of America major field awards (aviation meteorology).
- Received one Institute of Electrical and Electronics Engineers major field award (control systems).
- Negotiated a Memorandum of Agreement with NASA Ames for jointly funded research in a portfolio of civil aeronautics technologies.

Industry Research Programs

Technology Transfer Awards

- Made Technical Transfer Awards of approximately $43K in FY 2000.

FAA Field Offices at NASA Research Centers

- Facilitated development of training strategies and materials for Free Flight Phase 1 Center TRACON Automation System (CTAS) Tools.
- Developed an educational CD-ROM, "Gate to Gate," about Air Traffic Control.

- Developed an enhanced FAA Wake Turbulence training package incorporating recent National Transportation Safety Board (NTSB) recommendations and NASA research data.
- Assisted NASA in the deployment of the Airborne Information for Lateral Spacing (AILS) demonstration at the Minneapolis-St. Paul Airport.

R&D Partnerships: The collective vision of this chapter is to provide safe and secure air transportation through partnerships that 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 2001 ACCOMPLISHMENTS:

University Research Programs

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 complement FAA R,E&D.

Industry Research Programs

Technology transfer/cooperative activities

- Presented technology transfer awards.
- FAA Field Offices at NASA Research Centers
- Developed an integrated FAA/NASA 5-year wake turbulence research plan.
- Continued production and distribution of "Gate to Gate" CD-ROM.
- Implemented a Technology Transition Plan between NASA and FAA to facilitate transition of NASA-developed technologies into the NAS.

KEY FY 2002 PRODUCTS AND MILESTONES:

University Research Programs

Joint University program

- Publish research results reported on at quarterly reviews.

Industry Research Programs

Technology transfer

- Continue annual technology transfer awards.

FAA Field Offices at NASA Research Centers

- Continue FAA/NASA Coordination at the Langley and Ames Research Centers.
- Continue the development and implementation of Free Flight Phase 1 and 2 Tools.
- Continue the development and implementation of Aircraft structural safety programs.
- Continue the development and implementation of Terminal Airspace Productivity tools.
- Continue to study the feasibility of the Small Aircraft Transportation System.

FY 2002 PROGRAM REQUEST:

Industry and University Research Program Group

Funds are sought for three particular purposes:

- Sustain FAA's partnership with NASA in maintaining the research provided by the Joint University Program.
- Fund the Technology Transfer Awards program directed by the Congress.
- Maintain the FAA Field Offices at the NASA Langley and Ames Research Centers.

APPROPRIATION SUMMARY

	Amount ($000)
Appropriated (FY 1982-2000)	$ 43,418
FY 2001 Enacted	0
FY 2002 Request	609
Out-Year Planning Levels (FY 2003-2006)	2,530
Total	$ 46,557

Budget Authority ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Contracts:					
Strategic Partnerships	0	0	0	0	211
NASA Field Offices	258	0	0	0	368
Personnel Costs	1,446	973	0	0	21
Other In-house Costs	296	27	0	0	9
Total	**2,000**	**1,000**	**0**	**0**	**609**

OMB Circular A-11, Conduct of Research and Development ($000)	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request
Basic	0	0	0	0	0
Applied	21,000	1,000	0	0	609
Development (includes prototypes)	0	0	0	0	0
Total	**21,000**	**1,000**	**0**	**0**	**609**

A10a – Strategic Partnerships Product and Activities	FY 2002 Request ($000)	Program Schedule					
		FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY2006
101-210 Strategic Partnerships							
Industry Research Programs	$211						
Technology Transfer/Award			◇	◇	◇	◇	◇
University Research Programs							
Joint University Program			◇	◇	◇	◇	◇
Hold Quarterly Reviews			◇	◇	◇	◇	◇
101-220 NASA Field Offices							
Conduct Annual Reviews in Support of R,E,&D Efforts Between FAA NASA for Multiple Programs	$368						
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							
Personnel and Other In-House Costs	$30						
Total Budget Authority	$609	$0	$609	$619	$627	$639	$646

Note: Out year numbers are for planning purposes only. Actual funding needs will be determined through the annual budget process.

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APPENDIX A
RESEARCH, ENGINEERING AND DEVELOPMENT 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 reports. This document summarizes recent Committee recommendations and FAA responses.

FAA's R,E&D Advisory Committee and NASA's Aero-Space Technology Advisory Committee will continue joint meetings to establish a framework that allows FAA and NASA to communicate, coordinate, and manage their R&D goals in the areas of safety, efficiency, and environment and energy.

Since preparation of the 2000 *FAA National Aviation Research Plan*, the Committee submitted the following reports:

- Committee's Recommendations on Fiscal Year 2001-2005 R,E&D Investment Portfolio, dated June 11, 1999 (Updated FAA response-Sept. 1, 2000)
- Committee's Guidance on FY 2002 Budget, dated December 17, 1999 (FAA response-Sept. 1, 2000)
- Committee's Recommendations on Fiscal Year 2002-2006 Investment Portfolio, dated July 13, 2000 (FAA response pending)

In 2001, FAA expects to receive the Committee's recommendations on FAA's planned research and development investments for fiscal year 2003, including detailed recommendations from the standing subcommittees.

Also in 2001, the Committee will be receiving recommendations from two ad hoc Subcommittees: the Tiltrotor and Advanced Rotorcraft Technology in the NAS (TARTNAS) and the Small Aircraft Transportation Systems (SATS).

COMMITTEE'S RECOMMENDATIONS ON FISCAL YEAR 2001-2005 R,E&D INVESTMENT PORTFOLIO (DATED JUNE 11, 1999)

At the April 21, 1999, Committee meeting, the Committee reviewed FAA's planned FY 2001-2005 R,E&D Investment Portfolio and provided recommendations to FAA in a letter dated June 11, 1999 from Committee Chairman Mr. Robert Doll to Administrator Jane Garvey. The FAA provided an interim response at the September 14, 1999, Committee meeting and an updated response at the April 11, 2000 meeting. FAA provided a formal response by letter dated September 1, 2000. The recommendations and FAA's responses are provided below.

COMMITTEE RECOMMENDATIONS:

We recently concluded our first round of meetings for 1999 of the Research, Engineering and Development Advisory Committee and its Subcommittees. Another round of subcommittee meetings will be held between now and September 14, 1999 when we will convene our last REDAC meeting for this year. We hope that you will be able to attend the opening session of the September meeting when perhaps you could share your views on the Agency's progress in RE&D and particularly about free flight and its attendant programs.

We are now working with the appropriate people in NASA to assure the maximum coordination of our respective advisory committee efforts and RE&D programs we are charged to oversee. A coordinating committee composed of members of the REDAC and NASA's ASTAC has been formed for the purpose of coordinating the goals of the agencies. An initial meeting of the new committee will be held June 22 through June 24.

All of the concerns that have been underlying the REDAC's efforts for the past few years are still prevalent and, in fact, growing in many areas. Of particular concern is the continuing lack of funds appropriated to the FAA and NASA to support research for aviation and the shift of significant RE&D budget allocations to F&E accounts.

Not a meeting goes by without a discussion of the serious consequences of the continued under funding of the RE&D aviation budget. The comparative level of RE&D expenditures within the European Union continues as a topic of interest to the REDAC. The U.S. aviation industry produces hundreds of billions of gross revenue dollars annually and accounts for a large proportion of our foreign trade revenues. The percentage of the gross revenues that the U.S. aviation/aerospace industry spends on RE&D is scandalously small. The responsibility lies with both the government and the private sector.

If we do not pay attention to developing the systems, facilities and equipment needed to handle the growth that our economy demands of the air transportation system, the growth of our economy will be adversely affected. This is a very simple equation.

I understand from industry sources that a major new study of European aviation related expenditures, including RE&D expenditures, is about to be released. I believe that this report will show that the US continues to be dramatically outspent in absolute terms by the EU in all areas of aviation RE&D.

We face the very real prospect of losing our lead in air traffic management systems and standards and the related hardware that we have traditionally supplied to the global aviation community. The potential impact to our economy of the loss of industry leadership is difficult to estimate.

A visit by a high level FAA team will take place with European leaders this month. We understand that US interests are entitled by treaty to share in the results of European RE&D efforts. We need to take advantage of this right to access the RE&D work in Europe. We strongly support this meeting.

The idea that the portion of RE&D expenditures funding needed for facilities and equipment is not related to RE&D but to project implementation is a bad idea. Equipment and facilities acquisitions are an integral part of the RE&D process. To remove these expenditures from the RE&D budget incurs a high risk of the money disappearing from RE&D availability over the longer term. It is imperative that any RE&D funds that have been moved to the F&E Budget be effectively “fenced” for RE&D like activities.

In our eyes, the acquisition of facilities and equipment for RE&D outside of the purview of RE&D personnel is fraught with danger. We fear that the research requirements for specific features of that equipment could be lost on F&E acquisition personnel.

This is a major concern in the Airport Technology RE&D budget where all of the dollars were moved to F&E. What may not be apparent to the decision-makers is that the Pavement Test Facility is completed. There will be very little spending required on F&E in the future for Airport Technology RE&D. Therefore there is no rationale for having Airport Technology funding in the F&E budget.

The REDAC supports the FY 2001 RE&D budget as constructed by the roll-up of the individual RPD requirements. We believe that a strong effort to meet this funding level is required of the FAA before the GAO and Congress. We hope that the idea of Flagship Initiatives is pursued to provide a significant boost to FY 2001 funding.

The high-level budget requirements for FY 2001 were presented to us in our April meeting. The FY 2001 requirements and the comparable previous year request and authorizations appear in the table on the following page.

Category	FY 1999 Appropriation	FY 2000 President's Budget	FY 2001 RPD Requirements
Aircraft Safety	$ 34.9	$ 39.6	$ 60.0
Aviation Security	$ 51.7	$ 53.2	$ 66.3
Environ & Energy	$ 2.9	$ 3.5	$ 7.4
Human Factors	$ 25.1	$ 26.2	$ 29.7
R&D Management	$ 2.2	$ 2.7	$ 2.7
ATM	$ 90.9	$ 94.0	$ 132.2
Safe Flight 21*	$ 16.0	$ 16.0	$ 30.0
Airport Technology**	$ 5.0	$ 7.2	$ 10.0
CAASD ATM R&D***	$ 31.8	$ 35.8	$ 37.4
Total	$ 260.5	$ 278.2	$ 375.7

* FY 1999 Safe Flight Funds are in the F&E Account

** All Funding is in the F&E Account

*** Funds are provided from the RE&D and F&E Accounts

Congress has essentially mandated the level of the Aviation Security expenditure. The explicit Human Factors portion of the entire budget is significant and includes monies dedicated to Aircraft Safety and ATM RE&D projects. We would like to see more money spent in Human Factors but the practicalities of anticipated funding and mandates do not allow reallocation of money from other RPDs into the explicit Human factors efforts. We believe that industry must step up to supporting efforts such as Human Factors and Aircraft Safety to bring themselves more in line with the benefits they derive from those efforts.

The severe budget cuts proposed for NASA are truly alarming to the REDAC. The prevailing view in the industry is that NASA may need to be renamed NSA, dropping any reference to "Aeronautics" in their name if the present budget cuts are sustained. NASA's leaders have stated that they will eliminate efforts related to aeronautics in order to maintain their space program expenditures.

The REDAC believes that progress on aircraft engine emissions and noise-related research will be severely impacted as NASA is forced to wind down current research efforts. The cessation of funding for noise and emission research is not in the public interest. The FAA will be hampered in its future efforts to effectively certify new systems and to produce effective regulation for the air transport system.

Discontinuities in basic research can't be recovered. The simple fact is that, even if money could be transferred from the NASA research budget to the FAA RE&D budget, the money would not be effectively spent as the FAA is not equipped or staffed to accomplish basic R,E&D.

FAA RESPONSE:

Your first recommendation expresses a concern over lack of adequate R&D funding, which threatens the U.S. lead in Air Traffic Management (ATM). FAA shares the Committee's concern about the lack of adequate R&D funding compared to that within the European Community (EC) and its impact on U.S. leadership in ATM. Our overtures to the EC about sharing in the results of European R&D efforts have not been fruitful. EC programs require matching funds from European industry teams; therefore, results are held closely to provide a competitive advantage. It is unlikely that any EC funded results will be shared with the U.S. other than information made available to the general public. We will continue working with Europe on ATM technology through the FAA/Eurocontrol R&D Committee, which has already proven beneficial to the U.S. and Europe. The EC participates in this forum, providing us an avenue for exchanging information.

Your second recommendation expresses concern over the movement of programs from the R,E&D to the Facilities and Equipment (F&E) appropriation. Similarly, your third recommendation questions the rationale for moving the Airports Technology program from R,E&D to F&E. In FY 1999, Congress moved the R,E&D programs in Capacity and ATM Technology, Communication, Navigation and Surveillance, and Airport Technology from the R,E&D to the F&E appropriation. The FY 1999 Conference Report created the "Advanced Technology Development and Prototyping" budget item in Activity 1 of the F&E appropriation and allocated the former R,E&D items into this line item. The FY 1999 House Report stated the following:

"The Committee recommends $45,857,000 for a new activity, 'Advanced technology development and prototyping'. Previously these activities were budgeted in the Research, Engineering and Development (R,E&D) appropriation under activities titled 'Capacity and air traffic management technology' and 'Communications, navigation and surveillance'. The Committee believes that, because these activities fit closely with follow-on activities funded in F&E, management could be improved if they were funded together in F&E. These activities are funded at the budget request levels, except for the 'Flight 2000' project, for which no funds are provided. The Committee does not intend for this budget adjustment to change the authorizing committee of jurisdiction in the House, which has historically been the Committee on Science. For that reason these activities are recommended in a single new program, rather than dispersed throughout the F&E appropriation."

Congress made the decision to move these programs from the R,E&D to F&E appropriation, and FAA must follow the legislation resulting from that decision. Although the appropriation has changed, we have been able to manage the programs within the new line item. First, the programs within the new F&E line item are essentially the same programs that were under the former R,E&D line items. Second, the new line item has retained a consistent level of funding since the move, so the programs have not suffered from lack of funding. Third, we have modified and are continuing to improve our internal budget process for managing our R&D investment portfolio, which includes both the R,E&D and F&E Activity 1 programs. Finally, the Integrated Product Teams (IPT) have "cradle to grave" responsibility for programs. That means that an IPT manages a program from its initial research to its implementation. Therefore, the same personnel continue to manage these programs even though the programs have moved from the R,E&D to F&E appropriation, so there is no change in personnel or any loss of knowledge.

Your fourth recommendation points out the potential for FAA to share the results of the European Union (EU) R&D program. As your letter indicates, a high level FAA team met with European leaders in June 1999. FAA conducted a second, follow-up meeting with the European Commission (EC) in Brussels in October 1999. Dr. Aaron Gellman, a member of the R,E&D Advisory Committee at the time, attended the meeting. As a result of the meeting, FAA and EC agreed to share information from R&D efforts of mutual interest. Both organizations identified the crashworthiness area as a candidate program for further mutual cooperation. Since October, FAA and EC have shared specific program plans in that and other areas. Although FAA has shared R&D results with the EC, there are complications related to FAA accessing EC R&D results as mentioned previously. The EC restricts its R&D results through proprietary rights designations to protect industries within the EU and promote the global competitiveness of the EU throughout the world. This makes it difficult and often prohibitive for FAA, a U.S. Government agency, to access EU R&D results.

Your fifth recommendation provides approval for our FY 2001 R&D program. The table below [next page] provides the President's FY 2001 budget compared to the figures in your table, which show our total requirements in FY 2001. As shown in the table, the FY 2001 President's budget includes a total of $257.5 million for R&D programs in the categories listed, which include R,E&D, F&E and Airport Improvement Program (AIP) appropriations.

		President's Budget			
	FY 2001	FY 2001			
Category	RPD Requirement	R,E&D	F&E	AIP	Total
Aircraft Safety	$60.0	$49.4			$49.4
Aviation Security	66.3	49.4			49.4
Environment & Energy	7.4	7.4			7.4
Human Factors	29.7	25.1			25.1
R&D Management	2.7	1.3			1.3
ATM	132.2	41.2	$40.8		82.0
Safe Flight 21	30.0		25.0		25.0
Airport Technology	10.0			$7.4	7.4
CAASD ATM R&D	37.4	5.0	*32.4		37.4
Information Security		5.5			5.5
Total	$375.7	$184.3	$65.8	$7.4	$257.5

* Total of $63.4M in F&E for CAASD in FY 2001 President's Budget

Your sixth recommendation indicates concern over the alarming cuts in the National Aeronautics and Space Administration (NASA) budget. We have forwarded the Committee's concerns to the NASA Associate Administrator for Aerospace Technology. As you know, FAA and the U.S industry is critically dependent on NASA research in several areas, including aircraft engine emissions and noise. FAA has strongly supported NASA's environmental research to the Office of Management and Budget (OMB) and Congress. It appears that some of NASA's environmental research funding is now supported by Congress and may be increased in FY01.

Your comments specifically address concern over the lack of funds for NASA engine emissions and noise-related research and the impact of this on FAA's ability to effectively certify new systems and produce effective regulation for the air transport system in the future. This is a difficult issue because of evolving priorities within the executive and legislative branches of the U.S. Government. As you know, the NASA Advanced Subsonic Technology (AST) and High-Speed Research (HSR) programs were terminated in FY 1999. However, a new NASA Quiet Aircraft Technology program has begun in FY 2000 as a result of Congressional action, and it is planned to continue that effort in the President's FY 2001 budget request. New emissions work has also begun in FY2000 within the NASA Ultra Efficient Engine Technology program. Both new programs are currently included in budget plans through FY 2005. These programs are currently funded at lower levels than the earlier AST and HSR programs and will not develop technology at the same rate or to the same high readiness levels. This is a concern that must be addressed by the entire aviation community, and we are not convinced that the program priorities as evidenced by projected funding levels are entirely appropriate to meet the real needs. To help lead the necessary discussion, the FAA and NASA have requested the National Research Council (NRC), through its Aeronautics and Space Engineering Board, to assess whether appropriate research policies and sufficient programs are in place to foster technological improvements that ensure environmental constraints do not become a significant barrier to growth of the aviation sector. The final report of this respected authority will likely be available in about two years, and we hope that R,E&D Advisory Committee will closely follow the NRC deliberations in the meanwhile.

COMMITTEE'S GUIDANCE ON FY 2002 BUDGET (DATED DECEMBER 17, 1999)

Each year in September, the Committee provides recommendations on how the FAA should invest its R,E&D funds. The Committee provided guidance on FAA's FY 2002 budget in a letter to the Administrator dated December 17, 1999. The Committee received a formal response by letter dated September 1, 2000. The recommendations and FAA's responses are provided below.

COMMITTEE RECOMMENDATIONS:

At the meeting, NASA made a most effective presentation on their concept of a Small Aircraft Transportation System (SATS). We feel that SATS has potential as a significant new opportunity to increase air transport efficiency. It is evident to the REDAC that SATS will provide many new challenges for the FAA in the next decade that must be met if the program is to mature from the NASA research phase. Funds will be needed to begin RE&D work in the FAA. NASA's Gen. Sam Armstrong informed us that the FAA/ NASA Executive Committee wishes to study SATS further, since aspects of the SATS program are not yet defined. We approved an ad hoc group to work jointly with NASA on the developing SATS program and to review a Transportation Research Board (TRB) charter. The ad hoc group has been busy organizing a joint meeting with NASA to be held on January 18, 2000.

Our techical discussions centered on the continuing problem of funding the research and development of critical aeronautics initiatives. Of continuing priority are the programs that are critically needed to meet the rapidly growing demands for air travel that sorely taxed the system this past summer. The problems that were experienced by air travelers are the classic symptoms that arise when a server system is reaching its true capacity.

Several ideas were discussed as to how, as individuals, we might help deliver a message of the REDAC's deep concern regarding aeronautics R&D funding to Congress and to the Administration. We concluded that it would be most effective to carry the message back to the organizations represented by the members of the REDAC. We agree that the FAA and NASA should charter a "blue ribbon" group from the National Research Council. This group would solicit and synthesize the views of all of the stakeholders. The result will be a consensus vision of the civil aviation system of the future. They would be tasked to make a first order estimate of the resources required to enable this vision. With this NRC report, the FAA and NASA would have a basis for their individual budget requests for the next several years.

In October the REDAC Air Traffic Services (ATS) Subcommittee and the NASA ATM Executive Steering Committee held a joint meeting. Based on the information received at the meeting, the ATS Subcommittee sent a letter on December 10 to Steve Zaidman recommending that the FAA should become more involved with NASA's ATM efforts at all levels of the FAA but particularly at the top levels of the organization. Involvement must include the FAA's operational organizations as well as the Research and Acquisition organization. Top level involvement is necessary to support funding for NASA's aviation program with the Congress and the Administration. Of equal importance is the harmonization of the FAA's implementation capabilities with the NASA program to assure NASA's resources are used most effectively. We urge that you support Steve Zaidman in this effort.

The REDAC reiterates that the system capacity issue involves more than just the efficient use of the airspace. Unless airport facility issues, ground handling issues and noise and emission issues are pursued with equal vigor, the system will not be able to meet traveler's demands in the very near future. The frustration that the REDAC finds is that there are not any funds visible in other areas such as human factors, security or aircraft safety that could be reallocated without affecting critical programs in those areas. With the looming phase out of the current NASA noise and emissions program, it becomes ever more urgent that Congress and the Administration understand that these issues are real and need a bipartisan solution.

FAA RESPONSE:

Your first recommendation is that we apply funds to begin R&D work on the Small Aircraft Transportation System (SATS). As you mentioned in your letter, SATS is a National Aeronautics and Space Administration (NASA) research program. Currently, FAA is working with NASA through the FAA/NASA Executive Committee to determine an appropriate and achievable level of participation by the FAA in the SATS Program. Although we do not have contract funds assigned to SATS in our FY 2000 or 2001 programs, we do have personnel working on planning efforts related to SATS and are working to include contract funds for SATS in our FY 2002 R,E&D budget. However, like all federal agencies, FAA must operate within budget constraints; therefore, we cannot assure you that this effort will move forward in our FY 2002 budget. We can assure you that we are monitoring the NASA SATS program and working to accommodate it to the extent that our resources allow.

Your second recommendation is for FAA and NASA to charter a Blue Ribbon panel from the National Research Council (NRC) to develop a consensus vision of the civil aviation system of the future. We appreciate your support in our effort to work with NASA to formulate the Aerospace Transportation System After Next, with an objective to define the aerospace transportation system required in the years 2020 to 2050. We expect to use the result to plan future research efforts. At your April meeting, I presented our proposal to work with NRC on this effort. As we discussed at the meeting, we plan for REDAC along with the NASA Aero Space Transportation Advisory Committee (ASTAC) to lead a large part of the effort. We appreciate your approval to form a joint task force with the ASTAC to guide the vision development process.

Your third recommendation addresses the need for all levels of FAA, and particularly top-level managers and operational organizations, to become more involved with NASA's Air Traffic Management (ATM) efforts, with a focus on harmonizing FAA's implementation capabilities with the NASA program. We agree with your recommendation. We believe that having more involvement at all levels in the operational organizations would improve the harmonization of the R&D and its implementation. However, the operational side, in particular, requires Operations and Facilities and Equipment (F&E) resources to participate. This is a challenge, because resources in these budgets are limited. New requirements must compete with very high-priority operational and NAS modernization programs. One area where we are working to identify increased NASA and operational organization involvement is Free Flight Phase 2. Although planning is still underway, the structure will clearly identify increased involvement between NASA and FAA operational organizations. We consider this an important step toward increased harmonization.

Your final recommendation expresses concern over lack of funding designated to address noise and emission issues, which if unresolved could constrain future growth of the aviation system. We are working to increase our Environment and Energy program. In the FY 2001 President's budget, we more than doubled our request for Environment and Energy from the $3.4 million received in FY 2000 to $7.4 million. Most of this increase is in the noise area, which supports our rulemaking, standards setting, and modeling to assess noise impacts. Although the FY 2001 appropriations process is not complete, both the House and Senate have indicated the amount will be close to that provided in the current year. Thus, we will not likely be able to enhance our Environment and Energy program as you have advised.

COMMITTEE'S RECOMMENDATIONS ON FISCAL YEAR 2002-2006 R,E&D INVESTMENT PORTFOLIO (DATED JULY 13, 2000)

At the April 11-12, 2000, Committee meeting, the Committee reviewed FAA's planned FY 2002-2006 R,E&D Investment Portfolio and provided recommendations to FAA in a letter dated July 13, 2000 from Committee Chairman Mr. Robert Doll to Administrator Jane Garvey.

COMMITTEE RECOMMENDATIONS:

The majority of the REDAC supports the requirements shown in the table below. Some members of the committee feel that the sub committees are not given enough detail to make such a decision. We are working on procedural changes to assure that all of the sub committees feel comfortable with the depth of information they receive. We believe these funding levels accurately reflect the appropriations required by each line of business to advance its programs and achieve important goals.

These include the strategic plan goals of safety, security, and efficiency as well as the enabling environmental goals.We note the disparity between the requirements and the Office of Management and Budget (OMB) target level funding. The OMB target falls significantly below the required funding level. Therefore, we strongly support an effort by FAA to develop Flagship Initiatives to supplement the OMB target level funding in order to bring it closer inline with the required funding level. We believe a strong R&D program is essential to our future aviation system, and the required funding level is a step toward strengthening the R&D program that will contribute to achieving the goals of your strategic plan.

The majority of the committee endorses the "Aviation System After Next" effort to develop a longer-term vision for the aviation system beyond the year 2020. The FAA and the National Aeronautics and Space Administration (NASA) propose it as a unified effort including government and private-sector stakeholders led by a joint working group of our Committee and the NASA Aero Space Transportation Advisory Committee (ASTAC). Currently, we are participating with the NASA ASTAC to develop a plan for accomplishing this effort. We feel that it is our responsibility to ensure that future generations of Americans will have the quality of life and economic prosperity that the current national aviation system affords our generation today. A minority of the committee felt that this effort was too far reaching and could not produce meaningful results. They felt the industry would be better served with an effort to better define what comes after Free Flight I/II before efforts are spent going beyond 2020.

We support the congressional direction under the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century (AIR-21) to create a Chief Operating Officer (COO) for the air traffic control system, appointed by the Administrator and reporting directly to the Administrator. We believe that this action is long overdue and have been recommending it for some time now. In April 1997, we presented our National Airspace System (NAS) Air Traffic Management R&D report to Acting Administrator Barry Valentine. One of our primary recommendations in this report was to establish a Deputy Administrator position responsible for the air traffic control system – including the creation, operation, and maintenance of the NAS but not the regulatory obligations. As we said in our 1997 report, the new COO will help breakdown the walls between the engineering and operational organizations and, thereby, focus the necessary actions to achieve a successful NAS. Therefore, we support this important initiative.

Program Area	FY 2002 Requirement ($M)	FY 2002 OMB Target ($M)	Delta ($M)
Aircraft Safety	78.6	66.0	12.6
Aviation Security	92.8	50.2	42.6
Environment & Energy	7.7	7.7	--
R&D Management	2.5	2.5	--
Information Security	10.5	5.5	5.0
Air Traffic Systems	164.8	128.6	36.2
Safe Flight 21	45.0	25.0	20.0
Airport Technology	10.0	7.5	2.5
TOTAL	411.9	293.0	118.9

We recommend separating the aviation security R&D program from the balance of the R&D program, because its requirements are so demanding that it is draining funds from the remaining R&D program. In the next decade, the aviation security program will require several billion dollars to achieve the zero-tolerance goals established by both Congress and the White House. This puts a tremendous financial burden on FAA as the sole agency responsible for fighting terrorism in our aviation system, because significant increases to the R&D budget to accomplish this mission have not been forthcoming. As the security portion of the R&D budget has increased, the total R&D budget has declined.

This has exhausted the balance of FAA's R&D program including air traffic systems, airports, aircraft safety, human factors, and environment and energy. Furthermore, the trend threatens to continue over the next decade unless something is done to correct it. We do not believe the security program goals are unimportant. Our citizens should expect to travel safely in our aviation system. They also should expect to travel in a timely fashion, but the security program alone does not provide these services. There are other efforts within the R&D program that contribute to safety and efficiency. Therefore, we recommend segregating the aviation security R&D program from the balance of your R&D program to protect the continued existence of these programs.

Although we support the goals of the environment and energy program, we believe the program is grossly under funded and may not meet its goals at current funding levels. I have asked Mr. James DeLong, Chairman of our Subcommittee on Environment and Energy, to investigate and report on this issue in more detail. In the meantime, I would like to share some of the subcommittee's preliminary findings. FAA invests $7.7 million per year in its environment and energy program. This is grossly out of proportion to what the rest of the community spends each year. For example, Louisville spent an average of $75 million per year for 10 years to expand its airport. A large part of that expenditure was related directly to environmental concerns, primarily noise. Compare FAA's $7.7 million to Louisville's $75 million: that is one airport and one investment. It seems out of proportion. Denver built a new airport for no other reason than environmental concerns, specifically noise and emissions. The price tag was $4.5 billion. In the first year, Denver violated noise restrictions with fines of $35 million for that year alone. These were levied as landing fees, which resulted in higher airfares. We all pay when airfares increase. Studies show that a 10 percent increase in airfares results in a reduction in air travel by as much as 27 percent. That is quite an elastic demand curve compared to automobile travel, which reduces only 2-3 percent for a 10 percent increase in gasoline prices. When air-

fares increase, the economy suffers and so does our quality of life.

Another example is Seattle Tacoma, which plans to build a new runway to access the Far East. It should cost $60 million, but it probably will cost $300 million after addressing environmental concerns. These concerns include relocating 10 acres of wetlands and 700 homes and businesses; sound proofing historic sites, schools, and 170 homes; and using staged construction due to environmental restrictions, which will delay completion of the project, thereby, increasing cost.

Historically, the FAA has set aside about 12% of its annual airport budget for noise abatement or mitigation. This will amount to $300 million in FY 2002. This type of expenditure will continue for the foreseeable future for sound proofing and acquiring homes. As stated above, the $7.7 million allocated to environmental and energy research programs pales in comparison. The Subcommittee on Environment and Energy will consider a detailed recommendation at their next meeting for the FAA to fund a feasibility study for the development of a "green" engine focusing on how some of the abatement funds might be better directed toward a potential solution to the noise problem rather than building ever larger buffer zones.

Environmental impacts extend beyond our national borders. They threaten our global competitiveness. Europe is attempting to eliminate acoustically treated aircraft from operating in Europe. This action would restrict our aircraft from that market. The FAA's environmental R&D provides the regulation, certification, and policies that the industry needs both in the U.S. and worldwide. We recommend more funding for environment and energy, because we see it as perhaps the greatest inhibitor to the growth of our industry.

We want to direct your attention to the fuel problem facing general aviation. There is a worldwide trend to phase out leaded general aviation fuel. The European Union plans to ban leaded fuel after 2005. We believe that the effort to find a replacement for leaded fuel will require R&D funds of $4 million in FY 2002. Current general aviation fuel supplies are drying up and represent such a small percentage of the petroleum industry that the industry may stop producing it. These factors drive the need for alternative fuels for general aviation.

However, new fuels require new engine technology, and this requires retrofitting the fleet with new engines, which could take 30 years or more. There is compelling need for an alternative fuel that is transportable, adaptable to the existing fleet, and available in large quantities. Without it, we risk losing general aviation. Without it, we risk losing the primary training-arena that feeds pilots to the regional and commercial fleet. Without it, we fear fatalities as aviators attempt to use unapproved alternative fuels. Therefore, we recommend $4 million in R&D to upgrade the FAA research lab that certifies general aviation fuels. One of our members describes the current facility as shockingly archaic.

APPENDIX B

ALPHABETICAL LISTING OF NATIONAL AVIATION RESEARCH PLAN BUDGET LINE ITEMS

APPENDIX C
NUMERICAL LISTING OF NATIONAL AVIATION RESEARCH PLAN PROJECTS

Project Number	Budget Program	Budget Item
011-130	System Planning and Resource Management	A01a
011-140	William J. Hughes Technical Center Laboratory Facility	A01b
011-160	Center for Advanced Aviation System Development (CAASD)	A01c
011-170	Information System Security	A01d
041-110	Weather Program	A04a
060-110	Aviation Safety Risk Analysis	A06g
061-110	Fire Research and Safety	A06a
062-110/111	Advanced Materials/Structural Safety	A06b
063-110	Propulsion and Fuel Systems	A06c
064-110/111	Flight Safety/Atmospheric Hazards Research	A06d
065-110	Aging Aircraft	A06e
066-110	Aircraft Catastrophic Failure Prevention Research	A06f
071-110	Explosives and Weapons Detection	A07a
073-110	Airport Security Technology Integration	A07b
075-110	Aircraft Hardening	A07d
076-110	Aviation Security Human Factors	A07c
081-110	Flight-Deck/Maintenance/System Integration Human Factors	A08a
082-110	Air Traffic Control/Airway Facilities Human Factors	A08b
086-110	Aeromedical Research	A08c
091-110/111/114	Environment and Energy	A09a
101-210/220	Strategic Partnerships	A10a
4554085599	Runway Incursion Reduction	1F01
26600855002	System Capacity, Planning and Improvements	1F01
9882085599	General Aviation and Vertical Flight Technology Program	1F01
TBD	Safe Flight 21	1F01
9861085599	Operations Concept Validation	1F01
9875085500	Software Engineering R&D	1F01
1127085500	Navigation	1F01
6710085500	Surveillance	1F01
9720085500	Airspace Management Lab	1F01
2661085500	Separation Standards	1F01
TBD	Domestic Reduced Vertical Separation Minima	1F01
TBD	NAS Requirements Development	1F01
TBD	Airport Technologies	TBD
TBD	Commercial Space Transportation Safety	TBD

APPENDIX D

LISTS OF ACRONYMS

The following high-frequency or generally well known acronyms often appear in the text of this plan without statement of their full equivalent.

AC	Advisory Circular
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Services
CONOPS	Concept of Operations
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
F&E	Facilities and Equipment
FAA	Federal Aviation Administrator
GAO	General Accounting Office
NAS	National Airspace
NASA	National Aeronautics and Space Administration
NTSB	National Transportation Safety Board
OMB	Office of Management and Budget
R&D	Research and Development
R,E&D	Research, Engineering and Development
REDAC	Research, Engineering and Development Advisory Committee
TRACON	Terminal Radar Approach Control

The following acronyms will generally appear with their full equivalent stated at its first occurrence in each major section of this plan or each program description.

A

AAAE	American Association of Airport Executives
AANC	Airworthiness Assurance Nondestructive Inspection Validation Center
ACARS	Airborne Collision Avoidance Radar System
ACAS	Airborne Collision Avoidance System
ACE	Aviation Capacity Enhancement
ACI-NA	Airports Council International – North America
ACSEP	Aircraft Certification Systems Evaluation Program
ADL	Aeronautical Data Link
ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance—Broadcast
AEAP	Aviation Effects on the Atmosphere Project
AED	Automatic External Defribilator
aFAST	active Final Approach Spacing Tool
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
ALEAN	Airport Law Enforcement Agency Network
ALPA	Airline Pilots Association
AMASS	Airport Movement Area Safety System
AMCP	Aeronautical Telecommunications Network Panel
AOC	Airline Operational Control
AOPA	Aircraft Owners and Pilots Association

APARMO	Asian/Pacific Approvals Registry and Monitoring Organization
APB	Acquisition Program Baseline
APEC	Asia Pacific Economic Cooperative
API	Adaptation Process Improvement
APMS	Automated Performance Measurement System
AQP	Advanced Qualification Program
ARAC	Aviation Regulatory Advisory Committee
ARTCC	Air Route Traffic Control Center
ASAC	Aviation Security Advisory Committee
ASDE	Airport Surface Detection Equipment
ASDI	Aircraft Situational Display for Industry
ASMM	Aviation Safety Risk Analysis
ASRA	NASA Aviation System Data Monitoring and Modeling
AST	Advanced Subsonic Technology
ASTI	Airport Security Technology Integration
ASTM	American Society on Testing and Materials
ATA	Air Transport Association
ATC	Air Traffic Control
ATCA	Air Traffic Control Association
ATCS	Air Traffic Control Specialist
ATIS	Automated Terminal Information Service
ATM	Air Traffic Management
ATS	Air Traffic Services
ATSOIT	Air Traffic Satellite Operational Implementation Team
ATSP	Air Traffic Service Plan
AVOSS	Advanced Vortex Spacing System
AWT	Area Work Team

B

BITE	Built-In Test Equipment
C	
CAA	(British) Civil Aviation Administration
CAASD	Center for Advanced Aviation System Development
CAEP	Committee on Aviation Environmental Protection
CAMI	Civil Aeromedical Institute
CAPPS	Computer Assisted Passenger Pre-Screening System
CASR	Center for Aviation Systems Reliability
CAST	Certification Authorities Software Team
CBT	Computer-Based Training
CDM	Collaborative Decision Making
CDTI	Cockpit Display of Traffic Information
CERAP	Center Radar Approach Control
CFC	chloroflourocarbon
CFIT	Controlled Flight into Terrain
CIS	Cockpit Information System
CNS	Communication, Navigation, and Surveillance
COCOTS	Constructive COTS
COE	Center of Excellence
COMSTAC	Commercial Space Transportation Advisory Committee
COTS	Commercial-off-the-Shelf
CPBVE	Crew Protective Breathing and Vision Equipment
CPDLC	Controller Pilot Data Link Communications
CRC	Coordinating Research Council
CRCT	Collaborative Routing Coordination Tools
CRDA	Cooperative Research and Development Agreement
CRDA	Converging Runway Display Aid
CRM	Crew Resource Management

CST	Commercial Space Transportation
CTAS	Center TRACON Automation System
D	
DARWIN	Design Assessment of Reliability with Inspection
D-ATIS	Digital-Automated Terminal Information Service
DFDR	Digital Flight Data Recorder
DOE	Department of Energy
DSR	Display System Replacement
DSS	Decision Support System
E	
EAA	Experimental Aircraft Association
EARTS	Enroute Automated Radar Tracking System
EDA	En Route Descent Advisor
EDD	Explosives Detection Device
EDM	Expert Decision Making
EDMS	Emissions and Dispersion Modeling System
EDP	Expedite Departure Path
EDS	Explosives Detection System
EEHWG	Electromagnetic Effects Harmonization Working Group
EGNOS	European Geostationary Navigation Overlay Service
EMS	Emergency Medical Service
ETC	Engine Titanium Consortium
F	
FANG	FMS-ATM Next Generation
FAR	Federal Aviation Regulation
FAST	Final Approach Spacing Tool
FEM	Finite Element Model
FFP1, FFP2	Free Flight Phase 1, Free Flight Phase 2

FICAN	Federal Interagency Committee on Aviation Noise
FIS	Flight Information Service
FL	Flight Level
FMS	Flight Management System
FOQA	Flight Operations Quality Assurance
FQT	Formal Qualification Testing
FSM	Flight Schedule Monitor
FTE	Full Time Equivalent
FTHWG	Flight Test Harmonization Working Group
FY	Fiscal Year
G	
GA	General Aviation
GAMA	General Aviation Manufacturers Association
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
HFACS	Human Factors Analysis and Classification System
HIC	Head Injury Criteria
HIRF	High Intensity Radiated Field
HSI	Human Systems Integration
HUMS	Health/Usage Monitoring System
I	
IAIPT	Interagency ATM Integrated Product Team

IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ID	Intrusion Detection
IDACS	Intelligent Damage Adaptive Control System
IDM	Integrated Design and Manufacturing
IEEE	Institute of Electrical and Electronics Engineers
IFR	Instrument Flight Rules
IGEB	Interagency GPS Executive Board
IMT	Integrity Monitoring Test Bed
INM	Integrated Noise Model
IPHWG	Ice Protection Harmonization Working Group
IPT	Integrated Product Team
ISS	Information Systems Security
IWG	Interoperability Working Group
J	
JAA	Joint Aviation Authorities
JRC	Joint Resource Council
JSAT	Joint Safety Awareness Team
L	
LAAS	Local Area Augmentation System
LTP	LAAS Test Prototype
LVLASO	Low-Visibility Landing and Surface operations
M	
MANPAD	Man Portable Air Defense
MASPS	Minimum Aviation System Performance Standards
MMIR	Maintenance Malfunction Information Reporting
MOA	Memorandum of Agreement
MOPS	Minimum Operational Performance Standards

MOU	Memorandum of Understanding
MRM	Maintenance Resource Management
N	
NAPTF	National Airport Pavement Test Facility
NATCA	National Air Traffic Controllers Association
NAWCAD	Naval Air Warfare Center Aircraft Division
NCARC	National Civil Aviation Review Commission
NDI	Non-Developmental Item
NDT	Non-Destructive Testing
NEXRAD	Next Generation Weather Radar
NHTSA	National Highway Traffic Safety Administration
NICE	North Atlantic Implementation Management Group Cost Effectiveness
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NLA	New Large Aircraft
NOAA	National Oceanic and Atmospheric Administration
NOTAM	Notice to Airmen
NPRM	Notice of Proposed Rulemaking
NQR	
NRS	National Resource Specialist
NSTB	National Satellite Test Bed
NSTC	National Science and Technology Council
NWS	National Weather Service
P	
P3I	Pre-Planned Product Improvement
PBFM	Passenger Baggage Flow Model
PDC	Pre-Departure Clearance

pFAST	passive Final Approach Spacing Tool
PIP	Program Implementation Plan
PIREP	Pilot Report
PIRG	Planning and Implementation Regional Group
PPBM	Positive Passenger Baggage Matching
PPIHWG	Powerplant Installation Harmonization Working Group
R	
R&D	Research and Development
R,E&D	Research, Engineering and Development
RAA	Regional Aircarrier Association
RF	Radio Frequency
RGCSP	Review of the General Concept of Separation Panel
RIAT	Runway Incursion Action Team
RIRP	Runway Incursion Reduction Program
RITA	Rotorcraft Industry Technology Association
RLV	Reusable Launch Vehicle
RNP	Required Navigation Performance
RV	Reentry Vehicle
RVSM	Reduced Vertical Separation Minimum
S	
SAE	Society of Automotive Engineers
SAMA	Small Aircraft Manufacturers Association
SARPS	Standards and Recommended Practices
SATB	South American Test Bed
SATMS	Space and Air Traffic Management System
SATORI	Systematic Air Traffic Operations Research Initiative
SATS	Small Aircraft Transportation System
SBAS	Satellite Based Augmentation System

SBIR	Small Business Innovative Research
SCAEP	Space Charged Aerosol Electrostatic Precipitator
SDTF	Surface Development and Testing Facility
SEIPT	Security Equipment Integrated Product Team
SERC	Software Engineering Resource Center
SFP	Surveillance Fusion Platform
SICAS	Secondary Improvements and Collision Avoidance System
SITA	Societe Internationalale De Telecommunications Aeronautiques
SLD	Supercooled large Droplet
SMA	Surface Movement Advisor
SMPC	Specialty Metals Processing Consortium
SNI	Simultaneous Non-Interfering
SOIT	Satellite Operational Implementation Team
SPAS	Safety Performance Analysis System
SPEARS	Screener Proficiency Evaluation and Reporting System
SPIE	Society for Optical Engineering
SSAC	Streamlining Software Aspects of Certification
STARS	Standard Terminal Automation Replacement System
SUA	Special Use Airspace
SUPCOM	Support Command
SVM	Service Volume Model
T	
TAP	Terminal Area Productivity
TATP	Triacetone Triperoxide
TC	Transport Committee
TCA	Transport Canada Aviation
TCAS	Traffic Alert and Collision Avoidance System
TDLS	Tower Data Link System

TERPS	Terminal Instrument Procedures
TFM	Traffic Flow Management
TIP	Threat Image Projection
TIS	Traffic Information Service
TIS-B	Traffic Information Service-Broadcast
TMA	Traffic Management Advisor
TMS	Traffic Management System
TOGAA	Technical Oversight Group On Aging Aircraft
TWIP	Terminal Weather Information for Pilots
U	
URET	User Request Evaluation Tool
USAF	U.S. Air Force
V	
VFR	Visual Flight Rules
VHF	Very High Frequency
VLTA	Very Large Transport Aircraft
VNTSC	Volpe National Transportation Systems Center
W	
WAAS	Wide Area Augmentation System
WATRS	West Atlantic Route System Separation Standards
WFD	Widespread Fatigue Damage
WJHTC	William J. Hughes Technical Center
WSDDM	Weather Support to Deicing Decision Making
WVSS	Water Vapor Sensing System

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