2.3 Aircraft Safety

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 digital flight control and avionics systems, associated imbedded software, and construction of new nonmetallic 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 in the following research programs:

- Support aging aircraft by developing technologies, procedures, and practices that ensure the continued airworthiness of aircraft structures in the civil flee
- 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 conducting 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
- Enhance aviation safety risk analysis by improving FAA and industry measurement of and accountability for safety performance through risk assessment and operational indicators and sharing safety-related data

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

- Reducing the approximately 30 to 35 U.S. fire fatalities per year and 135 worldwide, in otherwise survivable accidents. At an estimated savings of $2.7 million per life, saving 24 lives per year would pay for the entire aircraft safety research, engineering, and development effort.
- Using a more reliable airframe inspection technique, which has been approved as an alternate 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 re-

pair, and publishes advisory circulars to outline acceptable means of meeting the rules. The FAA also disseminates technical information in various forms to agency 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 can demonstrate compliance and developing 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, crew, and passenger safety. It focuses on eliminating hazards to the air transportation system, by both preventing accidents from happening and by 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/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 segments of the Aircraft Safety program area. Most recently the subcommittee completed a review of the Aging Aircraft program in 1997. 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). The act mandates the FAA to "undertake or supervise research to develop technologies and to conduct data analysis for predicting the effects of aircraft design, maintenance, testing, wear, and fatigue on the life of aircraft and on air safety, to develop methods of analyzing and improving aircraft maintenance technology and practices." The 1988 act 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 ex-

panded the FAA research mission. While the FAA mission originally focused on airplane improvements, the 1990 amendment added proactive research to make airplanes free from catastrophic failure.

Safety aviation research will reduce the hazards of operating aircraft, thus providing a high 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 fourfold improvement in sensitivity for detecting the type of flaw that led to the 1989 Sioux City accident that killed 211 people.

Numerous advisory circulars (AC's) have been developed for a wide range of aviation safety-related activities, including crew resource management, design of composite structures, corrosion control, aircraft deicing, inspection, and repair. AC's 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 AC's provide guidelines for developing adequate deicing procedures.

Technical data have been developed to support standards development and the certification process and the Airworthiness Directive (AD) and Notice of Proposed Rulemaking (NPRM) issuance. For example, an alternative method of compliance was developed for composite structures that significantly reduced fatigue testing time to ensure required service life. This method has been used successfully in the certification process of many aircraft components (a recent example: General Electric GE90 turbofan engine fan blades) and has been adopted as an international standard.

R&D Partnerships

Program activities are closely coordinated with related initiatives underway within other Government agencies, including the Department of Energy (DOE), the Department of Defense (DOD), and the National Aeronautics and Space Administration (NASA). Formal agreements of cooperation are in place with the Air Force, Army, Navy, NASA, DOE, and in developing standardization data for materials in MIL-HDBKS 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.

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 9 core members, 68 industry partners, 31 university affiliates, and 12 other partners, including other Government laboratories and state organizations. The COE provides matching funds, which solidify a significant COA-FAA partnership. Through this partnership, the Government, academic institutions, and industry leverage the resources available for aviation research.

Technology Transfer

Technology transfer occurs through a variety of mechanisms:

- 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 Aging Aircraft Nondestructive Inspection Validation Center (AANC) demonstrations and validations of cost-effective aircraft inspection equipment and techniques to industry

Long-Range View

The need for safety and safety-related research will continue indefinitely. With the emergence of new and advanced technologies, there will be an ongoing need to improve air transportation system safety. There will always be a need to understand the impact of new technology on operator performance. As air traffic continues to increase, and as aircraft continue to age, there will always be a need to address issues related to aging aircraft.

With new technology, new damage mechanisms may occur, introducing hazards that must be understood and addressed. Similarly, medical advances in diagnosis and treatment force a continuing examination of crew or passenger limitations in existing and future aircraft. Research in aircraft safety must be continued to understand the impact of changes in technology on current regulatory safety standards, certification procedures, and acceptable practices for demonstration of compliance mandates.

A06a Fire Research and Safety

GOALS:

Intended Outcomes: The FAA intends to improve system safety by developing technologies, procedures, test methods, and criteria for preventing accidents caused by in-flight fires and eliminating burning cabin materials as a factor in 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 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 by new materials and formulations, new test methods, government-owned patents, reports, and journal publications.

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

- The subcommittee of the FAA Research, Engineering and Development Advisory Committee has repeatedly endorsed the Fire Research and Safety program and placed high priority on its activities.
- Long-term research in fire-resistant materials is required by specific language in the Aviation Safety Research Act of 1988 and is directly supported by the aircraft industry and materials producers through university-based FAA research consortia.
- The aircraft manufacturers and airlines have a need to evaluate halon replacement agents and improve interior material fire tests. Recognizing FAA's unique capabilities in fire safety, the aviation industry actively participates in separate working groups headed by the FAA to develop approval standards for halon replacements and improved material fire tests. 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 onsite accident investigation, such as the ValuJet and TWA 800 accidents.

Accomplishments: Fire research and safety results 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:

- Supported a major new regulation, issued February 10, 1998, that requires the retrofit of 2,994 transport aircraft with cargo compartment fire detection and suppression systems
- Documented full-scale fire tests, demonstrating significant fuselage burnthrough improvements provided by new or protected thermal acoustical insulation materials
- Documented full-scale fire test findings related to cargo compartment fire protection, including the effectiveness of halon against aerosol cans and oxygen generator fires, and the effectiveness of halon replacement agents
- Published technical report describing initial development of an exploding aerosol can simulator
- Published final report reviewing flammability hazard of Jet A fuel vapor in civil transport fuel tanks
- Developed computer program that predicts the probability of a fuel tank explosion based on input flight and fuel temperature profiles
- Completed large-scale fire tests and recommended a draft thermal protection test standard related to the shipment of pressurized

oxygen bottles in support of pending rulemaking

- Demonstrated near-zero heat release of chlorobisphenol polymers (potential for entire family of cost-effective, noncombustible plastics and resins for aircraft cabins)
- Developed accurate, simple model of fuel generation process in burning plastics to guide development of new, low-heat-release materials
- Determined that health hazards of airborne fibers from burning carbon fiber-reinforced aircraft composites are negligible for firefighters and airport personnel
- Determined that fire retardant chemical additives are not effective in heat-resistant polymers

In addition, about 24 reports and published papers are generated yearly from in-house activity. Fire test laboratories are used annually to train FAA certification engineers, and program personnel participate in approximately three major accident investigation yearly at NTSB request. The FAA operates the most extensive aircraft fire test facilities in the world.

R&D Partnerships: The FAA sponsors an international halon replacement working group. The group collaborates in research and development leading to alternate agent selection for aircraft applications as well as test methods and criteria. The FAA also sponsors an international aircraft materials fire test working group. This group strives to improve standardization of material fire tests, such as engaging in round-robin testing to ensure that the lab-to-lab variation in results is acceptably small.

The FAA organized an interagency working group on fire and materials to provide a vehicle for technology exchange among U.S. Government agencies and to prevent unwarranted duplication of work. The FAA has interagency agreements with the U.S. Air Force and the National Institute of Standards and Technology for common-interest research. The agency has a memorandum of cooperation with the British Civil Aviation Administration for a variety of fire safety research efforts and separate letters of cooperation with Canadian, Japanese, and European aviation authorities.

The Fire Research and Safety program also has grant programs with many educational institutes. Several Fortune 500 companies share costs of developing new fire-resistant materials at university-based FAA research consortia.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

Fire resistant materials

- Scaled up benzoxazine chemistry and produced fire resistant, nontoxic interior panels for evaluation of heat release rate
- Demonstrated decorative panel with 50 percent reduction in heat release rate
- Demonstrated optimized design, theory, and operation of microscale heat release rate calorimeter for commercialization
- Published heat release rate database on current, new, and developmental fire-resistant polymers

Fire detection and suppression

- Developed performance standards for gaseous halon replacement agents in cargo compartment and engine fire-extinguishing systems
- Evaluated aircraft smoke/fire detector responsiveness and characterized smoke environment during full-scale cargo compartment fire tests

Fire safety design

- Developed a stringent fire test standard for thermal acoustical insulation
- Completed design guidelines for post-crash fire burnthrough resistance hardening of aircraft fuselages
- Published upgraded *Aircraft Materials Fire Tests Handbook*

KEY FY 2000 PRODUCTS AND MILESTONES:

Fire-resistant materials

- Demonstrate thermoplastic for molded parts with 50 percent reduction in heat release rate

- Determine heat-release rate of chlorobisphenol-based polymers

Fire detection and suppression

- Complete cargo compartment water mist fire suppression system evaluation
- Complete full-scale test evaluation of solid propellant gas generator technology for application in engine fire extinguishing systems
- Develop smoke/fire simulants for use in cargo detector approval testing
- Determine fuel tank explosive hazards of fuel pump sprays

Fire safety design

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

FY 2000 PROGRAM REQUEST:

In FY 2000, long-range research on ultra fire-resistant aircraft interior materials will focus on synthesizing and evaluating the heat-release rate of an entire class of promising polymers based on a chlorobiphenol monomer. Also, as part of a multiyear endeavor to demonstrate interim improved material performance, thermoplastics for use in molded parts with a 50 percent reduction in heat-release rate will be identified. Near-term fire safety improvement testing will concentrate primarily on fire detection and suppression. Solid propellant gas generator technology developed by the military will be evaluated for application in civil transport engine fire-extinguishing systems. The effectiveness of water mist systems against various types of cargo compartment fires, including those fires involving aerosol cans, will also be determined. Additionally, smoke and fire simulants will be developed and evaluated for use in smoke detector certification testing. New research and testing related to fuel tank explosion will determine the hazards of fuel pump sprays commonly used in fuel tank systems. Finally, work will commence related to oxygen system fire safety by initiating a study to document and analyze past aircraft fire fatalities and hull losses caused by the malfunction or crash impact damage of oxygen systems.

A06a - Fire Research and Safety Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
061-110 Fire Research & Safety						
Fire Safety Design						
Initiated Study of Aircraft Hull Loses and Fatalities Caused by Oxygen System Malfunction or Damage	◆					
Published Upgraded Material Fire Test Handbook	◆					◇
Completed Design Guidelines for Postcrash Fire Burnthrough Resistance Hardening of Aircraft Fuselages	◆					
Evaluate In-flight Flame Spread Characteristics of Thermal Acoustical Insulation		◇				
Fire Resistant Materials						
Scaled-Up Benzoxazine Chemistry and Produced Fire Resistant, Non-toxic Interior Panels for Evaluation of Heat Release Rate	◆					
Demonstrated Decorative Panel with 50% Reduction in Heat Release	◆					
Published Database on Heat Release Rate of Current, New and Developmental Fire Resistant Polymers	◆					
Demonstrated Optimized Design, Theory and Operation of Microscale Heat Release Rate Calorimeter for Commercialization	◆					
Demonstrate Thermoplastic for Molded Parts with 50% Reduction in Heat Release Rate		◇				
Determine Heat Release Rate of Chlorobiphenol-based Polymers		◇				
Fire Detection and Suppression						
Completed Cargo Compartment Water Mist Fire Suppression System Evaluation	◆					
Developed Performance Standards for Gaseous Halon Replacement Agents in Cargo Compartment & Engine Fire Extinguishing Systems	◆					
Evaluated Aircraft Smoke/Fire Detector Responsiveness and Characterized Smoke Environment	◆					
Determine Fuel Tank Explosive Hazards of Fuel Pump Sprays		◇				
Complete Full-scale Test Evaluation of Solid Propellant Gas Generator Technology		◇				
Revise Draft Advisory Circular for Smoke/Fire Detection			◇			
Criteria for Approval of Reduced False-Alarm Smoke/Fire Detector Designs				◇		
Assess O2/N2 Separation Membrane Technology				◇		
Draft Oxygen Systems Safety AC						◇

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	1,999	2,963	3,377	2,098	2,070
Personnel Costs	3,072	3,345	3,001	2,315	3,116
Other Costs	629	685	615	337	342
Total	**5,700**	**6,993**	**6,993**	**4,750**	**5,528**

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 of accidents. The advanced materials area 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 on remaining strength and life of composite aircraft structure
- Reliability methods, as they apply to the design of composite aircraft components, and criteria for acceptable risk

The structural safety area focuses on the following technical areas:

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

Agency Outputs: The FAA establishes rules for aircraft certification and operation and publishes advisory circulars to provide acceptable means of achieving compliance with those rules. While the rules are the same for composite or metal structure, the means of compliance reflect behavioral differences in the structural materials. AC 20-107A, "Composite Structure," has been published, but advances in technologies and materials necessitate periodical update and expansion of the AC.

Technical information is disseminated to regulatory personnel through technical reports, handbooks, and guidance by the FAA National Resource Specialist. The goal is to develop pertinent data so that the regulatory processes keep pace with industry advances, including state-of-the-art test and evaluation for state-of-the-art technology and design.

The Advanced Materials/Structural Safety program provides support in rulemaking and development of guidance material for industry compliance. In structural safety, the FAA revises or updates Federal Aviation Regulations to accommodate new information for overhead stowage bins, auxiliary fuel tanks, and seat/restraint systems.

Customer/Stakeholder Involvement: The FAA has established the need for the Advanced Materials/Structural Safety program through consensus building activities:

- The Aviation Rulemaking Advisory Committee (ARAC) is an FAA/industry forum established to ensure that agency rulemaking is effective in achieving intended results. ARAC is also effective in identifying requirements and priorities for supporting R&D activities.
- The Challenge 2000 report concludes that FAA should enhance its already effective program of gathering data and improving the certification of composite structures.
- A recent National Research Council report highlights the needs related to advanced materials and urges FAA to step up advanced materials research for aircraft community benefits.
- The 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, conduct data analysis for current aircraft, and anticipate problems of future aircraft.

Accomplishments: Program results are provided to aircraft manufacturers, maintainers, and operators in the form of technical reports, handbooks, advisory circulars, and guidance in the process of certification.

In the advanced materials area, the program has updated or issued two advisory circulars and four handbooks; published more than 40 technical reports, articles, and papers; and co-sponsored 3 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 authorita-

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

In the structural safety area:

- Four 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.
- Inservice overhead stowage bins have been made more resilient to crash impact.
- A workshop on a crash impact modeling code developed by the FAA was held for certification engineers and industry participants

R&D Partnerships: In the advanced materials area, the FAA coordinates with NASA to leverage research expenditures. The FAA concentrates on safety and certification issues, including testing, while NASA has the lead in analysis and design issues. Currently, the FAA supports NASA efforts to develop a composite property data base for general aviation (GA) aircraft under the NASA Advanced General Aviation Transport Experiments (AGATE)/Integrated Design and Manufacturing (IDM) program.

The FAA co-sponsors, with the U.S. Army, MIL-HDBK-17, a primary and authoritative source for statistically based characterization data of current and emerging composite materials. This international reference reflects the best available data and technology for testing and analysis and includes data development and usage guidelines. FAA officials use the handbook as a primary supporting document in structural substantiation in the certification process. On recommendations by the ARAC committee, material data contained in the handbook will be acceptable for use in the certification process. There is also one international agreement to share work on reliability prediction methods for composites.

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

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 1999 ACCOMPLISHMENTS:

Advanced materials

- Updated *Composite Materials Handbook* (*Volume 2–Material Properties*) for use by rulemaking and compliance personnel
- Completed research on damage accumulation in composites due to repeated loads. This aids in developing certification criteria for composite structural components
- Verified previously developed risk assessment software using different estimation methods
- Identified the principal risk drivers that control the safety of composite airframes
- Provided data base on test methods for shear loading of composite structures to provide information for an authoritative compendium on state-of-the-art composites testing, with recommendations on test methods

Structural safety

- Completed vertical drop test of one B-737 fuselage section with an auxiliary fuel tank to determine the dynamic loads imposed on fuel tanks

KEY FY 2000 PRODUCTS AND MILESTONES:

Advanced materials

- Establish methodology to predict delamination initiation and growth at critical details in composite structures
- Provide a data base for support to AGATE/IDM on effects of bond thickness on structural performance of small composite aircraft
- Generate a data base for durability of textile forms and stitching as manufactured by resin transfer molding

Structural safety

- Complete vertical drop test of a B-737 fuselage section with overhead storage bins to determine the dynamic loads imposed on storage bins
- Complete assessment of the crash resistance of current rotorcraft, commuter, and transport fuel systems
- Establish guidelines for conducting head injury criteria component testing to supplement full-scale testing
- Complete aircraft crash modeling tool for accident investigators

FY 2000 PROGRAM REQUEST:

In FY 2000, 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 data base on effects of bond thickness on structural performance of small bonded composite aircraft.

Within the structural safety area, characterization of crash-induced commuter airplane loads, transport category overhead storage bins, and auxiliary fuel tank systems are continued. Other areas of research to be continued are crash resistance of fuel systems and development of a component tester for head injury criteria compliance.

A06b - Advanced Materials/Structural Safety Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
062-111 Advanced Materials Structures						
Advanced Materials						
Provided Database on Test Methods for Shear Loading	◆					
Verified Developed Risk Assessment Software	◆					
Identified the Principal Risk Drivers of Composite Airframes	◆					
Establish Methodology to Predict Delamination Initiation		◇				
Establish Database on Effects of Bond Thickness		◇				
Generate Database for Durability of Textile Forms		◇				
Update AC-107A Composite Structure for Durability			◇			
Establish Guidelines for Probabilistic Design Certification				◇		
Develop Database on Verified Design Practice for Adhesive Joints				◇		
Develop Database on Damage Tolerance of Sandwich Structure					◇	
Durability and Damage Tolerance Data for Rotorcraft					◇	
Identify Data for Certification of Materials at Elevated Temperatures						◇
Develop Certification Methodology for New Materials and Forms						◇
062-110 Structural Safety						
Structural Safety						
Completed Vertical Drop Test of a B737 Fuselage Section with Auxiliary Fuel Tank	◆					
Establish Guidelines for Conducting HIC Component Testing		◇				
Complete Assessment of the Crash Resistance of Transport Fuel Systems		◇				
Complete Vertical Drop Test of B737 Fuselage Section with Stowage Bins		◇				
Complete Aircraft Crash Modeling Tool for Accident Investigators		◇				
Publish Data on Ditching and Water Impact			◇			
Publish Data on Crash Resistance of Transport Aircraft Stowage Bins			◇			
Identify Transport Ditching Requirements				◇		
Define Rotorcraft Crash Pulse					◇	
Define New Occupant Injury Criteria					◇	
Establish Crash Test Database						◇
Validate Water Impact Model						◇

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	332	1,249	2,059	809	1,089
Personnel Costs	1,384	1,507	835	803	1,109
Other Costs	284	309	171	122	140
Total	**2,000**	**3,065**	**3,065**	**1,734**	**2,338**

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 program outcomes include:

- Continued reliability and safety of general aviation operations by providing a safe transition to a new high octane unleaded aviation gasoline
- A reduction in the number of intrinsic turbine rotor failures by improved and standardized design and life-management procedures
- Improved manufacturing process standards for premium quality titanium alloy, turbine rotor components
- Reduced turbine engine failure/downtime and improved maintenance efficiency through advanced monitoring/diagnostic hardware and software
- Minimized the probability of in-flight fuel tank explosions
- Continued reliability and safe use of Jet A fuel containing red dye contamination

Agency Outputs: The FAA maintains the airworthiness of aircraft engines, fuels, and airframe fuel management systems by issuing certification and advisory standards and by supporting technical society specifications and recommended practices. The FAA also publishes technical information in the public domain in various forms. The agency may also provide technology to the industry through hardware and software prototype demonstrations and technology workshops or various training media. This research program provides the resources and oversight to deliver the necessary propulsion, fuel, and fuel transfer system technology to support 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. The team advises on the adequacy of industry standards and procedures to ensure the safety of titanium alloy high-energy rotating components of turbine engines. Industry participates through working committees under the Aerospace Industries Association (AIA), including the Materials and Structures Committee, Rotor Integrity Subcommittee, and the Jet Engine Titanium Quality Committee.
- The AIA committees identify potential improvements in manufacturing process control, manufacturing and in-service inspection, and design and life management of failure-critical rotating engine parts. These improvements are the basis for identifying specific R&D already underway or planned for this program.
- The FAA participates and provides leadership in testing capability for the Coordinating Research Council (CRC) Unleaded AVGAS (Aviation Gasoline) Development Group. The group was formed in February 1995 to oversee research and testing for development of the next generation of high-octane unleaded aviation gasoline. Environmental Protection Agency (EPA) regulations and the Clean Air Act of 1990 mandate removal of lead from all gasoline.

  The critical need for developing this fuel is reflected by the list of CRC development group participants. Active participants and members 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 FAA New England Region Engine and Propeller Directorate; and the FAA Small Airplane Directorate in Kansas City.
- The FAA-sponsored Technical Oversight Group on Aging Aircraft (TOGAA) ensures effective technical coordination of the airworthiness assurance R&D activities with related activities in DOD and industry. TOGAA has

provided feedback on the progress of the turbine engine program over the last 3 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 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 in May 1991.
- The program supports the ARAC Fuel Tank Harmonization Working Group.
- 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 resulted in an effort to be funded by the FAA, Defense Energy Support Center, Internal Revenue Service (IRS), Air Transport Association, American Petroleum Institute, and engine and airframe manufacturers.

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 that provides guidance on the testing of aircraft engines.
- Hosted a joint FAA/Air Force public workshop with published proceedings on the application of probabilistic design methodology to gas turbine rotating components
- Demonstrated integrated titanium alloy probabilistic design code (DARWIN version 2.0) to provide commercial aircraft engine manufacturers a tool to augment their current safe-life management philosophy approach
- Completed vacuum fatigue crack growth testing of titanium alloy
- Determined the fleet octane requirement to be the single most critical parameter for developing high-octane unleaded aviation gasoline
- Completed validation of ground-based procedures for determining octane requirements for developing a new high-octane unleaded aviation gasoline
- Participated in establishing matrix components for developing candidate fuel formulations
- Conducted engine tests on new fuel formulations
- Completed report on engine octane requirements
- Determined and defined detonation detection procedures for proposed ASTM method to test unleaded replacement fuel(s)
- Made final determination of fleet octane requirements for unleaded replacement in high fuel performance piston engines to be greater than 100 octane
- Completed interim report on in-service Jet A fuel sample analysis volatility survey
- Completed interim data report on Jet A fuel vapor ignition characterizations

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, Allied-Signal, and Allison. This work develops probabilistic-based turbine rotor material design and life management tools for improved rotor integrity. The work is closely coordinated with the 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 plans to transfer the completed probabilistic engine design code to the public domain via a training workshop.

  A research partnership has been initiated with Specialty Metals Processing Consortium (SMPC) based at Sandia National Laboratory, which includes Sandia Liquid Metals Processing Laboratory, Allvac, Oremet Titanium Company, RMI Titanium Co., Timet Co., General Electric Aircraft Engines, Pratt & Whitney, and Concurrent Technology Corporation. SMPC will conduct research in tita-

nium and nickel alloy melting technology (purity) enhancements.

- The CRC Unleaded Aviation Gasoline Development Group partnership provides an arena to conduct research that is unprecedented in the aviation gasoline industry. The proprietary and competitive forces inhibiting progress in high-octane aviation gasoline development have been set aside. This allows technology be transferred to and from government and industry to the benefit of all participants. Industry participants include Texaco, Exxon, Phillips Petroleum, Chevron, British Petroleum, Cessna, Raytheon (Beech), Teledyne Continental, and Textron Lycoming.
- Efforts have been initiated to award a contract to Southwest Research Institute to determine an acceptable contamination that allows continuous safe turbine engine operation. The following organizations contribute funding to this effort: FAA, Defense Energy Support Center, IRS, Air Transport Association, American Petroleum Institute, General Electric, Pratt & Whitney, Rolls Royce, AlliedSignal, and Boeing.
- The program is benefiting from a close working relationship with the Airworthiness Assurance Center of Excellence. The research is leveraged by the monetary and intellectual contributions of its core universities.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

- Demonstrated and delivered the final titanium alloy defect deformation micro code for analysis of the turbine disk forging conversion process
- Demonstrated and delivered the integrated probabilistic rotor design code (DARWIN version 3.2) for titanium alloy melt defects
- Conducted DARWIN code version 3.2 FAA/ Industry training workshop
- Issued reference report “State-of-the-Art in Turbine Engine Monitoring Systems”
- Completed laboratory characterization of industry-supplied candidate fuels
- Began engine ground testing of industry supplied candidate unleaded fuels
- Issued final draft report on Jet A vapor ignition characterizations
- Issued final draft report on in-service Jet A fuel sample analysis volatility survey

KEY FY 2000 PRODUCTS AND MILESTONES:

- Deliver a framework definition for probabilistically based rotor design code for nickel alloys
- Introduce damage-tolerant rotor design through a draft advisory circular with analytical software code (DARWIN) and standardized data bases
- Complete benchmark basis for plasma hearth melt modeling
- Characterize titanium defect melt source causes
- Characterize and test industry-supplied candidate fuels using flight test aircraft and engine ground test facilities
- Determine an acceptable concentration of red dye contamination in Jet A fuel for continuous engine operation

FY 2000 PROGRAM REQUEST:

In FY 2000, the program will continue developing a probabilistically-based turbine engine rotor design code with damage-tolerance assessment. This code will be a public-domain, generic-design, life management tool—to augment the current safe-life design approach—for integration into engine manufacturer rotor design procedures. Use of this tool, as an 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. All parameters impact on safe engine operation and all data support eventual certification of a replacement fuel.

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 engine failure fatal accident rate.

A06c - Propulsion and Fuel Systems Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
063-110 Propulsion and Fuel Systems Research						
Turbine Engine Research						
Demonstrated and Delivered Final Titanium Alloy Defect Deformation Microcode	◆					
Demonstrated and Delivered the Integrated Probabilistic Design Code (DARWIN Version 3.2)	◆					
Issued Reference Report "State–of-the-Art in Turbine Engine Monitoring Systems" Monitoring Systems"	◆					
Conducted DARWIN Code Version 3.2 Training Workshop	◆					
Characterize Titanium Defect Melt Source Causes		◇				
Deliver Framework Definition for Probabilistic Rotor Design Code – Nickel Alloys		◇				
Introduce Damage Tolerant Rotor Design through a Draft AC with Analytical Software Code (DARWIN)		◇				
Complete Benchmark Basis for Plasma Hearth Melt Modeling		◇				
Demonstrate Probabilistic Integration Design Code – Surface Flaws			◇			
Demonstrate the On-line Monitoring for Alloy Composition Control in a Commercial Electron Beam Melt Furnace				◇		
Unleaded Fuels and Fuel System Safety Research						
Completed Laboratory Characterization of Industry Supplied Candidate Fuels	◆					
Issued Final Draft Report on Jet A Vapor Ignition Characterizations	◆					
Issued Final Draft Report on In-service Jet A Fuel Sample Analysis Volatility Survey	◆					
Begin 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		◇				
Characterize and Test Industry Supplied Candidate Fuels Using Flight Test Aircraft and Engine Ground Test Facilities		◇				
Complete Draft and Final ASTM Specification for High Octane Unleaded Aviation Gasoline			◇		◇	
Complete Fleet Evaluation of Candidate Unleaded Aviation Gasoline				◇		

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	1,716	1,566	3,643	1,761	1,754
Personnel Costs	1,398	1,522	1,126	932	1,230
Other Costs	286	312	231	138	142
Total	**3,400**	**3,400**	**5,000**	**2,831**	**3,126**

A06d Flight Safety/Atmospheric Hazards Research

GOALS:

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

In the area of aircraft icing, the program focuses principally on establishing operating rules and procedures for deicing and anti-icing to ensure a clean aircraft at takeoff. It also focuses on developing technology to determine the existence of frozen contamination and the failure of anti-icing fluids on critical aircraft surfaces. The program 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 electromagnetic hazards to aircraft systems program focuses on protecting aircraft electrical and electronic systems from the effects of lightning and high-intensity radiated fields (HIRF). These effects may come from airborne, shipborne, and ground-based emitters, as well as from portable electronic devices (i.e., tape players, laptop computers, cellular phones, etc.).

The Flight-Critical Digital Systems 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.

Agency Outputs: The FAA establishes rules for aircraft operation in icing conditions and the electromagnetic environment. It establishes rules on digital flight controls and avionics systems and on 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 the aircraft and avionics industry. The program also fosters development of promising technologies, such as sensors, to detect frozen contamination and anti-icing fluid failure. The aircraft icing project joins SAE in preparing annual updates to aircraft holdover time guidelines. These provide time estimates of the effectiveness of deicing and anti-icing fluids.

Customer/Stakeholder Involvement: The program directly supports the Aviation Safety Plan by assisting the zero accident goal. It does this through enhancements to aircraft certification, inspection, and maintenance related to atmospheric hazards and advanced digital systems. It also directly supports Challenge 2000 through research and increased awareness 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 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 operating 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.

SAE committees also address aircraft lightning protection (AE4L) and aircraft HIRF protection (AE4R). These two government and industry committees develop advisory circulars, test standards, and related users manuals to improve flight safety. The FAA provides leadership to the SAE G-12 Aircraft Ground Deicing Committee. This committee addresses holdover time guideline updates, standards establishment for deicing and 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. These consisted of technical reports, handbooks, information bulletins, advisory circulars, and rules. Since 1992, the program has updated or issued two advisory circulars, five technical bulletins, and the *Aircraft Icing Handbook*. It also has published more than 30 technical reports or papers, including reports on ice-phobic technologies.

The program has held international conferences on aircraft ground deicing (more than 600 participants from more than 10 countries attended) and on aircraft in-flight icing (more than 400 participants from 20 countries attended). It has also issued holdover time guidelines for deicing and anti-icing fluids.

In the area of digital systems, the program continued to assess modified condition/decision coverage (MCDC) requirements for avionics software testing. The assessment will also include software mutation techniques. Additionally, the program studied applying formal methods to software partitioning to protect avionics software in highly integrated systems. The program also supported the Streamlining Software Aspects of Certification Project.

In the electromagnetic hazards area, the program completed an analysis of a stochastic evaluation of the HIRF testing environment for aircraft. An update to the FAA research and development electromagnetic data base (FRED) containing lightning strike data and waveforms was published. The update included C-160 aircraft data. A report was completed concerning a feasibility study of a PED detector for civil aircraft, and a HIRF Risk Analysis was initiated to support a Notice of Proposed Rulemaking (NPRM).

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

- ARAC, EEHWG international certification authority/industry forum—HIRF environment, User's Guide for AC 20-1317
- SAE -AE4L Lightning Protection of Aircraft, Lightning Environment, Waveforms and Testing Standard, Aircraft Zoning Standard, and User's Manual for AC 20-136
- RTCA Special Committee-182, "A Minimum Operational Performance Standard (MOPS) for an Avionics Computer Resource (ACR)"
- RTCA Special Committee-190, software guidance for issues missed or arising since publication of RTCA DO-178B
- 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
- Multiyear FAA/DOE interagency agreement with Idaho National Engineering Laboratory in characterization of lightning strike data and development of a lightning waveform database
- Multiyear interagency agreement with Naval Air Warfare Center Aircraft Division to assess the HIRF environment for aircraft
- Letter of agreement to leverage HIRF certification research with Sandia Corporation; the Army Directorate for Applied Technology, Test and Simulation; and ORION International Technologies, Inc.
- Cooperative efforts on aircraft icing activities with the NASA Lewis Research Center
- More than six aircraft icing grants and agreements in place with academia and other government agencies to leverage interests and capabilities
- International agreement with Transport Canada on research on aircraft ground deicing issues
- ARAC IPHWG directly supported with data on and analysis of SLD conditions in the atmosphere

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

Aircraft icing

- Evaluated time-effectiveness of recently developed new and environmentally-friendly deicing and anti-icing fluids
- Completed report on glycol-reduction methods
- Completed report on hot water deicing methods and procedures

- Produced final report on effect of large droplet ice accretions on airfoil and wing aerodynamics and control
- Completed report to ARAC IPHWG on SLD data aloft
- Continued collecting SLD data aloft

Flight-critical digital systems

- Published Report on Analysis of Structural Coverage Requirements of RTCA DO-178B
- Published Report on Feasibility of an In-flight Advisor for General and Commercial Aviation
- Electromagnetic Hazards to Aircraft Systems
- Published HIRF User's Guide for AC 20-1317
- Published Lightning User's Manual for AC 20-136
- Published Report on HIRF Risk Analysis for NPRM

KEY FY 2000 PRODUCTS AND MILESTONES:

Aircraft icing

- Evaluate time effectiveness and aerodynamic performance of environmentally friendly and other modern fluid.
- Complete report on fabrication of active Aircraft Mounted Wide Area Ice Detector prototype system
- Complete report on glycol temperature buffer reduction investigation
- Complete report on consolidation of SLD data at flight altitudes

Flight-critical digital systems

- Publish report on certification techniques for COTS hardware and software
- Publish report on certification techniques for advanced hardware
- Publish acceptance criteria for software reuse

Electromagnetic hazards to aircraft systems

- Publish report on single-event effects and upset
- Publish report on analysis of commercial lightning data base
- Publish aircraft lightning zoning and protection techniques

FY 2000 PROGRAM REQUEST:

Aircraft icing

- Continue to collect and assess the global atmospheric icing environment data with emphasis on the SLD environment
- Determine acceptance criteria and enhancements for icing tankers, tunnels, and analytical icing computer codes; and quantitatively characterize ice roughness, shape, and aerodynamic effect

Flight-critical digital systems

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

Electromagnetic hazards to aircraft systems

- Continue lightning protection, HIRF protection, electromagnetic compatibility, single-event effects/upset and continued integrity research

A06d - Flight Safety/Atmospheric Hazards Research Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
064-110 Flight Safety						
Flight Critical Digital Systems						
Published Report on Feasibility of an In-flight Advisor of General and Commercial Aviation	◆					
Published Report on Analysis of Structural Coverage Requirements	◆					
Publish Acceptance Criteria for Software Reuse		◇				
Publish Report on Certification Techniques for COTS Hardware and Software		◇				
Publish Report on Certification Techniques for Advanced Hardware		◇				
Publish Alternate Approaches to Software Modified Condition/Decision Coverage (MCDC)				◇		
Publish Criteria for Avionics Software Changes						◇
064-111 Atmospheric Hazards						
Aircraft Icing						
Finalized Reports on Effect on Large Droplet Ice Accretions on Airfoils and Wing Aerodynamics and Control	◆					
Reported to ARAC IPHWG on Supercooled Large Droplet (SLD) Data Aloft	◆					
Continued Collecting SLD Data Aloft	◆					
Evaluate Time of Effectiveness & Aerodynamic Performance of Environmentally Friendly Modern Fluids	◆	◇				
Report on Fabrication of Active Aircraft Mounted Wide Area Ice Detector Prototype System		◇				
Report on Consolidation of SLD Data at Flight Altitudes		◇				
Report on Glycol Temperature Buffer Reduction Investigation		◇				
Report on Quantitative Characterization of Ice Roughness and Shape and Aerodynamic Effect			◇			
Report on Global Atmospheric Icing Environment					◇	
Publish Fluid Failure & Holdover Times Procedures for Manufacturers					◇	
Electromagnetic Test and Analysis						
Published High Intensity Radiated Fields (HIRF) User's Guide	◆					
Published Lightning User's Manual for AC 20-136	◆					
Published Report on HIRF Risk Analysis for Notice of Proposed Rule Making (NPRM)	◆					
Publish Report on Single Event Effects and Upset		◇				
Publish Report on Analysis of Commercial Lightning Database		◇				
Publish Aircraft Lightning Zoning and Protection Techniques		◇				

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	3,535	1,368	705	1,494	1,942
Personnel Costs	530	577	1,127	973	1,744
Other Costs	108	118	231	152	158
Total	**4,173**	**2,063**	**2,063**	**2,619**	**3,844**

A06e Aging Aircraft

GOALS:

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

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

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

Customer/Stakeholder Involvement: The FAA has established an extensive network for collaboration in the Aging Aircraft program.

- ARAC is an FAA/industry forum established to ensure that agency rulemaking is effective in achieving intended results and that the industry resources are used to their fullest. ARAC also identifies requirements and priorities for supporting R&D activities.
- The FAA-sponsored 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 on maintaining the airworthiness of the aging commercial fleet.
- The Aging Non-structural Systems Research program is the primary vehicle for supporting the recommendations of the White House Commission on Safety and Security, which state that "in cooperation with airlines and manufacturers, the FAA's Aging Aircraft program should be expanded to cover nonstructural systems."

Accomplishments: An on going research effort provides guidance for complying with assessment programs on WFD in both the civil and military aircraft fleets. The research is co-funded by the FAA, NASA, and the U.S. Air Force (USAF) and is conducted by Boeing Company. The integrated

effort includes development of analytical methods by both the FAA and NASA and testing by the FAA and the USAF. This integrated effort continues to validate government-developed analysis codes to predict the onset of WFD.

A small crack detection structured experiment was completed by the FAA's AANC. The experiment demonstrated that commercially available instruments can detect small cracks in aircraft skins under the rivet heads. Prototype instruments developed by Northrop and NASA could detect cracks before reaching the edge of the rivet head. This is significant because these cracks reflect the WFD identified in the Aloha Airlines accident. This information assists the FAA and industry in specifying and approving future inspection equipment.

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

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

R&D Partnerships: Program activities are closely coordinated with related initiatives underway at NASA, DOD, and industry. The FAA and NASA, through a Memorandum of Agreement (MOA), have cosponsored several conferences on aging aircraft and airworthiness assurance. Interagency agreements are in place between the FAA and NASA, U.S. Navy (USN), USAF, National Institute of Standards and Technology (NIST), and DOE. International agreements are in place between the FAA and the regulatory authorities in the United Kingdom, the Netherlands, Australia, and Canada.

A center of excellence for airworthiness assurance, established in FY 1997, brings together the monetary and intellectual resources of its core universities and numerous industrial and governmental partners. The Center for Aviation Systems Reliability (CASR) is a consortium of four universities—Iowa State University, Northwestern University, Wayne State University, and Tuskegee University—formed to develop nondestructive inspection techniques. The AANC is partnering with Sandia National Laboratory to test and evaluate inspection techniques in a realistic hangar environment and enhance technology transfer. The Engine Titanium Consortium (ETC)—Iowa State University, Pratt & Whitney, General Electric, and Allied-Signal—was formed to develop methods for inspecting engine components. Numerous research grants have been awarded through the aviation research grants program, and are in place with universities and not-for-profit laboratories to leverage their interests and capabilities. Cooperative research and development agreements (CRDA's) are in place with two airline operators as part of the flight loads data collection program.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

- Developed Supplemental Inspection Document (SID) for the Fairchild Metro airplane
- Developed a crack-growth-based predictive methodology for static engine parts
- Transferred thermal wave imaging technology for corrosion detection to industry
- Developed and validated ultrasonic and eddy current inspection tools for airframe and engine applications
- Conducted video landing parameter survey at Philadelphia International Airport's commuter runway
- Published flight loads data reports for additional aircraft model (i.e., B-767)
- Established permanent video landing loads data facility

- Established a test bed for validation of technologies designed to ensure the safe operation of aircraft electrical and mechanical systems
- Initiated research into the development of an arc-fault circuit interrupter for aircraft applications
- Initiated research into the development of systems that assess the physical and functional integrity of aircraft wiring

KEY FY 2000 PRODUCTS AND MILESTONES:

- Complete development of an engineering manual with guidelines to predict the onset of WFD and residual strength and structures
- Continue enhancement to user-friendly software tool for damage tolerance analysis and design of aircraft repairs for commuter aircraft
- Develop guidelines for developing supplementary inspection programs for commuters
- 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 widespread fatigue damage
- Continue data collection, analysis, and reduction for large transport flight loads and publication of A-320 data
- Transfer pulse eddy current technology for inter-layer crack detection to industry
- Complete Health and Usage Monitoring Systems (HUMS) advisory material and compliance guidance for Part 29 and Part 27 rotorcraft monitoring post flight
- Conduct a video landing loads survey at Denver International Airport to quantify high altitude landing parameters for civil transport aircraft
- Develop first-generation, prototype arc-fault circuit interrupter for aircraft applications
- Complete assessment of feasibility of service life for aircraft wiring

FY 2000 PROGRAM REQUEST:

In FY 2000, the program will continue to focus on the areas listed at the beginning of the “Goals” section above. Near-term emphasis is on better understanding the effects of widespread fatigue damage, developing supplemental inspection requirements to better account for airframe and component damage, and developing and validating enhanced inspection techniques.

A06e - Aging Aircraft Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
065-110 Aging Aircraft						
WFD and Residual Strength Analysis						
Completed Development of a Crack-Growth Based Predictive Methodology of Static Engine Parts	◆					
Complete Development of an Engineering Manual with Guidelines for onset of Widespread Fatigue Damage (WFD)		◇				
Continue Development & Validation of Inspections Techniques		◇				
Publish AC on Inspection and Maintenance of Static Engine Parts			◇			
Commuter Aircraft Inspection Requirements						
Developed SID for the Fairchild Metro Airplane	◆					
Develop Guidelines for Development of Supplemental Inspection Programs for Commuters		◇				
Airborne Data Monitoring Systems						
Publish Technical Report and Continue Data Collection Analysis on Flight Loads	◆	◇	◇	◇	◇	◇
Conduct Video Landing Parameter and Loads Survey at Philadelphia, Denver and Other Airports	◆	◇	◇	◇	◇	◇
Established Permanent Video Landing Loads Data Facility	◆					
Maintenance and Inspection						
Transferred Thermal Wave Imaging Technology for Corrosion Detection in Industry	◆					
Developed and Validated Ultrasonic and Eddy Current Inspection Tools	◆					
Continue Enhancement to User-friendly Software Tool for Damage Tolerance Analysis and Design		◇				
Transferred Pulsed Eddy Current Technology for Inter-layer Crack Detection to Industry		◇				
Continue Development and Validation of Enhanced Inspection Systems for Engine Components		◇				
Complete Development of Ultrasonic Inspection Tools for Engines				◇		
Complete AC on Repair and Maintenance of Engine Propellers				◇		
Release Repair Analysis Software Tool for Commuter Aircraft					◇	
Develop Prototype for Detection of WFD-Size Cracks					◇	
Rotorcraft Structural Integrity						
Complete Final HUMS AC and Compliance Guidance for Part 29 and 27 Rotorcraft		◇				
Update AC 29-2A and 27-1 for Fatigue and Damage Tolerance					◇	

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	16,615	10,585	18,466	11,945	12,118
Personnel Costs	2,810	2,742	2,251	2,831	3,547
Other Costs	575	562	523	368	333
Total	**20,000**	**13,889**	**21,540**	**14,694**	**15,998**

A06f Aircraft Catastrophic Failure Prevention Research

GOALS:

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

The Aircraft Catastrophic Failure Prevention program's objective is to ensure safe aircraft operation in the public domain. It focuses principally on using historical accident data to attack known problem areas, such as:

- Turbine engine uncontainment events, including mitigation and modeling of uncontainment and aircraft vulnerability to uncontainment (AC20-128, phase II)
- Examining issues associated with inappropriate crew response to propulsion malfunctions and working with industry to develop solutions to this critical problem
- Examining explosive fuel tank issues

Agency Outputs: The FAA establishes certification criteria for aircraft and publishes advisory circulars to outline acceptable means for meeting these rules. 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 that ensure a balanced, responsive aircraft catastrophic failure prevention program:

- ARAC is an FAA/industry forum established to ensure that agency rulemaking is effective in achieving intended results and that industry resources are fully used to accomplish these results. ARAC also effectively identifies requirements and priorities for supporting R&D activities. The ARAC Powerplant Installation and Harmonization Working Group (PPI-HWG) provides guidance to this program for updating AC 20-128.
- The FAA sponsors an annual workshop on turbine engine uncontainment characterization, modeling, and mitigation. The workshop brings together industry and government (civil and military) to review progress on this matter and to recommend future courses of action.
- The FAA (through Lawrence Livermore National Laboratories) has developed partnerships with Boeing, United Technologies (Pratt & Whitney), and Allied Signal Engines to work collaboratively to develop a modeling toolkit for modeling engine uncontainment events.
- The FAA supports the AIA Transport Committee project on propulsion system malfunction plus inappropriate crew response. This project brings industry and the FAA together to develop recommendations (and associated regulations and advisory material) on the subject of safety concern.
- The ARAC Fuel Tank Harmonization Working Group provides guidance to the program on explosive fuel tank issues.
- The program also responds to Public Law 100-591 (the Aviation Safety Act) and Public Law 101-508 (the Omnibus Reconciliation Act), which specifically established the aircraft catastrophic failure prevention program.

Accomplishments: Certification officials use results of catastrophic failure prevention program research provide the technical basis for rule changes as well as new or modified advisory circulars. Results are also provided to airframe and engine manufacturers and designers. Recent accomplishments:

- Completed uncontained engine failure fuselage damage data base and published reports on large engine uncontainment and small engine uncontainment data bases. These data bases are useful for scientific uncontained engine debris evaluation that will result in significant revision to AC 20-128. Accident investigations indicate debris damage spread angles are larger than current AC materials indicate.
- Developed a baseline aircraft vulnerability model to predict aircraft vulnerability to engine uncontainment events
- Completed beta testing of the aircraft vulnerability model

- Completed a detailed report examining DOD armor technology and its potential application to turbine engine uncontainment mitigation
- Started developing an advanced material DYNA-3D model
- Started developing training materials for propulsion malfunction plus inappropriate crew response
- Started work on determining effects of copper-silver sulfide corrosion on fuel quantity indicator system components

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

The following agreements, leveraged on existing facilities and expertise, provide significant program benefits:

- Interagency agreement with the 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, Allied Signal 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; in-kind support provided by Boeing and B. F. Goodrich.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

Engine uncontainment research

- Developed an aircraft vulnerability model improvement plan and started model improvements

Propulsion malfunction plus inappropriate crew response

- Developed a plan for producing crew training materials for propulsion-related malfunctions

Explosive fuel tank issues.

- Issued an interim report on problem of copper-silver sulfide contamination on fuel-quantity indicating systems

KEY FY 2000 PRODUCTS AND MILESTONES

Engine uncontainment research

- Begin modifications to vulnerability code based on airframe manufacturers' evaluations
- Complete DYNA-3D model of advanced barrier materials

Propulsion malfunction plus inappropriate crew response

- Develop crew training materials
- Initiate research on crew response to propulsion malfunctions

Explosive fuel tank issues

- Continue research into explosive fuel tank issues

FY 2000 PROGRAM REQUEST:

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

The program also develops crew training materials to better equip crews to deal with a variety of propulsion malfunctions, reducing the chance for inappropriate response. It examines ways to improve the fidelity of simulator training by more realistically reproducing instrument and sensory cues to propulsion malfunctions.

Lastly, it 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.

A06f - Aircraft Catastrophic Failure Prevention Research Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
066-110 Aircraft Catastrophic Failure Prevention Research						
Engine Uncontainment Research						
Developed an Aircraft Vulnerability Model Improvement Plan and Started Model Improvements	◆					
Begin Modifications to Vulnerability Code Based on Airframe Manufacturers' Evaluations		◇				
Complete DYNA-3D Model of Advanced Barrier Materials		◇				
Complete Vulnerability Model			◇			
Complete Advanced Analytical Uncontainment Mitigation Tool Kit			◇			
Explosive Fuel Tank Issues						
Issued Interim Report on Problem of Copper-silver Sulfide Contamination on Fuel Quantity Indicating Systems	◆					
Continue Research into Explosive Fuel Tank Issues		◇				
Propulsion Malfunction Plus Inappropriate Crew Response						
Developed a Plan for Producing Crew Training Materials for **Propulsion Related Malfunctions**	◆					
Develop Crew Training Materials for Propulsion Related Malfunction		◇				
Initiate Research on Crew Response to Propulsion Malfunction		◇				
Develop Recommendations for Training & Operation of Existing Systems					◇	
Develop AC Material & Recommendation for Future Design Certification					◇	

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	2,298	2,650	3,289	1,329	1,308
Personnel Costs	338	369	590	397	607
Other Costs	69	75	121	61	66
Total	**2,705**	**3,094**	**4,000**	**1,787**	**1,981**

A06g Aviation Safety Risk Analysis

GOALS:

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

- Developing and/or enhancing safety critical performance measures embedded in FAA analytical systems (e.g., flight standards service Safety Performance Analysis System (SPAS)) and the aircraft certification service safety management program products/risk-based analytical tools. These measures encompass particulars about aircraft design, aircraft maintenance, discrepancy reports, air carriers, air agencies, and air personnel.
- Developing advanced analytical/decision support capabilities and graphical techniques. These allow the FAA to more effectively and efficiently use information contained in various FAA and industry data bases.
- Establishing a forum with industry to exchange aviation safety performance measures and risk models and methodologies.
- Establishing a systems engineering, analysis, and system safety risk assessment effort to support certification, surveillance, and certificate management.
- Developing a safety analysis methodology that will be used in certifying new products and in analyzing continued airworthiness issues, as well as the operational safety of the fleet as experience with the certificated product evolves.
- Developing a risk-based tool to manage aircraft certification workload and prioritize oversight activities related to manufacturers.
- Developing an Internet-based information system for aviation safety related data emphasizing general aviation.
- Developing and/or enhancing the Maintenance Malfunction Information Reporting (MMIR) System with capabilities to track critical helicopter parts, capture part utilization/performance data, and perform trend analysis on the captured data.
- Developing guidelines on evaluation of U.S. military surplus flight safety-critical aircraft parts for installation on FAA U.S. type-certified products.
- Developing a methodology and software-based tool for performing large-scale software system reliability prediction and testing cost measures.
- Developing a Service Difficulty Analysis Tool geared toward analyzing a large number of aircraft of the same type and designing the capability to review trends in SDR submission.

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. Research program outputs improve the data, data gathering techniques, and decision support tools related to FAA certification, surveillance, and certificate management processes. The outputs enable systematic potential risk assessment and take proactive steps to reduce the rate of aviation-related accidents and incidents. The FAA increases its leverage of aviation safety inspector and certification engineering resources by targeting these resources based on risk.

Customer/Stakeholder Involvement: The Federal Aviation Authorization Act of 1996 states that the Administrator should give "high priority to developing SPAS." The legislation calls for deployment of SPAS II, initiated in FY 1997, to be completed by December 1999. The ASRA program enhances SPAS decision-support capabilities by providing 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). ATOS is a system-based approach to FAA certification, surveillance, and certificate management oversight. It is designed to provide the FAA with the people, proce-

dures, equipment, facilities, software, tools, and materials necessary to make surveillance more systematic and targeted to deal with identified risks. In support of this effort, the ASRA program will provide systems engineering, analysis (identification of performance measures through information presentation) and system safety risk assessment research.

The ASRA program responds directly to the Safer Skies Agenda and 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 is the general/flying public.

DOD will use several analytical tools, such as SPAS, to oversee defense contract carriers and charters.

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

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

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

R&D Partnerships: The U.S. Air Force/Air Mobility Command provides technical support and assistance in developing safety critical performance measures. The Flight Safety Foundation works with both the FAA and industry to analyze worldwide accidents and serious incidents and to establish and prioritize causal factors. An interagency agreement was established with DOE that enables Sandia National Laboratories to provide technical expertise in system development, system safety, and data quality strategy/data quality improvements implementation. The FAA has arranged with the National Academy of Sciences to develop a generally applicable, structured, safety management program for aircraft certification services. Finally, several university grants have been awarded to support development and testing of aviation safety risk models. The aviation safety digital library prototype, to be released in FY 1999, was developed in cooperation with general aviation groups, such as the EAA, AOPA, and GAMA, under a phase II small business innovative research (SBIR) contract.

MAJOR ACTIVITIES AND ANTICIPATED FY 1999 ACCOMPLISHMENTS:

Risk analysis decision support

- Implemented new and enhanced risk analysis models and capabilities
- Developed and implemented safety-critical performance measures into flight standards SPAS II and aircraft certification aviation safety management program initiatives
- Initiated design of flight standards next-generation, safety-critical performance measures and work processes based on a system safety model
- Initiated workshops with industry to discuss aviation safety risk analysis and performance measures
- Initiated development of risk/hazard/accident models and tools
- Continued development of the Intelligent Safety Performance and Evaluation System

Aircraft maintenance: maintainability and reliability

- Released the aviation safety digital library prototype

- Released a report on detailed trend analysis of fatigue and corrosion in 13 transport aircraft models
- Revamped the MMIR system to be Internet based
- Released a report on the methodology for accurately predicting reliability of large-scale software system

Safety analysis methodology

- Initiated data/data analysis improvements to the Aircraft Certification Systems Evaluation program (ACSEP)
- Initiated development of probabilistics safety assessment for aircraft safety

KEY FY 2000 PRODUCTS AND MILESTONES:

Risk analysis decision support

- Continue to develop, test, and validate new and enhanced risk analysis models and capabilities
- Continue to develop safety-critical performance measures
- Continue to develop the safety management program
- Release a report on the work processes to support a system safety model
- Initiate development of statistical analysis methods based on a system safety model
- Continue workshops with industry to discuss aviation safety risk models/methods
- Continue the development of the Intelligent Safety Performance and Evaluation System
- Continue the development of Risk/Hazard/Accident models and tools

Aircraft maintenance–maintainability and reliability

- Initiate analysis in support of Advisory Circular entitled *Eligibility and Evaluation of U.S. Military Surplus Flight Safety Critical Aircraft Parts, Engines, and Propellers.*

Safety analysis methodology

- Continue the development of probabilistic safety assessment efforts that address aircraft safety
- Continue data study supporting ACSEP evaluation frequencies for group II and IV facilities

FY 2000 PROGRAM REQUEST:

In FY 2000, research will continue to focus on the areas listed at the beginning of the "Goals" section above. Data assimilation and analysis that support the ASRA initiatives will continue. Analysts work with government, industry, and academia aviation safety subject matter experts to ensure that safety critical performance measures are properly defined, developed, tested, and evaluated before they are incorporated into decision support systems. The Aviation System Risk Analysis program investigates, tests, and recommends improvements, including standardization, to the quality (and quantity) of data used in the performance measures. It completes studies to identify and verify flight standards and aircraft certification safety information requirements.

A06g - Aviation Safety Risk Analysis Product and Activities	Program Schedule					
	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY2004
060-110 Aviation Safety Risk Analysis						
Risk Analysis/Decision Support (RADS)						
Develop Risk-based Forecasting Methods	◆	◇	◇	◇	◇	
Develop Safety Critical Performance Indicators (i.e. Operator, Air Agency, Aircraft, Air Personnel)	◆	◇	◇	◇	◇	◇
Conduct Workshops to Exchange Aviation Safety Risk Models/Methods with Industry	◆	◇	◇	◇	◇	◇
Continue Development of Intelligent Safety Performance & Evaluation System	◆	◇	◇	◇	◇	
Develop Risk/Hazard/Accident Models and Tools	◆	◇	◇	◇	◇	◇
Develop and Report on Next Generation Work Process Models in Support of ATOS	◆	◇				
Develop Statistical Analysis Methods in Support of Air Transportation Oversight System (ATOS)		◇	◇	◇	◇	◇
Develop User Defined Performance Measures				◇	◇	
Aircraft Maintenance: Maintainability & Reliability						
Released Web-based Digital Library Prototype with Emphasis on General Aviation (GA)	◆					
Released Report on Detailed Trend Analysis of Fatigue and Corrosion in 13 Transport Aircraft Models	◆					
Release Report on Methodology for Accurately Predicting Reliability of Large-scale Software System	◆		◇			
Revamp the Maintenance Malfunction Information Reporting (MMIR)	◆		◇		◇	
Conduct Analysis in Support of Advisory Circular: Eligibility & Evaluation of US Military Surplus Flight Safety Critical Aircraft Parts, Engines, & Propellers		◇	◇			
Release Version 1.0 of (SDR) Analysis Tool				◇		
Aircraft Continued Airworthiness Assessment						
Improve and Conduct Detailed Study of ACSEP Evaluation Frequencies for Groups II and IV	◆	◇	◇			
Continue Airworthiness Assessment of Various Aircraft Classes for each of Accident/Hazardous Incident Major Causes		◇	◇	◇	◇	◇

Budget Authority ($ in Thousands)	FY 1996 Enacted	FY 1997 Enacted	FY 1998 Enacted	FY 1999 Enacted	FY 2000 Request
Contracts	0	3,619	5,289	5,555	5,286
Personnel Costs	0	316	1,039	794	1,393
Other Costs	0	65	213	122	145
Total	**0**	**4,000**	**6,541**	**6,471**	**6,824**